Full dollarization versus monetary union: the case of Ecuador

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Abstract

This study proposes using optimum currency areas (OCA) as a theoretical basis for analysis of the full dollarization of Ecuador, viewing the country and the United States as an informal monetary union. At least two facets of this are of interest: (i) the convergence properties of inflation rates between Ecuador and the United States; and (ii) the degree of vulnerability of the Ecuadorian economy to changes in United States monetary policy. Unit roots and stationarity tests are used to study inflation rate convergence, structural vector autoregressive models are used to examine the Ecuadorian economy's vulnerability to changes in United States economic policy. We find evidence that inflation rates are converging ex-post the full dollarization of Ecuador and that monetary policy changes by the United States do therefore affect Ecuadorian macroeconomic variables. Moreover, we argue that OCA theory is potentially useful for studying fully dollarized economies.

Keywords

Monetary policy, dollar, economic integration, monetary unions, economic conditions, inflation, macroeconomics, econometric models, Ecuador

JEL classification

C12, C22, E31, E52, F15, F45

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I. Introduction

Discussion of the pros and cons of regional integration is one of the longest-running multidisciplinary debates. From the field of economics, multiple efforts have been made to develop and improve the theory of economic integration itself, which, among other stages, includes the study of what are known as economic and monetary unions (EMU): economic blocs formed by two or more countries creating a single currency area (Balassa, 1961a). The theory of optimum currency areas (OCAs) (Mundell, 1961) states that one of the main costs of belonging to an EMU is the loss of independent monetary policy. OCA theory also establishes some criteria for economic synchronization among countries that would minimize this impact. In addition, in an EMU, monetary policy decisions must be coordinated, as they are shared across the relevant area. The definition of an EMU provided by OCA theory has several similarities with the current fully dollarized monetary regime of Ecuador. Full dollarization could be said to be an extreme form of a hard peg, whereby the domestic currency is replaced with a foreign currency (Jácome and Lönnberg, 2010). The result is that the dollarized country and the foreign country use the same currency, as in an EMU. Therefore, both dollarization and EMUs can be described as forms of hard pegs.

This study proposes using OCA theory as a theoretical basis for analysis of the full dollarization of Ecuador by viewing the country and the United States as an "informal monetary union". As opposed to a traditional EMU, in which monetary policy is coordinated, formal dollarization of an economy involves sharing a currency without any coordination of monetary policy. In other words, under full dollarization the country issuing the currency —the United States— sets benchmark interest rates and makes use of other monetary policy tools independently. At least two facets of this are of interest: (i) the degree of synchronization of the key macroeconomic variables of Ecuador and the United States; and (ii) the degree of vulnerability of the Ecuadorian economy to changes in United States economic policy. This method allows the costs of full dollarization to be evaluated with an alternative approach.

This article examines full dollarization using the theoretical basis of OCA and the empirical tools adapted to its analysis, focusing on the case of Ecuador. Hence, this paper contributes to the exchange-rate regime debate by linking OCA theory to Ecuador's experience of full dollarization and by performing an econometric exercise to test ex-post fulfilment of a set of OCA criteria in a dollarized economy.

This article has four sections in addition to this introduction. Section II reviews the literature and connects the concept of an EMU with the practice of full dollarization, summarizing OCA theory and contrasting it with full dollarization to explain the econometric exercise. Section III outlines the empirical methodology. Section IV provides the numerical results and compares them with theoretical expectations. Lastly, section V summarizes the arguments and offers some conclusions.

II. Theoretical framework

Discussion of the pros and cons of regional integration is one of the longest-running multidisciplinary debates. In economic theory, the pioneering contribution is the Theory of Economic Integration proposed by Béla Balassa in 1961. Balassa (1961a and 1961b) proposes studying, separately and successively, five stages or degrees of economic integration, each more demanding than the last, in terms of removal of barriers between economic blocs. These stages, as summarized in table 1 below, are: (i) free trade area; (ii) customs union; (iii) common market; (iv) monetary union; and (v) total economic integration.

