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Economic growth and real volatility

The case of Latin America and the Caribbean

Rodrigo Cárcamo-Díaz
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This document has been prepared by Rodrigo Cárcamo-Díaz and Ramón Pineda-Salazar, Economic Development Division of the Economic Commission for Latin America and the Caribbean (ECLAC), within the activities of the Corean project (ROK/14/003).

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Abstract

Using a new database of quarterly data for 21 countries of Latin America and the Caribbean for the 1990-2012 period, we find that the duration of GDP contractions: i) appears to be a rather robust indicator of real volatility, and ii) is negatively correlated with long run growth in Latin America and the Caribbean during the period. Our results are consistent with different theoretical hypotheses in the literature that relate the duration of GDP contractions (i.e. recessions) with economic growth. We also show that the relationship between real volatility and economic growth in the region is robust to the inclusion of external variables that control for external uncertainty and volatility.

I. Introduction

The countries of Latin America and the Caribbean have had a modest performance in terms of economic growth, which in the past 30 years can be characterized as unstable and uneven (ECLAC, 2013). Because of these low levels of growth, the region has not only been unable to converge towards the income levels of the world's developed economies, but has even lost ground in this area. This has been identified as one of the main problems of development in the region (Restuccia, 2012).

Latin America and the Caribbean has also been characterized as a region with a level of macroeconomic volatility much higher than that registered by developed economies (Hausmann and Gavin, 2011; Céspedes and Poblete, 2011), something that has resulted in the loss of welfare to its citizens. The volatility registered by the economies in the region has been related to factors of external origin (Titelman, Minzer and Pérez, 2008) as well as internal, such as fiscal, monetary and exchange rate policies; the emergence of financial crises (Cerra and Saxena, 2008 and Jarrow, 2013) and institutional deficiencies related to historical factors (Acemoglu et al, 2003).

In recent years, policy-makers in the region have used various tools, including the active use of monetary and exchange rate policies to try to reduce macroeconomic volatility (Pineda-Salazar and Cárcamo-Díaz, 2013). Such efforts are motivated primarily by the consensus existing among policy-makers regarding the direct impact of volatility on welfare, via reductions in gross domestic product (GDP) per capita and the level of employment, increased poverty and a more regressive income distribution.

In addition to the close connection between real volatility and social welfare in the short term, there exists a negative relationship between macroeconomic volatility and economic growth. Beginning with the work of Ramey and Ramey (1995), different studies have found evidence of a statistically robust, negative correlation between real volatility and growth in different groups of countries. Subsequently, a series of theoretical studies have sought to develop theoretical models that explain this relationship (Martin and Rogers, 1997, Aghion, Angeletos, Banerjee and Manova, 2010; Fatas, 2002; Barlevy, 2007). These studies invariably assume that there is a negative causal relationship from volatility to growth.

A first hypothesis, proposed by Martin and Rogers (1997 and 2000), argues that volatility reduces the accumulation of human capital. These authors present a model where human capital is accumulated through a process of learning-by-doing, so that the implementation of macroeconomic policies that are

capable of maintaining employment levels against negative shocks increase growth by protecting such accumulation of human capital. Conversely, to the extent that economic activity is depressed for prolonged periods (recession), the rate at which human capital already installed becomes obsolete increases, reducing growth. Martin and Rogers (2000) empirically tested the relationship between volatility (measured by the standard deviation of the growth rate) and growth using annual data of different European regions, developed and developing countries. They found a statistically significant negative relationship between both variables for both European regions and developed countries, but not for developing countries. The authors argue that in the case of developing countries, this result could be due to growth not being determined by a learning-by-doing process.

A second hypothesis posits that the composition of investment changes during a recession, as during the latter there are disincentives to carry out investments that generate higher returns in the long term, but whose rate of maturity is slower. In Latin America and the Caribbean such investments would be those that result in the incorporation of new production techniques (for example, when new machinery and processes are introduced, bringing with them changes associated with training, procedures, and other factors), while in developed countries this is also related to investments in research and development (R & D).

Aghion et al (2010) argue that while in the presence of perfect credit markets there are incentives to make such investments during a recession (due to the lower opportunity cost relative to other investments, such as the expansion of installed capacity), in the presence of credit constraints and liquidity shocks it is feasible that such investments are pro-cyclical. Thus, in a model of endogenous growth, the authors argue that GDP volatility can reduce economic growth in the presence of credit constraints. In another interesting study, Barlevy (2007) argues that investments in new technologies and processes or in R & D generate revenue for innovative companies that are only (partially or totally) temporary. This occurs because such investments can be replicated and/or improved upon, so that a company may have fewer incentives to undertake such activities during a weak or recessive phase of the economic cycle. Companies considering such temporarily profitable investments know that the probability that their innovations are copied or improved upon increases with the passage of time, so that the further in the future the recovery of demand is, the less attractive[1] such investments will be. Thus, assuming that the expectations of the agents are *ex ante* positively correlated with the duration of the low phases of the economic cycle, the more persistent recessive stages of an economic cycle are, the lower the investment in increased productivity and growth will be.

In summary, in both models one might expect *a priori* that the duration of recessive periods[2] would be especially harmful for economic growth. In view of these postulates and of the *de facto* countercyclical behavior of the region's Central Banks, in this paper we test the hypothesis of whether in Latin America and the Caribbean real volatility is significantly correlated with the poor performance observed in terms of economic growth.

First, in this study we use different measures of macroeconomic volatility to test the empirical relationship between volatility and growth. In particular, in addition to using statistical measures of volatility already used by Ramey and Ramey (1995), Martin and Rogers (2000) and most other studies in the area (for example, the standard deviation, the coefficient of variation of the time series of real GDP growth and of the latter's cyclical component), other measures of real volatility were also used. These measures define real volatility on the basis of the contractions recorded by GDP, and in particular, by the frequency of the contractions, the duration of the contraction episodes and the GDP losses accumulated during such periods. These measures of volatility were previously used by Diebold and Rudebusch (1992) and Young and Du (2009) to study business cycles in the United States and in the studies that analyze the effects of financial crises on economic growth (Cerra and Saxena, 2007 and 2008; Prasad, Roggoff and Wei, 2004; European Commission, 2009; Furceri and Mourougane, 2012) as well as the impact of crisis in general on economic growth (Howard, Martin and Wilson, 2011; Haltmaier, 2012).

[1] The short-term profitability of an investment is, ceteris paribus, positively correlated with the stage of the economic cycle.
[2] Defined as episodes when GDP falls in at least two consecutive quarters.

Our study has found that statistical measures of traditional volatility are not correlated with economic growth in Latin America and the Caribbean, as already posited by Martin and Rogers (2000) for the case of developing countries in general. However, we found empirical evidence of the existence of a negative correlation between volatility and growth using measures of real volatility coming from the economic and financial crisis literature. The results obtained in this paper, namely that the duration of recessions is significantly (and robustly) correlated with economic growth in Latin America and the Caribbean between 1990 and 2012, adds empirical support to the theoretical explanations provided by specialized studies of the ways in which volatility may adversely affect the growth (Aghion et al, 2010; Barlevy, 2007).

In the second place, given that there exists a broad consensus regarding the vulnerability of the region to external shocks such as the reversal of capital flows or a negative shock to the terms of trade (Hausmann and Gavin, 2011; Céspedes and Poblete, 2011; Loayza, Ranciere, Servén and Ventura, 2007), the question arises about to what degree the volatility actually observed in Latin America and the Caribbean could be explained only by these exogenous shocks. By taking into account variables that control for these shocks and using the indicators of real volatility proposed above, the present study concludes that the correlation between volatility and growth is robust, to the inclusion of variables that control for external shocks. This opens the door to future studies on what are the internal sources the observed high volatility, and how could those be reduced using macroeconomic policy (namely fiscal, monetary and exchange rate policies).

This paper is organized into four sections, including this introduction. Section B contains a description of the methodologies and data sources used to construct the database we employed. Additionally, this section presents some stylized facts of economic growth and real volatility for 21 countries in Latin America and the Caribbean. Section C describes the evidence that points out to the existence of a statistically significant correlation between volatility and economic growth in the region. It is noted that the definition of volatility used is not innocuous when testing empirically the existence of a relationship between real volatility and economic growth. It is also pointed out that a definition of real macroeconomic volatility based on the characteristics of GDP contraction episodes seems to be the most appropriate for our purposes. This, due to the support provided to the latter coming from existing theoretical arguments and from the empirical results found in this study, where a statistically significant negative correlation between both variables was observed. Section 4, by way of conclusions, contains a discussion of the results obtained by the paper.

