SYNCHRONIZATION OF ECONOMIC ACTIVITY BETWEEN DOLLARIZED ECONOMIES AND THE UNITED STATES. THE CASES OF ECUADOR AND EL SALVADOR

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Abstract
We evaluate a possible consequence of dollarization: the synchronization of economic activity. The analysis considers the cases of Ecuador and El Salvador; both adopted the US dollar. The results of common cycles and cointegration tests suggest the existence of a common trend and a common cycle between the GDPs of Ecuador and the US after dollarization. For the case of El Salvador, a common trend was identified after dollarization but not before; no common cycles are evident in either period. We conclude that dollarization is associated with increased economic integration between the adopting countries and the US; as suggested by economic theory.

JEL Classification: E42, F44, F33

Keywords: Dollarization, Economic Synchronization, Common Cycles

I. Introduction
Dollarization has attracted significant attention from policymakers and academicians alike. This seems natural if one considers the importance of the decision for the implementing country. At the policymaking level, dollarization may bring about significant costs. The loss of the ability to conduct discretionary monetary policy and forgoing seigniorage are two of the most evident. Additionally, for the average citizen in the dollarized economy, a sense of loss of national identity will surely arise. Dollarization, on the other hand, may also produce sizable benefits. A decrease in inflation and interest rates usually accompany the adoption of a foreign currency. Moreover, a relatively stable currency can make investing in the country more attractive, promoting the development of capital and financial markets. Ex-ante, for a country deciding in favor of dollarization these benefits ought to appear greater than the potential costs; otherwise they would not implement the policy.

The literature on dollarization is ample and covers a wide array of approaches. Frankel and Rose (1998), for example, evaluate the conditions under which a country may consider taking on a foreign currency. Eichengreen (2002) specifically tackles dollarization and analyzes the timing of the decision and its implications for policymaking. Similarly, Alesina and Barro (2001) discuss the conditions that favor and counter the formation of currency unions. Berg and Borensztein (2000) and Quispe-Agnoli (2002), among others, have discussed the costs and benefits of the measure. Overall, a country's adoption of a foreign currency is a phenomenon well-addressed in the literature.

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A line of research rarely examined, however, is the integration process that is supposed to emerge as a result of dollarization. In particular, theory suggests that, when a country adopts a foreign currency as its own, economic integration is accelerated. This argument can be traced back to Frankel and Rose (1998), who find that countries with high trade linkages tend to have more correlated business cycles, in comparison to countries whose trade is less intensive. Berg and Borensztein (2000) point to this possibility as well, noting economic integration between some Canadian provinces and the US. Although synchronization of economic activity seems to be a plausible event, there has not been a significant effort to evaluate it.

In this paper we explore the possibility of synchronization between the US and the economies of Ecuador and El Salvador. These two Latin American countries adopted the US dollar as their domestic currency in the early 2000's. A series of documents have studied this monetary choice from various perspectives. Quispe-Agnoli and Whisler (2006), for instance, evaluate the effects of dollarization in the banking systems of these two countries. They find that dollarization improved banking conditions and hence produced a more robust financial system. An analysis of the political and economic impact of the measure is conducted in Ronnholm (2007). The author argues that policy credibility increased following dollarization but reforms need to be implemented to achieve long-run benefits. In contrast with the general perception of dollarization as a positive policy, Towers and Borzutzky (2004) suggest that the costs of increased inequality in El Salvador have outweighed the benefits. To our knowledge, no document has examined whether the argument of increased integration holds. The closest in spirit to this type of analysis is Lindenberg and Westermann (2012). They estimate the degree of codependence between the economies of the US and various Latin American economies, including El Salvador, for the sample period 1997 – 2008. The authors find that there is no codependence amongst these two countries. We contribute to the debate by evaluating whether dollarization has produced synchronization of economic activity between the US, Ecuador and El Salvador. As opposed to the previously mentioned document, we explicitly test for business cycle synchronization prior and post dollarization. If economic theory holds, it must be the case that the degree of integration between the US and the dollarized economies increased since they adopted the US dollar.