Table 1
Balassa's stages of economic integration

Integration stage	Features	Examples
1. Free trade area	• No tariffs or quotas against member countries. • Individual quotas against third countries.	• On 1 January 2008, the United States, Canada, and Mexico removed the last remaining tariffs between them, completing the North American Free Trade Agreement (NAFTA). NAFTA had entered into force in 1994. • The ASEAN Free Trade Area (AFTA) was launched in 1992.
2. Customs union	• No tariffs or quotas against member countries. • Common external tariff.	• The European Economic Community (EEC) was created in 1957. EEC formally ceased to exist in 2009 via the Treaty of Lisbon and its institutions were absorbed into the European Union. • The Southern Common Market (MERCOSUR), founded in 1991, and the Andean Community, originating from the Cartagena Agreement of 1969.
3. Common market	• No tariffs or quotas against member countries. • Common external tariff. • Free factor movement, including of labour.	• The European Union was created in 1993 through the Maastricht Treaty.
4. Economic and monetary union	• No tariffs or quotas against member countries. • Common external tariff. • Free factor movement, including of labour. • Harmonization of economic policies and single currency.	• The European Union Economic and Monetary Union (EMU) and the euro were rolled out in January 1999.
5. Total economic integration	• No tariffs or quotas against member countries. • Common external tariff. • Free factor movement, including of labour. • Harmonization of economic policies and single currency. • Unification of monetary, fiscal, social, and counter-cyclical policies. • Requires a binding supranational organization.	• The United States, which has had a federal government system since 1789.

Source: Prepared by the authors, on the basis of B. Balassa, *The Theory of Economic Integration*, Routledge, 1961; E. Dorrucci and others, "The link between institutional and economic integration: insights for Latin America from the European experience", *Open Economies Review*, vol. 15, No. 3, July 2004; and E. B. Essien and M. Dickson, "Economic integration among the less developed countries: myth and the new international realities", *Developing Country Studies*, vol. 4, No. 12, 2014.

Note: The provisional enforcement dates correspond to de jure economic regional integration, or the official dates of signing of the creation treaties. In some cases, the effective implementation of the measures specified by the integration agreements (de facto integration) is not finished. For instance, AFTA, Mercosur, and the Andean Community are de jure agreements because de facto integration has not yet been achieved, and thus, they are incomplete free trade agreements and common markets.

The traditionally recommended recipe for successful economic integration has been to follow these stages in sequence, replicating the European integration model. However, because multiple integration experiences exist that have not followed this order, especially in Latin America, there is a need to review traditional theory, so that these experiences are also evaluated and not automatically dismissed for not following the established scheme (Bonilla-Bolaños, 2021).

Theory behind each of the integration stages proposed by Balassa (1961a and 1961b) is vast. For the purpose of this research, we shall focus on the theory developed around Balassa's fourth stage, the economic and monetary union. The OCA theory formulated by Mundell (1961) and expanded by authors such as Frankel and Rose (1997), Frankel (2004), Issing (2011), therefore forms the theoretical basis of this study (see box A1.1 in annex A1 for a theoretical summary).

While an EMU refers to any geographical area in which countries share a single currency, the OCA concept includes the optimality condition. Thus, for an EMU to be an OCA, sharing a currency must enable maximization of economic efficiency, i.e., the benefits of using a common currency must outweigh the costs for individual economies of giving up their own currencies (Mundell, 1961). Theoretically, because an EMU is a hard fixed exchange-rate regime, the evident cost of such a regime is the loss of independent monetary policy; countries belonging to an EMU must have common monetary policy. So, for countries to constitute an OCA, Mundell argues they need to meet one of two conditions: (i) the countries must experience similar shocks so that having a single monetary policy is not costly; or (ii) if the countries experience different shocks, they must have high factor mobility so that they can adjust to them.