II. Economic growth and real volatility in the region (1990-2012): data and stylized facts

A. Description of the data used

To search for evidence of correlation between real volatility and economic growth in Latin America and the Caribbean, we used a database of 21 countries in the region, with data of quarterly frequency, starting in the first quarter of 1990 and ending in the fourth quarter of 2012. Overall, this database was "built" using information from official national accounts sources in each country, splicing when necessary different data series with different base years. In most cases, data interpolation methodology was used to complete some[3] missing observations and to extend the sample period. In all cases in which an interpolation method was used, the method used was that of Fernández (1981) and the information was processed using the "Ecotrim Package" software, developed by Eurostat. The quarterly series obtained were corrected by seasonal factors using the X.12 method developed by the Office Census, Department of Commerce of the United States, in order to perform the comparative analysis. In table 1 we synthesize the information about the sources of the data and the statistical methods used to complete the series (if any). In addition, we indicate the date of the first quarter that is obtained directly from official national account sources.

B. Stylized facts of economic growth in the region

1. Low relative growth *vis à vis* developed economies

Around the world, Latin America and the Caribbean is one of the regions with the lowest economic growth in the last 30 years. This has resulted in an increase in the income gap, as measured by GDP per capita of the population in the region *vis à vis* the level registered in developed economies. Table 2 shows that while the relative income of the region *vis à vis* the United States grew by 12.7% from 1990 to 2010, in the same period the relative income of countries of the Organization for Cooperation and

[3] For the Bahamas, quarterly data were obtained from annual GDP data to which the Fernandez (1981) related quarterly series methodology was applied.

Development (OCDE) increased by 19.6%. This, despite the fact that most of these economies in 2008-2009 were at the epicenter of the greatest international financial crisis registered since the Great Depression of the 1930s, with after-effects and fiscal problems in countries like Greece, Ireland, Italy, Portugal and Spain.

TABLE 1
LATIN AMERICA AND THE CARIBBEAN:
QUARTERLY GDP DATA, 1990-2012

Country	Data source	Interpolation with related series	Fist official observation
Argentina	Statistical office		Trim 1-1990
Bahamas	Statistical office	x	
Belice	Statistical office	x	Trim 1-1994
Bolivia (Plurinational State of)	Statistical office		Trim 1-1990
Brazil	Statistical office	x	Trim 1-1996
Chile	Central Bank		Trim 1-1990
Colombia	Statistical office	x	Trim 1-1994
Costa Rica	Central Bank	x	Trim 1-1991
Dominican Republic	Central Bank		Trim 1-1990
Ecuador	Central Bank		Trim 1-1990
Guatemala	Central Bank	x	Trim 1-2001
Jamaica	Statistical office	x	Trim 1-2003
Mexico	Central Bank		Trim 1-1990
Nicaragua	Central Bank	x	Trim 1-1994
Panama	Statistical office	x	Trim 1-1996
Peru	Central Bank		Trim 1-1990
Paraguay	Central Bank	x	Trim 1-1994
El Salvador	Central Bank		Trim 1-1990
Trinidad and Tobago	Central Bank	x	Trim 1-2000[a]
Uruguay	Central Bank		Trim 1-1990
Venezuela (Bolivarian Republic of)	Central Bank	x	Trim 1-1993

Source: On the basis of official sources.

[a] Change rate.

TABLE 2
RELATIVE PER CAPITA GDP RESPECT TO THE UNITED STATES
(Regional average)

	1990	2010	% Change
South Asian and Pacific	0.245	0.336	37.0
Central Europe and Asia	0.262	0.251	-4.3
Middle East and North Africa	0.208	0.458	120.3
South Asia	0.061	0.093	53.4
Sub-Saharan Africa	0.057	0.061	7.8
OCDE[a]	0.662	0.791	19.6
Latin America and the Caribbean	0.225	0.254	12.7

Source: Own estimations, on the basis of Penn World Tables (PWT 8,0).

[a:]This group includes the following countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Holland, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, New Zealand, Norway, Portugal, Republic of Korea, Spain, Sweden, Switzerland, the United Kingdom and the United States of America.

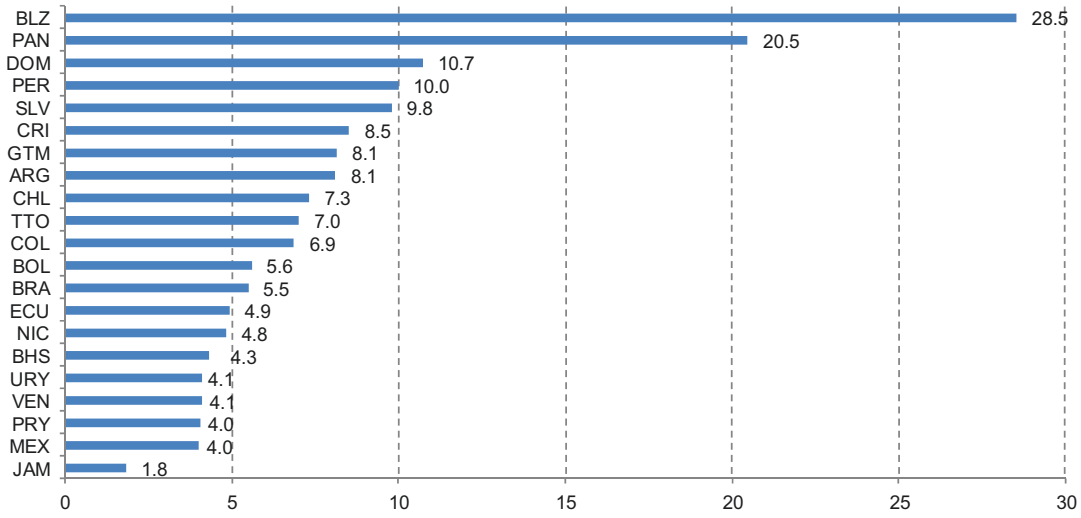
It can also be noted that the relatively low growth of Latin America and the Caribbean has resulted in an accumulated growth gap even with respect to other economies that in the early 1990s

registered a level of per capita GDP similar to or lower than that of the region[4]. For example, the economies of the Middle East and North Africa, which in 1990 had a GDP per capita equivalent to 20.8% of that in the United States, by 2010 it had reached 45.8% of the GDP per capita of the United States, an increase of 120.3%. Compared to the region, the per capita GDP of this group of economies grew from 92% of the level of Latin America and the Caribbean in 1990 to 180% of the latter region's level in 2010.

2. Growth heterogeneity within the region

Behind the low growth experienced by the region as a whole, one can also find strong heterogeneity among countries in terms of the dynamism of economic growth in each one of them. On the one hand, while countries like Belize and Panama recorded a cumulative growth of over 20% from the first quarter of 1990 to the fourth quarter of 2012, on the other hand, countries like Jamaica have only grown by 1.8% in the same period (see figure 1).

FIGURE 1
LATIN AMERICA AND THE CARIBBEAN: CUMULATIVE GDP GROWTH, FIRST QUARTER 1990 – FOURTH QUARTER 2012
(Percentage)



Source: Own estimations, on the basis of official sources.

[4] For more on this see Pineda-Salazar and Cárcamo-Díaz (2013).

C. Measuring real volatility in the region

1. Indicators of real[5] volatility

In the economic literature, a variety of indicators are used to measure the volatility of GDP. In general, these indicators can be classified into two groups:

- Statistical measures of dispersion of the time series studied, such as the coefficient of variation (CV) or standard deviation (SD) of the growth rate of the GDP. These measures are the ones most commonly used in studies linking volatility with economic growth (for example, Ramey and Ramey, 1995; Martin and Rogers, 1997 and 2000; Aghion et al., 2010).
- The second group of indicators has its origin in viewing crises (or abrupt contractions of gross domestic product) as an extreme form of "real volatility," as pointed out by Prasad, Roggoff and Wei (2004), or as indicators of the "instability of growth" (Pritchett, 2000). We can highlight three of these indicators: i) the number of episodes of crisis or "Break points"; ii) the duration of such episodes, and iii) quantifying the GDP loss observed during such episodes. The use of this second group of indicators has increased over time, especially as a result of the research efforts looking at links between crises (financial sector and balance-of-payments ones) and the behavior of long-term economic activity (Cerra and Saxena, 2007 and 2008). Of special interest are those studies analyzing the impact of financial crises on economic growth (European Commission, 2009; Furceri and Mourougane, 2012) and also those looking at the impact of economic crises in general on growth (Howard, Martin and Wilson, 2011; Haltmaier, 2012).