The analysis is conducted for the long-run and the short-run. In particular, we want to determine linkages in economic performance in the stationary state and during transitory periods. The methodology consists of estimating cointegration and common cycle tests for both time frames respectively. Finding cointegration would imply that the gross domestic product (GDP) of the US and the GDPs of the dollarized countries share a common trend. That is, permanent changes in the behavior of the US GDP are reflected in permanent changes in the dynamics of the other countries’ GDPs. Similarly, the existence of common cycles would mean that the economies of Ecuador and El Salvador respond symmetrically to transitory movements in the US economy. In other words, the business cycles of these countries are synchronized. We should note that this approach to determining synchronization among economies is standard in the literature. Herrera (2004), for instance, analyzes the existence of common movements

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1 Klein (2005) studies trade patterns associated with dollarization.
in the business cycles of Mexico and the US after the North American Free Trade Agreement was signed. He follows the empirical strategy we propose here, estimating cointegration relationships and then identifying common cycles.\textsuperscript{2}

The rest of the document is organized as follows: Section I presents a brief account of economic events in Ecuador and El Salvador before and after dollarization. In Section II we present the empirical exercise. Section III concludes.

2. The Economic Experience of Ecuador and El Salvador

Although El Salvador and Ecuador have both adopted the US dollar as their currency, and in that respect they are similar, their economic experiences are markedly different.\textsuperscript{3} El Salvador is the smallest country in Central America in terms of territory. Its economy is export-oriented and specializes in the production of commodities, primarily coffee. In recent years the country has also become highly dependent on the flows of remittances from the US. They correspond to about 16 percent of the country’s GDP and represent the main source of foreign reserves.

El Salvador endured twelve years of civil war that spanned from 1980 to 1992. Consequently, economic growth was virtually nonexistent during the 1980’s. The 1990’s represented a decade of reconstruction and stabilization. After many years of high inflation, high interest rates, and stagnant growth, the Salvadorian government announced in December of 2000 the adoption of the US dollar as its official currency. The exchange rate was set permanently at 8.75 Colones per US dollar. Nowadays the debate in El Salvador centers on the costs and benefits of dollarization. Policymakers and academicians ponder the outcomes of the measure. To some, adopting the US dollar has created more negative effects than positive. González-Orellana (2008), for example, argues that dollarization led to the so called Dutch disease and favors returning to the Colon. Castillo-Ponce and Rodríguez-Espinosa (2009), on the other hand, found that the reduction in inflation and interest rates may outweigh the cost associated with the policy. The debate on the balance of dollarization will surely continue for many years to come.

Ecuador, on the other hand, sailed through the 1980’s and early 1990’s without major adverse political or social events, other than the well-known Latin American debt debacle. Unfortunately, in the period 1997-1999 its economy endured a severe crisis; the effects of which were reflected on a GDP per capita equivalent to what it was in 1980. In addition, external debt amounted to 118 percent of its GDP. As a consequence, a large capital outflow took place in 1999. Financial and political crises erupted parallel to the economic crisis. Many banks and financial institutions became insolvent. Prominent policymakers, including the finance minister, resigned. Finally, in January of 2000 the fixed convertibility of the Sucre was announced. The measure was

\textsuperscript{2} Many other methodologies are available for measuring the degree of synchronization across economies. As suggested in Issler and Vahid (2001), however, imposing cointegration restrictions when identifying common movements improves efficiency.

perceived as a strategy to control the unstable economic situation developing in the country. Just as it is in the case of El Salvador, there is no consensus on the effects of dollarization in the country. As we previously indicated, Quispe-Agnoli and Whisler (2006) find a positive impact on the banking system of Ecuador. Similarly, Jameson (2003) identifies improvements not only in economic activity, but also in the political arena. In contrast, Acosta (2005) argues that the social costs and increased production costs due to dollarization are more significant than the benefits associated with the policy.

To illustrate the economic performances of Ecuador and El Salvador before and after dollarization, we present two illustrations. Figure 1 refers to the annual GDPs growth rates and Figure 2 reports the inflation rates.