Currently, high factor mobility is just one of several criteria included in OCA theory. Other prerequisites for belonging to an OCA (as detailed in box A1.1) include financial market integration, fiscal integration, inflation rate convergence and economic cycle synchronization (Mongelli, 2002). But what if any of the OCA criteria are met and two or more countries decide to share a single currency? What if a country, in this instance Ecuador, adopts a foreign country's currency? Can they synchronize ex-post?

Full dollarization, or formal dollarization as it is called in Ecuador, occurs when a country abandons its own currency and adopts another country's —which may or may not be the United States dollar— as a means of payment and unit of account. In essence, it is a form of a hard peg (Alesina and Barro, 2001). In fact, EMUs are also a form of hard peg. Therefore, OCA theory may be useful in studying full dollarization dynamics. Given all of this, it is possible to view the Ecuador-United States relationship as an informal monetary union: the formal dollarization of Ecuador can be studied as a special case of an EMU in which the United States and Ecuador share a currency but there is no monetary policy coordination. Viewed this way, it is possible that several of the criteria identified by OCA theory may be fulfilled ex-post, after Ecuadorian full dollarization.

Ex-post fulfilment of OCA criteria is known as the "endogeneity of the OCA criteria", a term coined by Frankel and Rose (1997 and 1998), formulated reflecting on the Lucas (1976) critique: currency union must be understood as a fundamental change of the policy regime; hence, it affects the underlying OCA criteria in such a way that they are more likely to be satisfied ex-post as both monetary and trade integration deepen. Therefore, the United States and Ecuador might be fulfilling some OCA criteria following Ecuadorian full dollarization.

In order to analyse the full dollarization of Ecuador using OCA theory it is necessary to recognize that: (i) if some OCA criteria are fulfilled, they must be attained ex-post (there was not an ordered process of joining together as for the eurozone; (ii) fulfilment of some OCA criteria between Ecuador and the European Union, for example, does not transform them into an OCA or into candidates for one.

At least two facets of this are of interest: (i) the degree of vulnerability of the Ecuadorian economy to changes in United States economic policy; and (ii) the level of synchronization of the main macroeconomic variables of Ecuador and the United States. An understanding of these two elements enables evaluation of the costs of full dollarization using an alternative approach.

The forces that favour and hinder currency unions and full dollarization are similar, because both entail abandoning a national currency. On the cost side of a single currency, monetary autonomy is relinquished, resulting in the loss of a national tool to smooth business cycles (Berg and Borensztein, 2000; Meade, 2009; Vernengo, 2006). This cost is especially important for an economy that is highly vulnerable to external shocks as Ecuador, whose business cycle is vulnerable to fluctuations in oil revenues (García-Albán, González-Astudillo and Vera-Avellán, 2021). On the benefit side, EMUs are said to have a benefit in terms of transaction costs, as using the same money facilitates trade in goods and services as well as financial exchanges. This is important because of globalization (Alesina and Barro, 2001). Moreover, full dollarization may lower the country's cost of foreign credit and enhance the credibility of government policy (Chang, 2000). Indeed, for a country with a track record of higher inflation and a reputation for breaking low inflation promises, a way to immediately gain low inflation credibility is to 'tie its hands' by forsaking national monetary sovereignty (Mongelli, 2008). A fully dollarized economy thus provides a framework of price stability whose benefits have been widely identified (Feldstein, 1997). In the case of Ecuador, stability of prices and exchange rates has reduced price speculation and general macroeconomic uncertainty, providing an economic planning environment that was expected to improve Ecuadorian inhabitants' economic well-being (Anderson, 2016).

Through dollarization Ecuador undoubtedly gained credibility and successfully stabilized its high inflation levels (Onur Tas and Togay, 2015). In short, Ecuador imported credibility from the United States, which is a clear advantage, but it is likely now more vulnerable to United States policy changes. Although the saying “when America sneezes, the world catches a cold” is well known, this pre-existing sensitivity might increase through dollarization. We therefore chose two OCA criteria to test: (i) inflation rate similarity or synchronization (convergence); and (ii) similarity of shocks and business cycles. Considering that the United States is autonomous in terms of monetary policy, testing ex-post achievement of these OCA criteria will shed light on how vulnerable the Ecuadorian economy is to United States economic policy changes.