Although the mentioned volatility indicators are generally closely related, there exist differences among them. In section C we show that the selection of an indicator of volatility is not neutral for the analysis of a possible connection between real volatility and economic growth in Latin America and the Caribbean.

2. Stylized facts of volatility in Latin America and the Caribbean

Real volatility has decreased from 1990 to 2012

Table 3 presents the comparison between the indicators of real volatility described above for the region[6]. We observe a comparison between the first period considered in this paper (12 quarters, from the first quarter of 1990 to the fourth quarter of 1992) with the last period considered (the 8 quarters starting with the first quarter of 2011 to the fourth quarter of 2012). The first block of indicators presented in Table 4 contains the series that reflects the volatility of the cyclical component of GDP, obtained applying the Hodrick-Prescott filter to the GDP series, and then calculating different measures of the variability (standard deviation or coefficient of variation) of the obtained cyclical component. In the second block of indicators of Table 4, volatility is calculated from the variability of the quarterly growth rate of the seasonally-adjusted GDP series. In the third block of the table we find indicators of volatility constructed by analyzing episodes of contraction in economic activity, namely, the number of episodes, their duration and the magnitude of the fall in the GDP series. For all the indicators presented, we observe that the value recorded in the first period (1990-92) is greater than in the latter (2011-2012), indicating that regional real volatility has decreased (see tables 4.A and 4.B).

[5] The region has also in the past been identified as one of the most volatile in the world in terms of nominal volatility, with the latter measured using the rate of inflation. However, the economies of the region have managed to significantly reduce their nominal volatility over time. In general, episodes of high inflation rates recorded in the nineties (in some cases, with three-digit-rates) have later given way to single-digit inflation rates in most countries (Pineda-Salazar and Cárcamo-Díaz, 2013).

[6] In order to carry out this analysis, data was organized in windows of 12 quarters, except for the last window, which only includes 8 quarters. The data in Table 3 correspond to regional averages for Latin America and the Caribbean.

TABLE 3
LATIN AMERICA AND THE CARIBBEAN: REAL VOLATILITY, COEFFICIENT OF VARIATION AND STANDARD DEVIATION OF THE GDP GROWTH RATE AND ITS CYCLICAL COMPONENT, 1990-1992 AND 2011-2012

			1990-1992	2011-2012
Block 1	Cyclical component of GDP	Standard Deviation	2.58	1.16
		Coefficient of Variation	83.2	7.9
Block 2	Growth rate	Standard Deviation	1.95	1.09
		Coefficient of Variation	2.4	1.9
Block 3	Contraction episodes	Cumulative drop (% of GDP)	2.20	1.10
		Duration (in quarters)	1.19	1.05
		Number of episodes	1.19	0.95

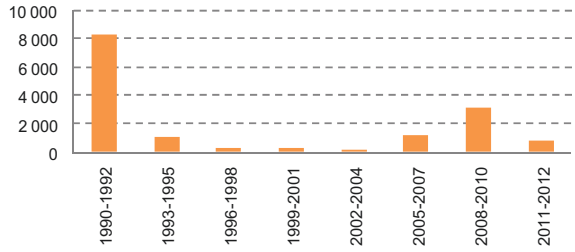
Source: Own estimations, on the basis of official sources.

However, this reduction in regional volatility has not occurred in a monotonic manner, as several volatility indicators register their maximum values around the period between the first quarter of 1999 and the fourth quarter of 2001 (see figures 2A and 2B). Another point to note is the fact that for most of the volatility indicators the recent global financial crisis (the period between the first quarter of 2008 to the fourth quarter of 2010) resulted in an increase in the average real volatility of the region. The variability in the growth rate and the economic cycle was greater than that recorded in previous periods, and the duration of contractions and the total declines experienced by GDP were also higher.

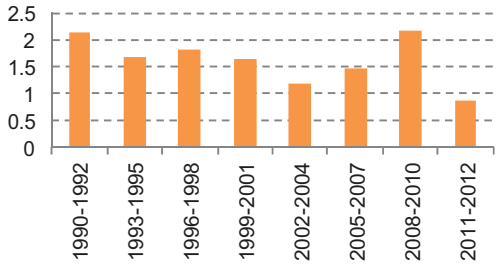
FIGURE 2.A
LATIN AMERICA AND THE CARIBBEAN: REAL VOLATILITY OF THE GDP GROWTH RATE AND ITS CYCLICAL COMPONENT, 1990-2012
(Regional median)