**Figure 1: GDP Annual Growth Rates, Percentage**

Source: Authors’ Reproduction with Data from the Central Banks of Ecuador and El Salvador and the Bureau of Economic Analysis

Figure 1 includes GDP for the US for comparison purposes. The source for GDP and inflation data is the IMF World Economic Outlook Database. From Figure 1, the 1997-1999 economic crisis in Ecuador is evident, a negative rate of about 6 percent is registered in 1999. The economy rebounded in 2000 and experienced an average growth of 4 percent until 2008. The global slowdown of 2009 is also reflected in the figure. For the case of El Salvador, we can observe a steady decrease in economic activity from 1995 to 2000. From 2000 to 2004 the economy grew at about 2 percent. An expansion from 2004 to 2007 is followed by the 2009 recession. Overall, we may say that Ecuador exhibits a more volatile behavior, with large swings in 1999, 2004, and 2008. El Salvador’s pattern is steady; especially after dollarization. In regards of their relative performances with respect to the US, no clear similarity is evident prior to the early 2000’s. The rebound of the US economy after the 1991 slowdown is not followed by the other two economies; on the contrary, the GDPs of Ecuador and El Salvador seem to be going on a downward trend. After dollarization, some common movements appear to arise, especially the improvement of the growth rate around 2004 and its collapse in 2008.

According to economic theory, dollarization should be associated with a decrease in inflation rates. This seems to be the case for Ecuador. Notice in Figure 2 that it went  

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4 Data and facts are described at length and in detail in Jameson (2003).
from almost 100 percent at the end of 1999 to single digit rates in 2002. Whether this is a direct result of adopting the US dollar is debatable, but the decrease in inflation is evident and coincides with dollarization. Inflation in El Salvador is also lower in the post dollarization period. However, the downward trend begins in 1993, well before the country dollarized. Inflation rates have been low since 1999. In this case it is even more difficult to establish a link between steady inflation and the adoption of the US dollar. Nonetheless, one can still note that low inflation rates prevail in a dollarized economy. Finally, it is worth mentioning how inflation remains at rates below 5 percent in Ecuador, whereas in El Salvador they are a little higher during the mid 2000’s. That is, inflationary dynamics in Ecuador appear to follow those observed in the US more closely after the US dollar was adopted.

Evidently, we cannot formulate any definite associations between economic performance and the adoption of the US dollar. If anything, we may simply note as interesting the fact that GDP growth rates and inflation rates of Ecuador and El Salvador resemble US rates in recent years. The econometric exercise that follows should shed light on whether dollarization is related to the synchronization of economic activity.


Data

We consider quarterly GDP data at constant prices from 1990 to 2012. For Ecuador the data is expressed in Sucre from 1990 to 2000, the year of dollarization. From then on the data is in US dollars. For El Salvador data for the entire sample is expressed in US dollars. Data for the US GDP at constant prices is also included. For the two Latin American countries the sources are their respective Central Banks. For the US data comes from the Bureau of Economic Analysis. Figures 3 and 4 illustrate the series for Ecuador and El Salvador in levels, respectively, prior to and post dollarization. Presenting the data in this manner allows us to have some idea of the patterns followed by the series. Notice for example, that prior to dollarization Ecuador’s GDP shows a significant break just before 2000. Also, in the post dollarization period the series for both countries appear to have sudden changes. We will consider these characteristics in the econometric estimations that follow.5

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5 The dynamics of the US GDP are well known and hence no graph is presented for the series.
Econometric Methodology

The econometric strategy consists of testing for common trends and common cycles. There is an abundance of possible tests for these exercises, nonetheless, we choose Johansen (1991) for cointegration and Vahid and Engle (1993) for common short-run movements. Documents including Issler and Vahid (2001) and Herrera (2004) show that, given the existence of cointegration, the Vahid and Engle methodology produces efficiency gains with respect to other methodologies. This is possible due to the cointegration and common-cycle restrictions imposed in the system. Without these restrictions variance decompositions and impulse response functions are biased.