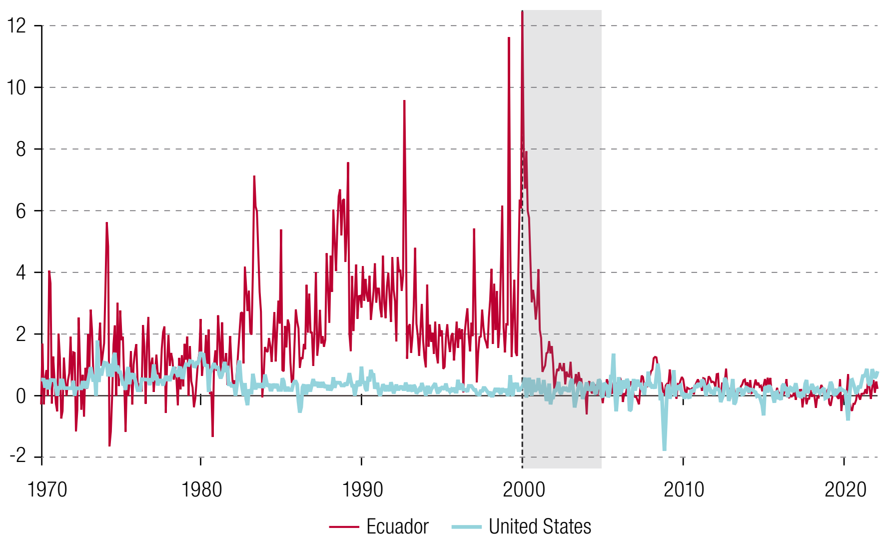
III. Methodological approach

Having outlined the theoretical basis of this study, we propose: (i) examining the degree of long-run synchronization between headline inflation rates in Ecuador and the United States using unit root tests and stationarity tests; and (ii) determining how vulnerable the Ecuadorian economy is to United States economic policy changes by estimating impulse-response functions through a structural vector autoregression (SVAR) model.

1. Long-run inflation rate synchronization

Figure 1 shows a clear post-2000 change in the pattern of Ecuadorian inflation: not only did it stabilize —as has been evidenced in empirical research, such as that by Onur Tas and Togay (2015)— it also seems to have synchronized with United States inflation. We therefore employ the strategy of Busetti and others (2007) to test synchronization between the inflation rates in the United States and Ecuador, using the difference between the two rates (the inflation differential, as shown in figure 2) to perform unit root and stationarity tests.

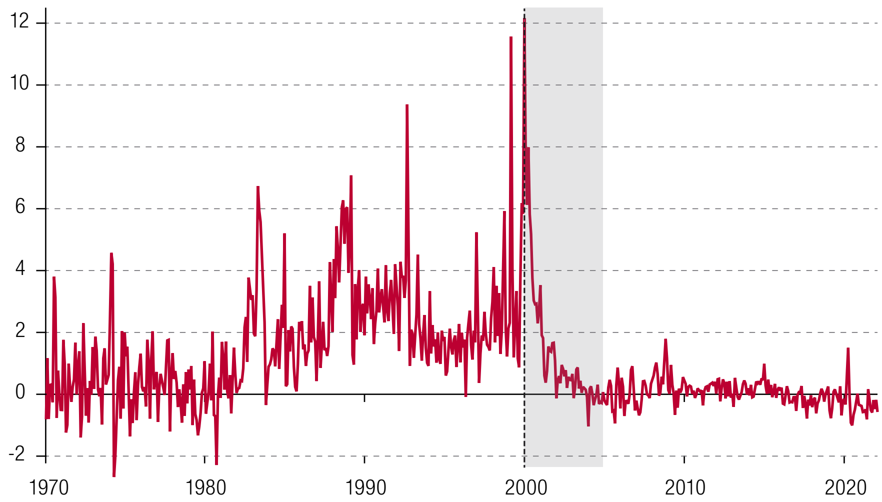
Figure 1
United States and Ecuador: headline inflation rates, January 1970–December 2021
(Percentages)