VOLATILITY OF THE CYCLICAL COMPONENT OF THE GDP

A. Coefficient of variation

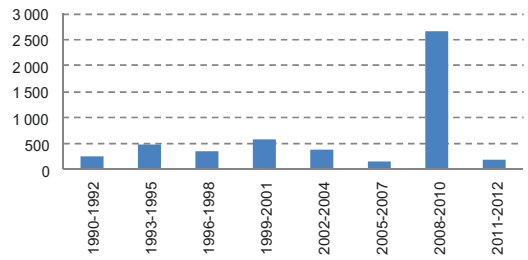


B. Standard deviation

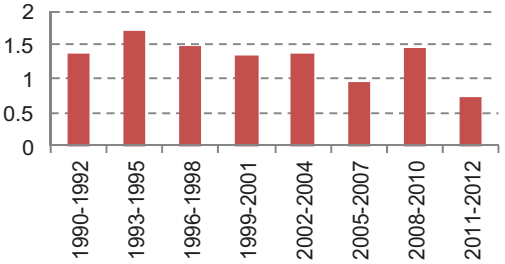


VOLATILITY OF THE GDP GROWTH RATE

C. Coefficient of variation

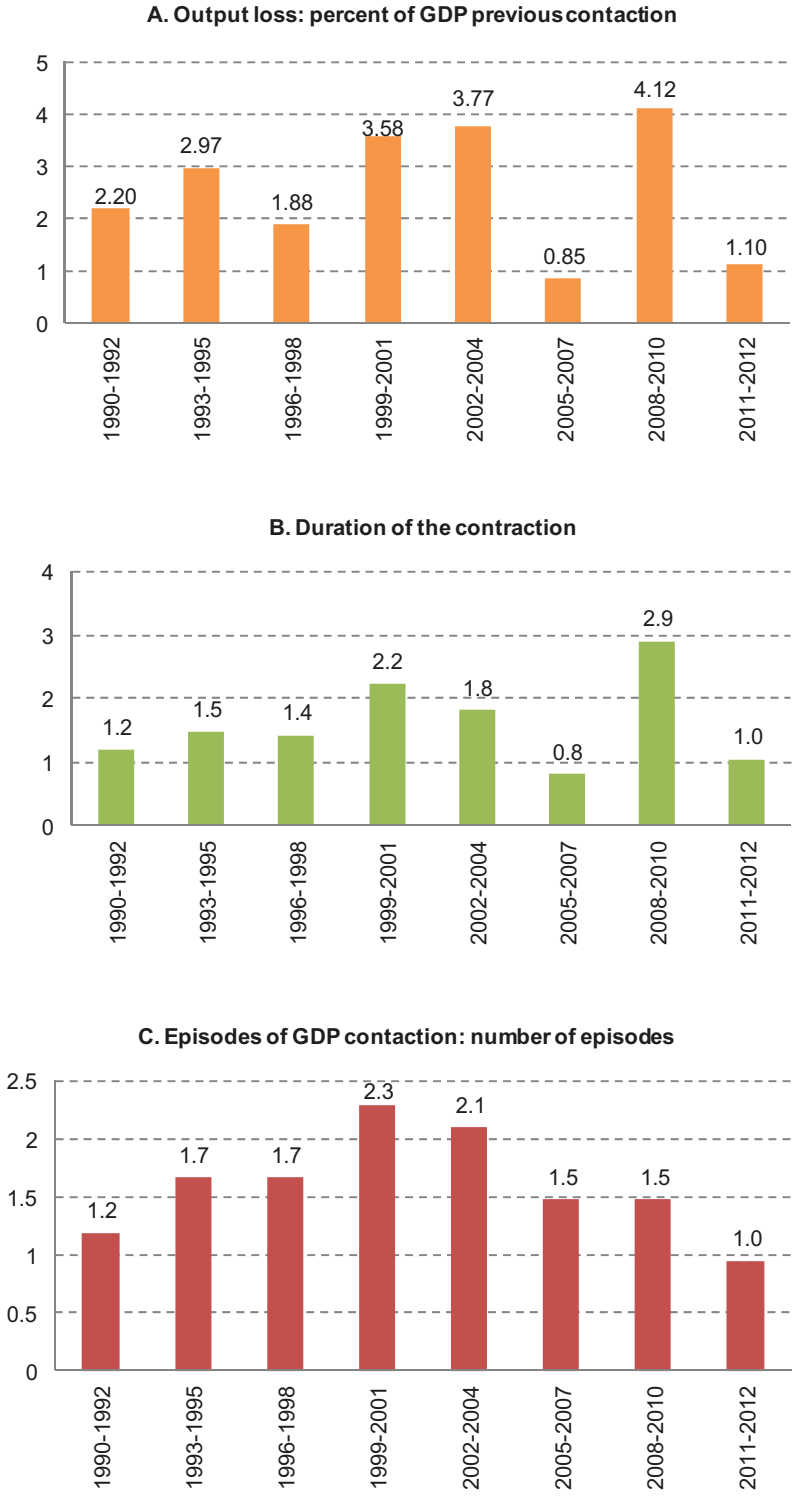


D. Standard deviation



Source: Own estimations, on the basis of official sources.

FIGURE 2.B
LATIN AMERICA AND THE CARIBBEAN: REAL VOLATILITY CHARACTERISTICS OF THE GDP CONTRACTION, 1990-2012
(Regional median)



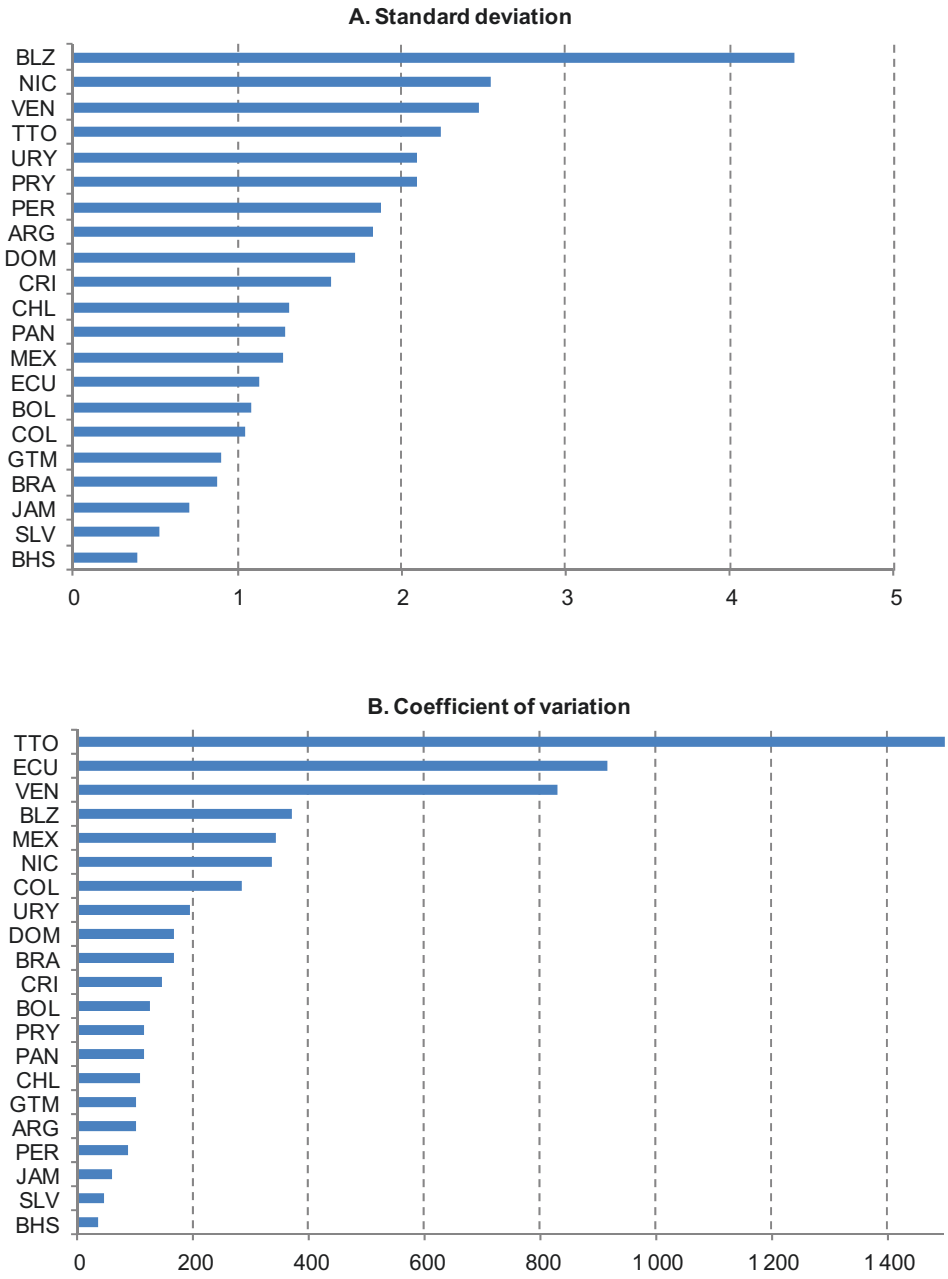
Source: Own estimations, on the basis of official sources.

Real Volatility is Heterogeneous Across Latin America and the Caribbean

A second fact to highlight is that the real volatility in Latin America and the Caribbean is not homogeneous among different countries. Figures 3A, 3B and 3C present evidence showing the high dispersion in the average values recorded by the different volatility indicators considered for each country.