Since Johansen’s cointegration methodology is amply known, we spare the reader from a detailed description. We briefly describe the Vahid and Engle (1993) methodology.

A first difference stationary vector $y_t$ takes its Wold form as follows:

$$
\Delta y_t = C(L)e_t = C(1)e_t + (1 - L)C^*(L)e_t
$$

(1)

By integrating expression (1) one can obtain:

$$
y_t = C(1)\sum_{i=0}^{\infty} e_{t-i} + C^*(L)e_t
$$

(2)

This is the standard trend-cycle representation of a time series. The first term in (2) refers to the trend component and the second term to the cyclical component, which is assumed to be stationary. $\alpha C(1) = 0$ implies cointegration and the $n \times r$ matrix $\alpha$
contains the $r$ cointegrating vectors. Similarly, $\alpha'C^*(L) = 0$ suggests the existence of common serial correlation and $\bar{\alpha}$ is a $n \times s$ matrix containing $s$ common cycles. $r$ is directly obtained by implementing the Johansen (1991) methodology. To compute $s$ Vahid and Engle propose estimating the squared canonical correlations in the system $\left(\lambda_j^2\right)$ and then testing the null hypothesis $\lambda_j^2 = 0, \forall j = 1, 2, ..., s$. The test statistic is $C(p, s) = -(T - p - 1)\sum_{i=1}^{s} \log \left(1 - \lambda_i^2\right)$ and has a $\chi^2$ distribution with $s^2 + snp + sr - sn$ degrees of freedom. Following this discussion, we note that the exercise we will carry out includes two steps. First we estimate cointegration and then, given the existence of common trends, we implement the Vahid and Engle methodology to identify common cycles.

A. Estimation and Results

The stochastic nature of the series is determined by estimating unit root tests. We consider two samples: the pre dollarization period for Ecuador is from 1990 to 1999 and for El Salvador it is from 1990 to 2000. The post dollarization period ends in the fourth quarter of 2011 for both countries. All tests are for the logarithmic transformation of the variables. The results of the KPSS test for the two samples are reported on Table 1. With the exception of Ecuador’s GDP in the post dollarization period, in all cases we can establish that the series are integrated of order 1. The null hypothesis of stationarity for the series in levels is rejected at the 5% significance level; the null is not rejected for the first differences.

<table>
<thead>
<tr>
<th>Table 1: Unit Root Tests Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDF1 C.V.</td>
</tr>
<tr>
<td>KPSS C.V. at 5%</td>
</tr>
<tr>
<td>Level</td>
</tr>
<tr>
<td>Prior</td>
</tr>
<tr>
<td>GDP USA</td>
</tr>
<tr>
<td>GDP Ecuador</td>
</tr>
<tr>
<td>GDP El Salvador</td>
</tr>
<tr>
<td>Post</td>
</tr>
<tr>
<td>GDP USA</td>
</tr>
<tr>
<td>GDP Ecuador</td>
</tr>
<tr>
<td>GDP El Salvador</td>
</tr>
</tbody>
</table>

* Reject null of stationarity at 5%
** Reject null of stationarity at 10%
^ Do not reject the null of a unit root at 5%

For the US GDP several documents concur with our finding, including Nelson and Plosser (1982) and Zivot and Andrews (1992). Tests on the statistics properties of El Salvador’s GDP show that the series is non-stationary in levels and stationary in first differences. As we indicated in the description of Figure 3, however, it is apparent that the series exhibit some structural breaks in their behavior. Hence, a unit root test that includes possible breaks is in order. We chose to implement the test suggested in Harvey et al. (2011) which allows for more than one structural break. We conduct the
test for the series of Ecuador and El Salvador for both periods. The results of the test, also presented in Table 1, indicate that the series are in fact integrated of order 1.\(^6\) The Modified Dickey-Fuller statistics (MDF) for 1 and 2 breaks fall in the no rejection area of the null of a unit root for the series in levels. Overall, we conclude that the GDPs of these three countries are I(1) series.