Source: Prepared by the authors, on the basis of Federal Reserve Bank of St. Louis, “Consumer price index: total all items for the United States (CPALTT01USM657N)”, Federal Reserve Economic Data (FRED), 2023 [online] https://fred.stlouisfed.org/series/CPALTT01USM657N and National Institute of Statistics and Census (INEC), “Índice de precios al consumidor”, 2023 [online] https://www.ecuadorencifras.gob.ec/indice-de-precios-al-consumidor/.

Note: The grey area indicates January 2000–December 2004, which is considered a period of adjustment (noise).

Figure 2
United States-Ecuador headline inflation differential, January 1970–December 2021



Source: Prepared by the authors, on the basis of Federal Reserve Bank of St. Louis, "Consumer price index: total all items for the United States (CPALTT01USM657N)", Federal Reserve Economic Data (FRED), 2023 [online] https://fred.stlouisfed.org/series/CPALTT01USM657N and National Institute of Statistics and Census (INEC), "Índice de precios al consumidor", 2023 [online] https://www.ecuadorencifras.gob.ec/indice-de-precios-al-consumidor/.
Note: The grey area indicates January 2000–December 2004, which is considered a period of adjustment (noise).

Augmented Dickey-Fuller (ADF) unit root tests (Cheung and Lai, 1995; Dickey and Fuller, 1979) are applied to establish whether the United States-Ecuador inflation series are in the process of converging, and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) stationarity tests (Kwiatkowski and others, 1992) to examine whether the series have converged (whether the inflation rate differential is stable). We have called this convergence process long-run synchronization, because even if the series have not yet converged, they may show synchronization patterns. To test for long-run inflation synchronization we apply ADF tests based on a p'th-order autoregressive process $(AR(p))$:

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \sum_{j=2}^{p} \rho_j \Delta Y_{t-j+1} + \varepsilon_t \quad (1)$$

where Y_t is the series capturing the inflation differential. If $\pi_{t,US}$ $(\pi_{t,EC})$ denotes the inflation rate series for the United States (Ecuador), properties of convergence between the United States and Ecuador can be studied using time series properties of the inflation differential between them, i.e. by studying $Y_t = \pi_{t,US} - \pi_{t,EC}$. Then, to determine whether convergence is occurring, the null hypothesis of a unit root is tested in (1). The hypotheses are:

H_0: $\rho = 0$; No synchronization is evidenced

H_a: $\rho < 0$; Synchronization is evidenced

The inflation patterns shown in figures 1 and 2, however, suggest convergence, hence we perform KPSS stationarity tests for Y_t to test a level stationarity null hypothesis (H_0). If the null is not rejected, convergence is evidenced: H_0: Convergence is evidenced.

The time series literature on convergence uses both unit root and stationarity tests to detect convergence (Busetti and others, 2007). While unit root tests are useful for identifying a process of convergence between two series, stationarity tests (such as KPSS) are suited for determining whether the series have converged, which is to say whether the difference between series is stable. In understanding such a process of convergence as long-run synchronization, our methodology is limited to a long-run pattern: we are testing for the existence of a single stochastic trend between the inflation rates series of the United States and Ecuador. As a result, business cycle synchronization patterns are not studied.

Because dollarization of the Ecuadorian economy is a structural change, we test pre- and post-dollarization inflation rate series separately: the pre-dollarization period covers monthly data from January 1970 to December 1999, and the post-dollarization period runs from January 2005 to December 2021. The series from January 2000 to December 2004 is not included as it is considered a period of adjustment (noise). Inflation rate differentials are constructed using the United States and Ecuadorian consumer price indices (CPI) retrieved from the Federal Reserve Economic Data (FRED) (Federal Reserve Bank of St. Louis, 2023a)[1] and the Ecuadorian National Institute of Statistics and Census INEC, 2023)[2] databases. So, Y_t in (1) is $Y_t = \pi_t^i - \pi_t^j$ with i, j = Ecuador, United States. Specifically, the inflation series, π_t, reflects the (monthly) log-differences of the national CPIs and their trends are shown in figures 1 and 2. The results of this exercise are discussed in section IV.1.