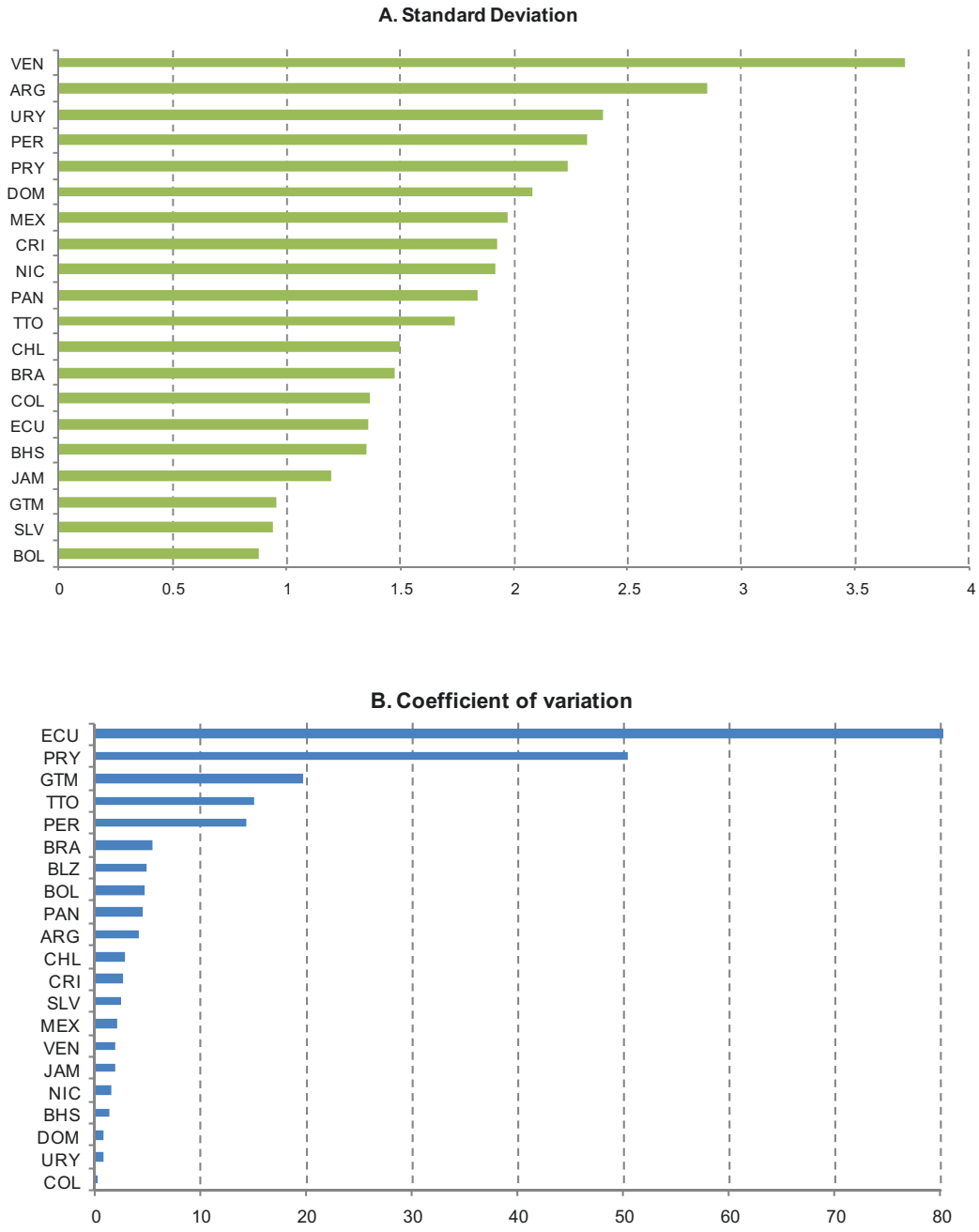
For example, note that while repeatedly both Belize and Venezuela (Bolivarian Republic of) lie among the group of the five countries with the highest real volatility, on the other extreme the Bahamas and El Salvador are repeatedly among the five countries with the lowest volatility.

FIGURE 3.A
REAL VOLATILITY OF THE GDP GROWTH RATE, 1990-2012



Source: Own estimations, on the basis of official sources.

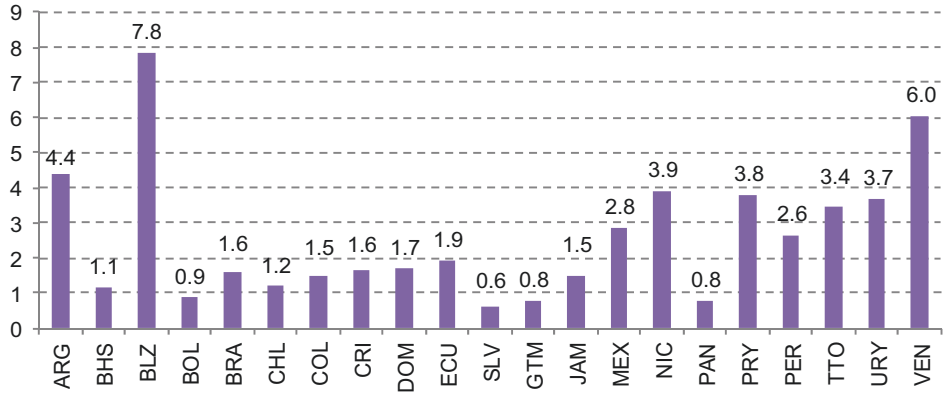
FIGURE 3.B
REAL VOLATILITY OF THE CYCLICAL COMPONENT OF GDP, 1990-2012



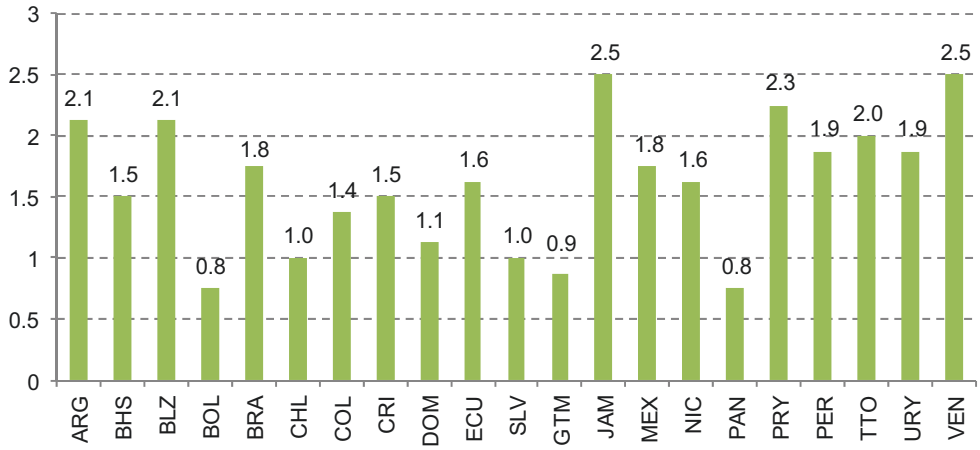
Source: Own estimations, on the basis of official sources.

FIGURE 3.C
LATIN AMERICA AND THE CARIBBEAN: REAL VOLATILITY CHARACTERISTICS OF THE GDP CONTRACTION, 1990 – 2012

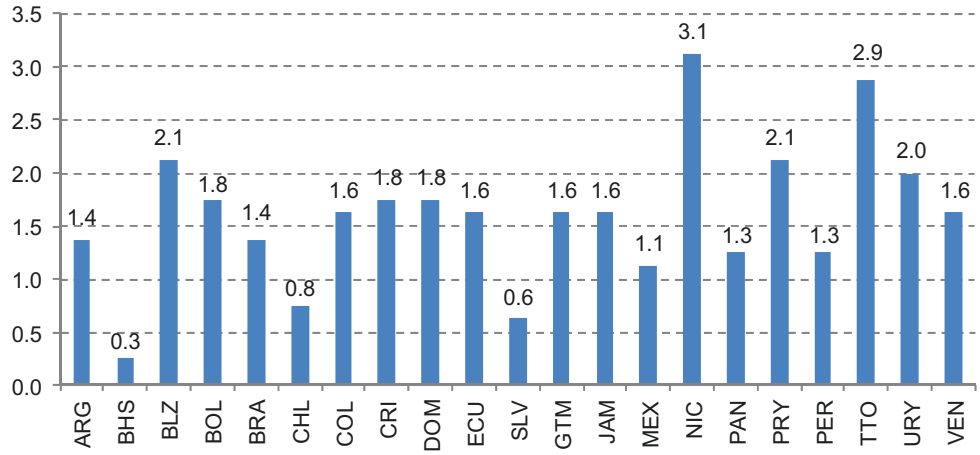
A. Output loss: percent of GDP previous contraction



B. Duration of the contraction episodes: quarters



C. Episodes of GDP contaction: number of episodes



Source: Own estimations, on the basis of official sources.

Although the average real volatility of Latin America and the Caribbean decreased during the period under study, in some countries in the region real volatility has tended to increase. As shown by pictures 4.A and 4.B, most indicators of real volatility recorded an increase between 1990 and 2012 in Paraguay (all indicators) and in Trinidad and Tobago (in six of the seven indicators).