We now estimate cointegration relations. We consider bi-variate systems which include the GDP of one of the dollarized economies and the US GDP. Two tests are implemented to check for robustness. The first is a basic test that follows Johansen’s methodology; the second is that proposed in Hansen (1996) and allows for structural breaks in the cointegrating vector. The results are reported in Table 2.

<table>
<thead>
<tr>
<th>System</th>
<th>Lag Structure</th>
<th>Hypothesis</th>
<th>Probability</th>
<th>ADF</th>
<th>Zt</th>
<th>Za</th>
<th>Break Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecuador, USA</td>
<td>(p = 1)</td>
<td>(r = 0)</td>
<td>0.125</td>
<td>-3.318</td>
<td>-3.474</td>
<td>-18.309</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(r \leq 1)</td>
<td>0.649</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>El Salvador, USA</td>
<td>(p = 1)</td>
<td>(r = 0)</td>
<td>0.0125(^*)</td>
<td>-2.643</td>
<td>-2.717</td>
<td>-12.561</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(r \leq 1)</td>
<td>0.1072</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecuador, USA</td>
<td>(p = 1)</td>
<td>(r = 0)</td>
<td>0.0001(^*)</td>
<td>-4.418^</td>
<td>-4.425^</td>
<td>-29.774</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>(r \leq 1)</td>
<td>0.3971</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.119)</td>
</tr>
<tr>
<td>El Salvador, USA</td>
<td>(p = 1)</td>
<td>(r = 0)</td>
<td>0.465</td>
<td>-3.561</td>
<td>-4.121</td>
<td>-23.487</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(r \leq 1)</td>
<td>0.2701</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^*\) Do not reject the null of cointegration at 5%  
\(^\wedge\) Reject the null of no cointegration at 10%  
Standard error in parenthesis

For the pre-dollarization period no strong evidence of cointegration is identified; although Johansen’s test suggests the existence of a common trend between El Salvador and the US, Hansen’s test rejects this possibility entirely. After dollarization there is some indication of a stable long-run relationship between the GDPs of Ecuador and the US. The Johansen statistics clearly point to one cointegrating vector, the Hansen results confirm this though only at the 10% significance level.\(^7\) The normalized coefficient reports a positive elasticity of 2.401. That is, a percentage change in the level of the US GDP is associated with a 2.401 direct percentage change in the level of Ecuador’s GDP in the long-run. For El Salvador’s GDP we are unable to identify a common trend with the US GDP, both the Johansen and Hansen tests reject the existence of cointegration. A few thoughts on these findings are expressed after the next estimation.

One particular result of the Hansen cointegration test is worth stressing: the date for the break point in the cointegrating vector. From Table 2, the break takes place at about 0.75 of the sample range. Since data begin in 2000, this number implies a break around

\(^6\) The only other document we found with evidence of the stochastic nature of Ecuador’s GDP is Christopoulos and Tsionas (2004), who identify the series to be I(1), though their unit root tests do not consider structural breaks.

\(^7\) For the Hansen test we report the results of Model 2 in Hansen (1996), the results of Models 3 and 4 are similar and are not reported for brevity.
late 2008, a period that corresponds to the beginning of the most severe episode of the recent crisis. With this, we are confident that the results reflect accurately the stochastic dynamics and relationships of the series.

We proceed to test for a common cycle for the Ecuador-US system after dollarization, the only one for which we found cointegration. The test cannot be applied to the series of El Salvador since no cointegration was identified. The results of the Vahid-Engle test are presented in Table 3. The existence of a common movement between Ecuador’s GDP and the US GDP is confirmed. According to the coefficient, a change in the cyclical component of the US GDP produces an instantaneous direct response of 0.567 percent in Ecuador’s GDP. More importantly, this results points to the existence of some degree of synchronization between the economic cycles of these economies. That is, it is apparent that a closer relationship exists in the cyclical movements of the US economy and those observed in the economy of Ecuador after the US dollar was adopted. An expansion in the US, for example, is likely to be associated with an expansion in Ecuador, just as a slowdown may be linked. To compute the common cycle between the two series we proceed with the methodology suggested in Issler and Vahid (2001), which essentially computes a linear combination of the GDPs using the common cycle coefficients. The common cycle is shown in Figure 5, the slowdown of 2001 and the recession of 2008 is clearly visible.