2. Structural vector autoregression modelling

SVAR modelling enables estimation of the response of a time series to an impulse in another time series included in the vector of variables (Sims, 1980 and 1986). Therefore, we employ a SVAR strategy to capture the response of Ecuadorian macroeconomic variables to changes (shocks) in the variables of monetary policy of the United States. Specifically, the econometric strategy is described by the linear simultaneous p'th-order difference-equation model as follows:

$$A_0 X_t = A_1 X_{t-1} + \ldots + A_p X_{t-p} + \varepsilon_t \tag{2}$$
$$A(L)X_t + \varepsilon_t \text{ with } \varepsilon_t | X_s \text{, s} < t \sim N(0,I)$$

Where X_t is a 3×1 vector of endogenous variables at time t and $X_t^T = (r_{fed}, \Delta y_{ec}, \pi_{ec})$ with r_{fed}: as the nominal interest rate of the United States Federal Reserve (its monetary policy tool), y_{ec}: as Ecuador's real GDP in logarithmic terms, and π_{ec}: as the Ecuadorian inflation rate. L is the lag operator, and p is a finite-order lag length. A_0 is a 3× 3 matrix that summarizes the contemporaneous relationships between the variables and ε_t is the 3×1 vector of structural disturbances. Data on the series included in X_t were obtained from the FRED database and Central Bank of Ecuador databases (Central Bank, 2023). Because dollarization is a structural change, we estimate two SVAR models for each subperiod: pre- and post-dollarization. The pre-dollarization period includes quarterly data from the first quarter of 1980 to the fourth quarter of 1999 and the post-dollarization period runs from the first quarter of 2005 to the fourth quarter of 2021. Again, the period from 2000 to 2004 is omitted as it is considered a period of adjustment (noise). Because for the pre-dollarization model, we were not able to recover quarterly Ecuadorian real GDP[3] data, the pre-dollarization model includes a X_t in (2) that is a 2×1 vector: $X_t^T = (r_{fed}, \Delta\pi_{ec})$ and ε_t in (2) is 2×1. In both the pre- and post-dollarization periods,

[1] Consumer Price Index: Total All Items for the United States [CPALTT01USM661S], index 2015=100, monthly, seasonally adjusted.

[2] Index 2014=100, monthly. We seasonally adjust the series and scale it to be index 2015=100. We treated seasonality using the seasonal R's package (see [online] https://www.r-project.org/about.html) following the methodology proposed by Sax and Eddelbuettel (2018).

[3] The Central Bank of Ecuador database only includes post-dollarization information. When asked for pre-dollarization data, the central bank responded that no quarterly data exist for Ecuadorian real GDP before 2000, and that only annual data is available for that period.

A_0 is assumed to be non-singular, such that (2) provides a complete description of the conditional distribution of X_t given X_s, and $s < t$ can be solved by multiplying through on the left by A_0^{-1} to produce the reduced form:

$$X_t = B_1 X_{t-1} + \ldots + B_p X_{t-p} + \mu_t \qquad (3)$$
$$B(\mathrm{L}) X_t = \mu_t$$

in which $B_0 = I$ and μ_t is white noise that represents the vector of canonical disturbances (3×1) for the post-dollarization period and (2×1) for the pre-dollarization period, whose variance-covariance matrix is not restricted. The canonical (μ_t) and structural disturbances (ε_t) are linked by the relationship $A_0 \mu_t = \varepsilon_t$. The identification strategy relies on a Cholesky decomposition, meaning that some restrictions are imposed on A_0, so that A_0^{-1} is a lower triangular matrix; i.e. the identification strategy relies on short-term restrictions. Thus, for post-dollarization:

$$A_0^1 = \begin{pmatrix} a_{11}^1 & 0 & 0 \\ a_{21}^1 & a_{22}^1 & 0 \\ a_{31}^1 & a_{32}^1 & a_{33}^1 \end{pmatrix}$$

meaning that the Federal Reserve nominal interest rate does not contemporaneously (within a quarter) respond to any Ecuadorian macroeconomic indicator, $\left(a_{12}^1, a_{13}^1\right) = (0,0)$; and that Ecuadorian real GDP growth rate does not instantaneously react to changes in the Ecuadorian inflation rate, $\left(a_{13}^1\right) = 0.$ And, for the pre-dollarization period:

$$A_0^2 = \begin{pmatrix} a_{11}^2 & 0 \\ a_{21}^2 & a_{22}^2 \end{pmatrix}$$

meaning that the Federal Reserve nominal interest rate does not contemporaneously respond to changes in the Ecuadorian inflation rate, $\left(a_{12}^2\right) = 0$. The results of this exercise are discussed in section IV.2.

IV. Results

Two aspects of the results of our exercise are discussed separately: (i) the long-run inflation synchronization between Ecuador and the United States in section IV.1; and (ii) Ecuadorian responses to United States economic policy changes in section IV.2.

1. Long-run inflation rate synchronization

Table 2 shows the results of the unit root and stationarity tests of United States-Ecuador inflation rate differentials for the pre- and post-dollarization periods. Sections A and B in table 2 contain the outcome of the ADF test (whether the null hypothesis is rejected at the 1%, 5%, or 10% significance level or not rejected; the retained lags and the test statistics), while section C displays the outcome of the KPSS test.

Table 2
Unit root and stationarity tests on United States-Ecuador inflation differentials

		Pre-dollarization January 1970–December 1999	Post-dollarization January 2005–December 2021
A. H_0: $\rho = 0$; No synchronization is evidenced			
ADF-No intercept	Statistic	-0.727	-3.152
	Reject[a]	Not rejected	10%
	Lags	12	12
B. H_0: $\rho = 0$; No synchronization is evidenced			
ADF-Intercept	Statistic	-1.975	-3.153
	Reject[a]	5%	10%
	Lags	12	12
C. H_0: Convergence is evidenced			
KPSS	Statistic	1.32	0.666
	Reject[a]	1%	Not rejected

Source: Prepared by the authors, on the basis of Federal Reserve Bank of St. Louis, "Consumer price index: total all items for the United States (CPALTT01USM657N)", Federal Reserve Economic Data (FRED), 2023 [online] https://fred.stlouisfed.org/series/CPALTT01USM657N and National Institute of Statistics and Census (INEC), "Índice de precios al consumidor", 2023 [online] https://www.ecuadorencifras.gob.ec/indice-de-precios-al-consumidor/.

[a] Refers to the rejection percentage: whether the null hypothesis is rejected at the 1%, 5%, or 10% significance level or not rejected.

The theoretical belief is that long-run inflation synchronization does exist in the post-dollarization period, i.e. ex-post achievement of OCA criteria (Frankel and Rose, 1998). Long-run synchronization of inflation rates in the pre-dollarization period is not necessarily expected. The evidence of post-dollarization long-run synchronization is strong: the ADF test rejects the null hypothesis at the 10% significance level. Pre-dollarization long-run synchronization is not conclusively demonstrated. Nevertheless, post-dollarization, the inflation rates of the United States and Ecuador inflation rates can be said to be in the process of converging. A stronger hypothesis is that the inflation rates of the United States and Ecuador have already converged. This does indeed appear to be the case. In the KPSS test results, the null of convergence is not rejected for the post-dollarization period. This convergence is immediately apparent in figure 2, and the results in table 2 merely confirm this supposition.