TABLE 4.A
LATIN AMERICA AND THE CARIBBEAN: REAL VOLATILITY, COEFFICIENT OF VARIATION AND STANDARD DEVIATION OF THE GDP GROWTH RATE AND ITS CYCLICAL COMPONENT, 1990-1992 AND 2011-2012

	Coe. Of Var.- Growth Rate		Std. Dev. - Growth Rate		Coe. Of Var.- Cyclical Com.		Std. Dev. - Cyclical Com.	
	1990-1992	2011-2012	1990-1992	2011-2012	1990-1992	2011-2012	1990-1992	2011-2012
ARG	1.3	1.5	2.5	1.7	3.4	7.4	2.2	2.4
BHS	0.5	2.7	0.4	0.2	5.2	3.5	2.7	0.8
BLZ	2.3	8.3	8.8	3.2	1.9	13.5	11.9	2.5
BOL	1.8	0.7	1.4	0.7	25.6	32.3	1.2	0.5
BRA	2.8	0.9	0.5	0.3	4.6	6.0	2.1	1.4
CHL	1.3	0.5	2.7	0.7	16.7	1.3	2.4	0.7
COL	3.0	0.6	1.5	0.7	3.5	1.8	2.4	0.6
CRI	1.0	0.9	2.1	1.0	2.7	26.5	1.9	1.1
DOM	3.8	1.2	1.9	1.2	12.4	1.6	3.1	0.9
ECU	1.0	0.4	1.1	0.7	1 543.8	0.6	1.0	0.5
SLV	0.7	1.3	0.9	0.7	2.0	23.8	1.3	0.7
GTM	1.0	0.6	1.0	0.5	72.6	8.0	0.9	0.3
JAM	1.3	6.8	1.5	0.7	5.3	1.5	2.9	0.4
MEX	1.2	0.5	1.1	0.5	6.2	1.1	1.3	0.9
NIC	4.0	1.2	2.1	1.7	1.4	2.3	2.0	1.3
PAN	0.5	0.3	1.3	0.8	3.6	1.7	2.4	0.8
PRY	1.2	4.9	0.7	2.2	4.0	9.0	1.2	2.9
PER	16.8	0.2	5.5	0.3	13.4	9.5	5.5	0.3
TTO	2.8	5.1	1.3	2.8	0.7	3.2	1.0	1.9
URY	1.3	1.6	1.6	1.8	10.3	9.2	1.5	1.6
VEN	0.8	0.6	1.3	0.8	6.7	3.1	3.4	1.9
LAC	2.4	1.9	1.9	1.1	83.2	7.9	2.6	1.2

Source: Own estimations, on the basis of official sources.

TABLE 4.B
LATIN AMERICA AND THE CARIBBEAN: REAL VOLATILITY, NUMBER OF EPISODES OF GDP DECLINE, DURATION OF THE EPISODES AND CUMULATIVE LOSS (1990-1992 AND 2011-2012)

(Number of episodes, quarters and percent of GDP)

	Episode of GDP Decline		Duration		Cumulative Loss	
	1990-1992	2011-2012	1990-1992	2011-2012	1990-1992	2011-2012
ARG	3	1	1.0	1.0	2.6	2.3
BHS	0	1		3.0		0.4
BLZ	1	2	3.0	2.0	19.9	5.0
BOL	1	0	1.0		1.1	
BRA	1	1	3.0	1.0	1.5	0.1
CHL	1	0	1.0		1.6	
COL	2	1	1.0	1.0	2.2	0.1
CRI	2	1	1.0	2.0	0.6	0.3
DOM	0	2		1.0		0.9
ECU	2	0	1.0		0.5	
SLV	1	1	1.0	1.0	0.4	0.2

Table 4 (concluded)

	Episode of GDP Decline		Duration		Cumulative Loss	
	1990-1992	2011-2012	1990-1992	2011-2012	1990-1992	2011-2012
GTM	1	0	1.0		1.5	
JAM	0	2		3.0		1.1
MEX	2	0	1.0		1.2	
NIC	1	2	3.0	1.0	3.5	1.6
PAN	0	0				
PRY	1	2	1.0	2.0	0.6	3.4
PER	2	0	4.0		6.7	
TTO	2	2	1.0	3.0	1.2	5.3
URY	2	2	1.0	1.0	1.2	2.4
VEN	0	0				
LAC	25	20	1.6	1.7	2.9	1.8

Source: Own estimations, on the basis of official sources.

III. Testing the empirical relationship between real volatility and growth in the region (1990-2012)

The stylized facts presented in the previous section characterize a region that has struggled to grow at the pace at which industrial countries have grown during the period under study. In addition to that, although there has been a reduction in volatility in many countries in recent years, Latin America and the Caribbean has maintained high levels of real volatility, no matter what indicator of real volatility we use to measure the latter.

In this section we try to determine empirically whether there exists a statistically significant relationship between the evolution of real volatility and growth using a balanced panel of quarterly data for 21 Latin America and the Caribbean, with data starting on the first quarter of 1990 and ending on the fourth quarter of 2012. A point to note is that most studies conducted to date that examine empirically this relationship use annual data (eg, Ramey and Ramey, 1995) instead, as quarterly data was probably not available.

A. Results using different volatility indicators

While all indicators of real volatility indicate a reduction of this variable in Latin America and the Caribbean during the 1990-2012 period (see section B above), the information found in each of these different indicators differs (see tables 4.A and 4.B). For this reason, the selection of the indicator to be used for our empirical analysis of the existence (or not) of a statistically significant relationship between real volatility and economic growth is very important.

The results of the estimation of the correlation between real volatility and economic growth for a panel of 21 countries in the region, carried out using the method of fixed effects[7], are presented in Table 5.

Group A presents the correlations between the average rate of GDP growth and the volatility of GDP growth[8], using the standard deviation and the coefficient of variation of the growth rate and of the

[7] The use of this method is appropriate given the assumption that unobserved country-specific characteristics are correlated with the "regressors" used. The Hausman test provides evidence in favour of this hypothesis.

cyclical component of GDP as indicators of real volatility[9]. This group of panel data regressions indicates that, unlike what other studies have previously found, during the period under study and using quarterly data we find no evidence of a statistically significant negative correlation between real volatility and economic growth in the region. In fact, the only indicator of real volatility that provides evidence of a statistically significant relationship of any sign between both variables is the coefficient of variation of the rate of growth, but the sign of the correlation is positive, which is contrary to what was expected *a priori*[10]. In general, the results presented by Group A of panel data regressions are similar to those in Martin and Rogers (2000) for the case of developing countries.

TABLE 5
LATIN AMERICA AND THE CARIBBEAN: REAL VOLATILITY AND GROWTH

GROUP A. COEFFICIENT OF VARIATION AND STANDARD DEVIATION

(Of the GDP Growth rate and its Cyclical Component)

	Equation 1		Equation 2		Equation 3		Equation 4		Equation 5	
Investment Rate	0.04117588	**	0.04121902	**	0.04122414	**	0.04166914	**	0.0426833	**
Population	-0.000000002		0.000000002		0.000000001		-0.000000002		-0.000000008	
Volatilidad real										
Var. Coef. GDP Growth Rate	0.00001249	**							0.0000123	**
Std. Dev. GDP Growth Rate			0.00289614						0.0383145	
Var. Coef. GDP Cyclical component					-0.00000023					
Std. Dev. GDP Growth Rate							-0.01099449		-0.000000265	
Constant	-0.00010986		-0.0002668		-0.00020432		-0.00002563		-0.0398232 -0.0001438	
N (total observations)	167		167		167		167		167	
Number of Countries	21		21		21		21		21	
R-Sqt: Within	0.0889		0.0835		0.0835		0.0839		0.0907	
Between	0.0715		0.0660		0.0652		0.0637		0.0775	
Overall	0.0478		0.0434		0.0431		0.0426		0.0495	
Rho	0.3642		0.3647		0.3645		0.3658		0.3692	

Source: Own estimations, on the basis of official sources.

Note: * p<0.05; ** p<0.01; *** p<0.001

[8] The results are similar when the accumulated GDP growth during the period is used as a dependent variable instead of the average of the growth rate during the period.

[9] To obtain the cyclical component of the GDP series, the Hodrick-Prescott filter was applied to each seasonally adjusted quarterly series.

[10] It should be noted that some studies, like Fang and Miller (2012), find that the volatility of the rate of GDP growth in the United States is positively correlated with the growth rate in that country.

GROUP B. FEATURES OF THE GDP CONTRACTION EPISODES

	Equation 6		Equation 7		Equation 8		Equation 9	
Investment Rate	0.04035128	*	0.03762334		0.03343458	*	0.03493761	
Population	0.000000003		0.000000003		-0.000000016		-0.000000004	
Volatilidad real								
Cumulative Output Loss	-0.00045464						0.00017884	
Duration of the Episode			-0.00212677	***			-0.00210689	***
Number of Episodes					-0.00181377	**	-0.00071315	
Constant	0.00109932		0.00398464		0.00487645		0.0054303	
N (total observations)	167		167		167		167	
Number of Countries	21		21		21		21	
R-Sqt: Within	0.1351		0.3507		0.1834		0.3950	
Between	0.0534		0.1552		0.0568		0.2171	
Overall	0.0696		0.2558		0.0953		0.3136	
Rho	0.3482		0.3616		0.3698		0.3403	

Source: Own estimations, on the basis of official sources.