<table>
<thead>
<tr>
<th>System</th>
<th>Hypothesis on s</th>
<th>p Value</th>
<th>Normalized Comovement Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecuador, USA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>El Salvador, USA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecuador, USA</td>
<td>&gt; 0</td>
<td>0.136</td>
<td>1,-0.567</td>
</tr>
<tr>
<td></td>
<td>&gt; 1</td>
<td>0.000</td>
<td>(0.186)</td>
</tr>
<tr>
<td>El Salvador, USA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Standard errors in parenthesis

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8 We acknowledge the fact that many other methodologies are available to determine the statistical association between time series, for example the estimation of correlations at different phases of the growth rate. However, the purpose of this exercise is to determine relationships among series first, in the long-run, and then in the short-run. The estimation of correlations and the like can be performed in future studies.

9 We thank Professor Issler at Fundacion Getulio Vargas for facilitating the original GAUSS code. The same was modified to implement the current analysis.

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Overall, the findings from the cointegration and common cycle tests indicate an increased degree of interdependence across the US economy and the economy of Ecuador after dollarization, and no evidence of it for El Salvador. Although explaining these facts is beyond the scope of the present analysis, we may offer a couple of plausible explanations. First, note that Ecuador adopted the US dollar one year prior to El Salvador. As such, the country has had more time to experience the effects of dollarization in its economy. In other words, time is a necessary condition for dollarization to produce some dynamics of synchronization.

Second, while examining imports data for the US, we recognized some interesting patterns. Figure 6 illustrates US imports from Ecuador and El Salvador from 1990 to 2011. The source is the Census Bureau. Imports are denoted in millions of nominal US dollars and adjusted by the consumer price index. It is clear that US imports from Ecuador increased significantly since 2000, whereas imports from El Salvador remain more or less constant. Thus, it appears that dollarization intensified trade between Ecuador and the US more so than trade between El Salvador and the US. Evidently, whether the increase in Ecuador’s exports to the US is a direct result of dollarization is subject to debate. Nonetheless, it is worth noticing this change in trade and how it coincides with signs of greater integration across these economies. Of course, this is
simply a suggestion, determining the channels whereby the economies of Ecuador and the US became synchronized is a task that should be pursued in the future.\textsuperscript{10}

4. Conclusion

Dollarization is a decision that countries adopt with the intention to improve their economic conditions. Although it is still too soon to fully evaluate the results of the measure, we can at least begin testing some of its possible consequences. In this paper we examined whether the adoption of the US dollar by Ecuador and El Salvador has increased the degree of synchronization between their economies. In theory, dollarization can decrease transaction costs in trading activities and promote economic integration across countries. This in turn may lead to the synchronization of economic activity. By estimating cointegration and common cycle equations, we find that the economy of Ecuador has strengthened its ties with the US economy after adopting the US dollar; this is not evident for El Salvador. Although we do not formally examine the channels whereby this synchronization occurred, we postulated a couple of possibilities: the length of time since dollarization and the increase in exports to the US. Future studies should focus their attention on understanding how the economies of these developing countries came to exhibit common movements with respect to the US, paying particular attention to the evolution of the external sector and the flows of remittances to these countries from the US.

References


\textsuperscript{10} We should note that the increase in exports from Ecuador is a bit puzzling, since the US dollar is a stronger currency relative to the Sucre. Thus, one would expect a decrease in exports to the US. Apparently, factors such as a reduction in transaction costs or an increased dependence on the US market have out-weighed factors that may affect exports negatively. Also, since dollarization remittances to El Salvador from the US have become an important source of income for the country, hence one would expect a high degree of dependence between the two economies. These are some issues that future studies would have to address.


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