Note: * p<0.05; ** p<0.01; *** p<0.001.

Group B of table 5 presents the results of the panel data regressions carried out using as regressors the second group of real volatility indicators described in Section A above. These indicators are: i) the (total) number of GDP contraction episodes registered during the period, ii) the (mean) cumulative loss of GDP, and iii) the duration of the episodes of GDP contraction observed.

We can see that Group B of table 5 presents evidence of a statistically significant negative correlation between real volatility, measured both by the number of GDP contraction episodes (Equation 8) and by the (mean) duration of these episodes (Equation 7), and the average growth rate of GDP. In Equation 9 we observe what occurs when the three indicators of the second group of real volatility indicators are included together as regressors. Note that in Equation 9 the individual correlation between the number of episodes of GDP contraction and economic growth becomes statistically insignificant, but the significance of the correlation between the (mean) duration of contractions and growth does not decrease.

Interestingly, no evidence was found of the existence of a negative and statistically significant correlation between the magnitude of the contractions (i.e. the cumulative loss of GDP) and economic growth.

Together with the theoretical models which link real volatility and growth mentioned in the Introduction of this paper, the results presented in table 5 allow us to argue that the duration of GDP contraction episodes is a good indicator of the real volatility in an economy. Using this indicator we find that real volatility was negatively correlated with the economic growth registered in Latin America and the Caribbean during the period between 1990 and 2012.

Another interesting item of note is that using the duration of the episodes of GDP contraction as an indicator of real volatility, the results of this study are similar to those found by Ramey and Ramey (1995) and by Martin and Rogers (2000) for developed economies.

In the next section we attempt to verify the robustness of this correlation to the occurrence of external shocks. In particular, we will test whether the negative correlation found between real volatility and growth in the region is robust to the incorporation in the panel data regressions of variables collecting information related to a) the evolution of prices of the main commodities traded by the region, and b) shocks to international trade and c) shocks to international financial markets.

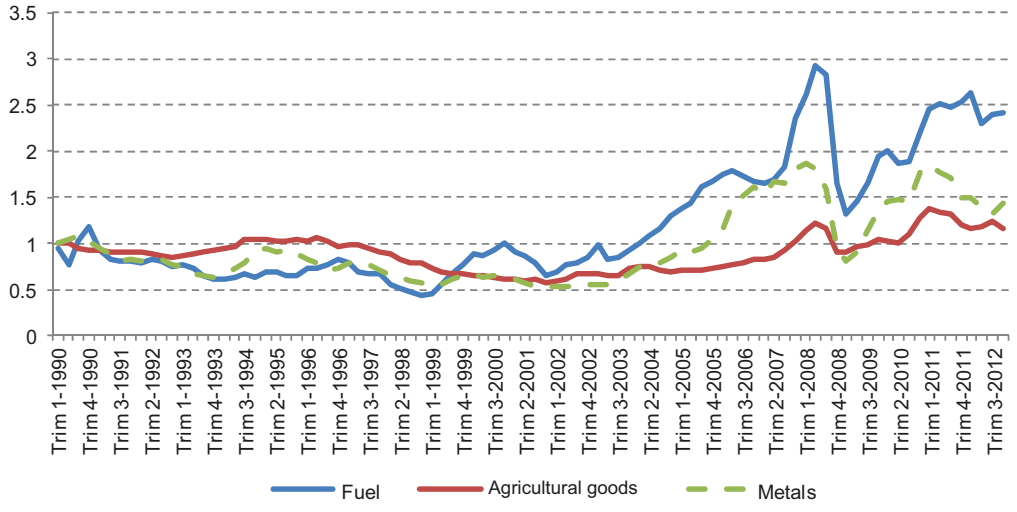
B. Volatility and growth: controlling for external shocks

The economic literature has highlighted the fact that Latin and the Caribbean is highly vulnerable to external shocks, and the latter are commonly associated with the poor macroeconomic performance

exhibited by the region[11]. The connections between these external shocks and macroeconomic performance in the region take place through different channels (ECLAC, 2012), as described below.

- *Commercial Channel*: movements in commodity prices and the volume of international trade in commodities significantly affect the countries in the region, given the significant share of these goods within the exports or imports of Latin American and Caribbean countries.
- *Public Revenue Channel*: for a large number of economies in the region, commodity exports generate large public revenues[12] either directly (through the public ownership of companies, as in Chile with the mining company CODELCO or in petroleum-exporting countries like Ecuador, Mexico and Venezuela) or indirectly, via tax and royalties imposed on private sector exporters of commodities. This is especially important for those countries where, due to their low domestic tax burden, their public finances depend to a large extent on the evolution of primary goods exports and therefore, the exposure of the economy to the volatility of commodity markets is high.
- *Financial Channel*: regardless of the degree of integration to international financial markets, the economies of the region are subject to frequent fluctuations in financial variables such as the prevailing interest rates in financial markets and the volume of capital inflows and outflows. The changes in prices and volumes of capital available in the countries in the region result in changes in the domestic cost of capital, affect the exchange rates and hence, economic activity.
- *Expectations Channel*: for those economies where an increase (decrease) in commodity prices results in higher (lower) current account surpluses, an increase (decrease) in these prices induce positive (negative) expectations about the future evolution of the economy. Such changes in expectations may affect the decisions of economic agents in terms of the pattern and volume of inter-temporal consumption and investment.

FIGURE 4
EVOLUTION OF COMMODITIES PRICES: COMPOSITE INDEX FOR FUEL, AGRICULTURAL GOODS AND METAL,1990-2012
(1990=1)



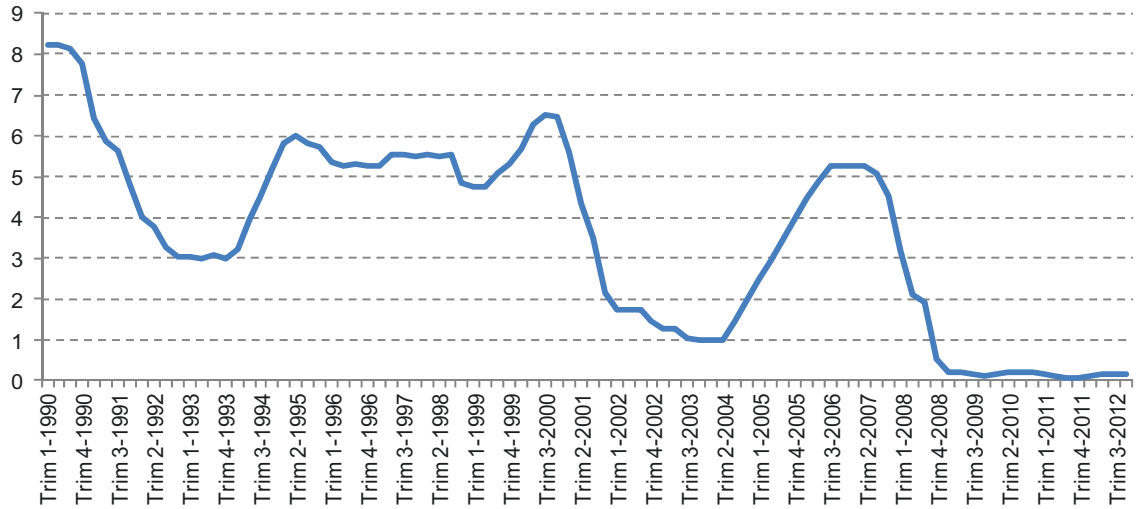
Source: Own estimations, on the basis of World Bank data base.

[11] See Hausmann and Gavin (2011), Céspedes and Poblete (2011), Loayza and others (2007) and ECLAC (2011).
[12] In some cases, imports of primary products also generate significant effects on public expenditure. For example, this occurs in Argentina with the import of energy products.

Figure 4 shows the evolution of the indices of real prices of different "bundles" or "baskets" of agricultural goods, metals and energy, for the period 1990-2012. These indices show the fluctuations recorded by the prices of these goods in this period which, in general, between 2003 and the occurrence of the international financial crisis in 2008-2009 experienced an upward trend.

After the international crisis of mid-2008, the federal funds interest rate[13] of the Federal Reserve of the United States has remained close to zero[14] during the period (see figure 5). It must be noted that access in Latin America and the Caribbean to international financial markets is quite heterogeneous and consequently, changes in the evolution of this variable have affected different countries in a heterogeneous way.

FIGURE 5
EVOLUTION OF FEDERAL FUNDS RATE, 1990-2012
(Percentages)



Source: Own estimations, on the basis of Federal Reserve Bank.

In equations 10-14 (see table 6) we present the results of a panel data statistical analysis where we explore the relationship between real volatility and economic growth while controlling for the occurrence of some types of external shocks. Specifically, we control for fluctuations in the prices of commodities (agricultural, metals and energy), the volume of international trade, and a variable that acts as proxy for the volatility of international financial markets: the federal funds rate of the Federal Reserve Bank of the US.

We observe that the inclusion of these variables to control for external shocks does not weaken the evidence in favor of the existence of a negative and statistically significant correlation between real volatility (measured using the duration of recession episodes) and economic growth. This can be interpreted as a sign of the robustness of the correlation between real volatility and growth.

In a series of papers, Bloom (2007 and 2009) shows how changes in uncertainty affect the investment decisions of the companies, and therefore, employment and growth in the United States. Carriere-Swallow and Céspedes (2013) found similar results in emerging economies. In this work the authors use the VIX index, a measure of the implied volatility of the Standard & Poor 500 index, as a

[13] The results are similar when the federal funds rate or the yield of federal bonds with ten-year maturities are used, given the high correlation between these variables.

[14] In addition to the reduction in interest rates, the Federal Reserve and other central banks after the start of the international financial crisis adopted a series of measures to inject large amounts of liquidity to stimulate the recovery of economic activity in their countries. This has resulted in a large increase in liquidity in international financial markets (ECLAC, 2013).

composite indicator of the level of overall uncertainty, given the high correlation that the VIX index has with systemic variables such as international political crises (wars), financial crises, shocks to energy prices and significant fluctuations in interest rates of the major global financial centers as well as international monetary and financial conditions. These studies find that jumps in the VIX reflect abrupt changes in the level of uncertainty of the international economic environment and that these modifications result in changes in the path of other variables such as employment and economic growth (see figure 6).

In equation 15 (see table 6) we included the VIX index as a regressor to control for systemic shocks and in order to verify the robustness of the evidence about the existence of a negative correlation between real volatility and economic growth. The correlation of the VIX variable with economic growth is negative and statistically significant, confirming the results of Carriere-Swallow and Céspedes (2013). Additionally, and as was the case with the other indicators of external volatility used in Equation 10, the data continues to show evidence in favor of the existence of a negative correlation between real volatility (measured by the duration of recession episodes) and the average growth rate.

TABLE 6
LATIN AMERICA AND THE CARIBBEAN: REAL VOLATILITY AND GROWTH CONTROLLING FOR EXTERNAL SHOCKS

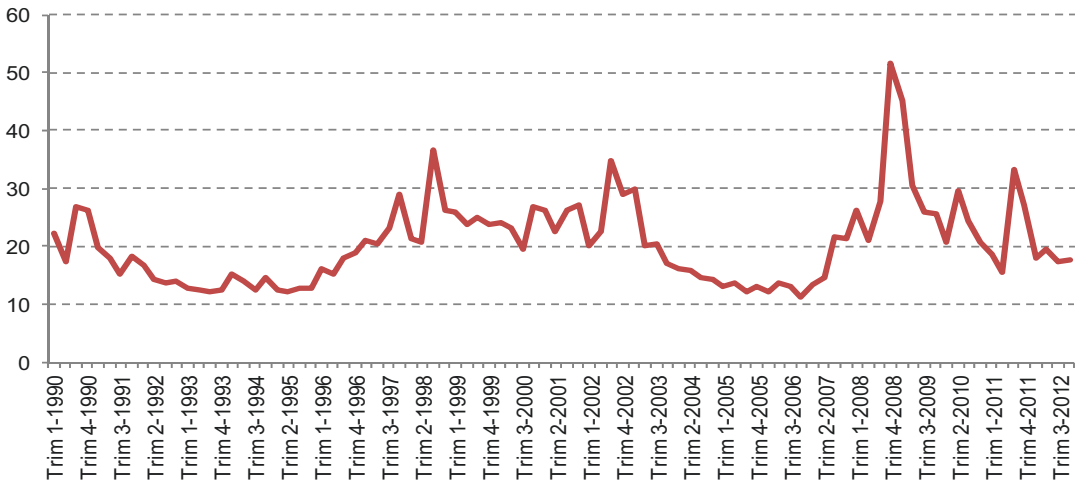
	Equation 10		Equation 11		Equation 12		Equation 13		Equation 14		Equation 15	
Investment rate	0.0364226	*	0.0378281	*	0.0377884	**	0.0379993	*	0.0410965	*'	0.0393607	**
Real Volatility												
Duration of the episode	0.00212327	***	-0.00209853	***	-0.0021282	***	-0.0020222	***	-0.0020278	***	-0.0018834	***
External volatility												
Growth of price index of agricultural goods	0.045375	*										
Growth of price index metal goods			0.02155719									
Growth of price index energy					-0.0056927							
Changes inf the FED rate							0.0043619					
Growth of international trade									0.1308112			
Variation of the VIX											-0.0002015	***
Constant	0.0042836		0.00392		0.0040884		0.0040002		0.0013791		0.0073983	**
N (total observations)	167		167		167		167		167		167	
Number of countries	21		21		21		21		21		21	
R-Sqt: Within	0.3752		0.3634		0.3516		0.3552		0.3642		0.3746	
Between	0.1613		0.1564		0.1573		0.1517		0.1458		0.1423	
Overall	0.2771		0.2636		0.2559		0.2552		0.2491		0.2598	
Rho	0.3644		0.3700		0.3638		0.3688		0.3936		0.3884	

Source: Own estimations, on the basis of official sources.

Note: * p<0.05; ** p<0.01; *** p<0.001

In conclusion, the results in this section indicate that controlling for shocks to global uncertainty does not weaken the evidence in favor of the existence a negative correlation between real volatility and economic growth in Latin America and the Caribbean.

FIGURE 6
UNCERTAINTY OF INTERNATIONAL FINANCIAL MARKETS:VOLATILITY INDEX – VIX[a]



Source: Own estimations, on the basis of Information from Bloomberg.

[a] Shows volatility of Standard & Poor's 500.

Conclusions

While the economies of Latin America and the Caribbean, on average, have managed to reduce their nominal volatility, they still have some way to go in terms of reducing the real volatility of their economies. The region continues to show indicators of volatility that are much higher than those in developed economies, as indicated by several studies (Pineda-Salazar and Cárcamo-Diaz, 2013; Céspedes and Poblete, 2011; Haussman and Gavin, 1996).

According to the evidence presented in this paper, the high real volatility in Latin America and the Caribbean is significantly related to the low economic growth exhibited in the region during the period 1990-2012. We must point out, however, that our paper does not present evidence of the existence of a causal link going from volatility to economic growth in the region. Nevertheless, the evidence indicates the existence of a strong correlation between the two variables.

In this paper we have focused our attention on measures of real volatility that use information about the number, duration and magnitude of GDP losses registered during episodes of contraction in Latin America and the Caribbean. We found that the duration of GDP contractions appears to be a rather robust indicator of real volatility, and to be negatively correlated with long run growth in Latin America and the Caribbean between 1990 and 2012.

Even though this paper does not attempt to verify empirically through which channel real volatility and economic growth are negatively correlated, the results are consistent with several theoretical hypotheses put forth in the literature (Martin and Rogers, 2010; Aghion et al, 2010; Barlevy, 2007), which posit that contractions and in particular the duration of those contractions, affects economic growth.

Finally, this paper shows that the relationship between real volatility and economic growth in Latin America and the Caribbean is robust to the inclusion of external variables that control for external uncertainty and volatility (i.e. the VIX index).

Identifying which channels of connection can account for the observed negative correlation between the duration of GDP contractions and economic growth is imperative for the countries of the region, especially for those where contractions have in the past been protracted, as in the cases of Argentina, Jamaica, Paraguay and Venezuela (B.R. of).

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