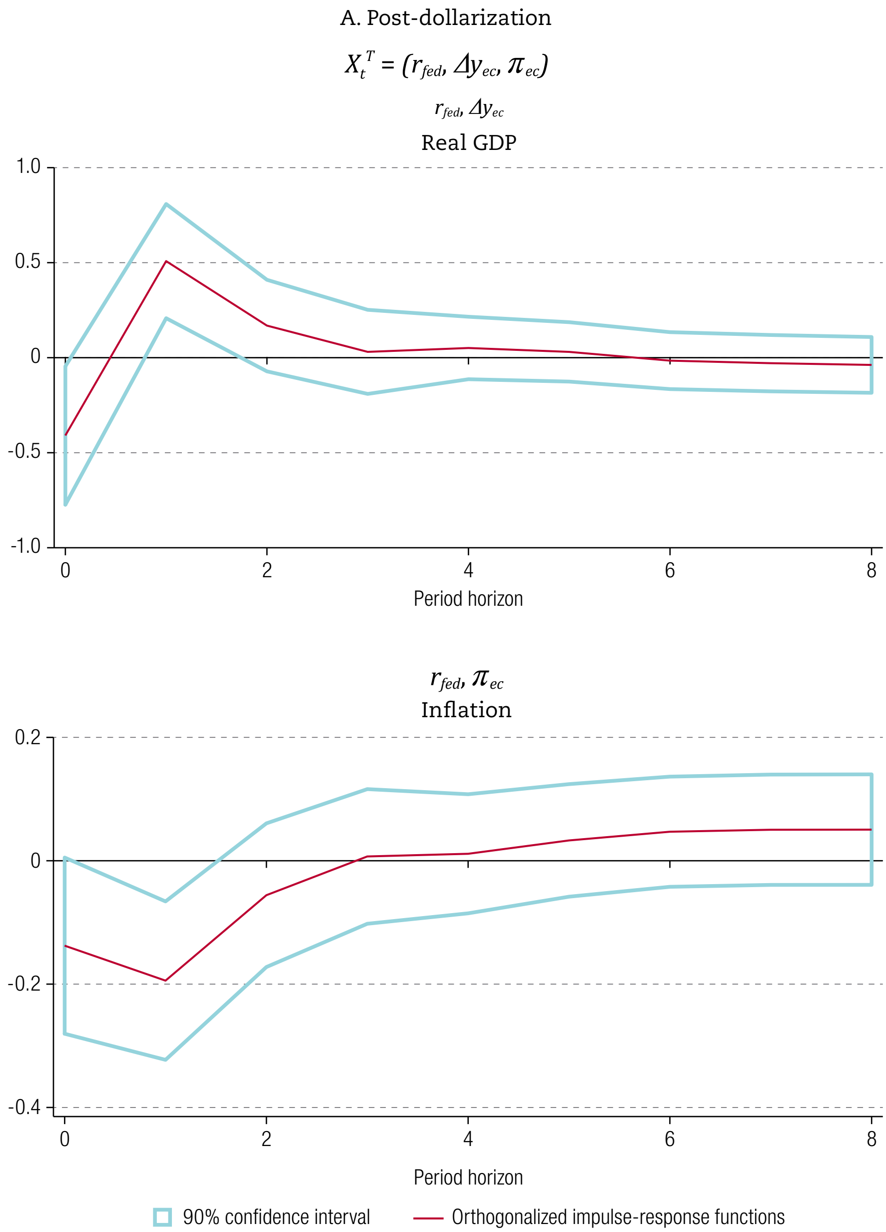
Given our results, not only has Ecuador gained credibility and successfully stabilized its inflation from high pre-dollarization levels (Onur Tas and Togay, 2015), its inflation also appears to have converged to United States levels. Although the KPSS test provides evidence of convergence, there are some non-negligible short-run patterns of divergence. For instance, since 2017, Ecuador has reported periods of negative inflation (see figure 1), while the United States has not. Some clues as to the repercussions of deflation can be found in Lin and Wu (2012) and Oikawa and Ueda (2018), among other studies. Regardless, negative inflation entails challenges in terms of economic stability and growth, the nature of which is still unknown in the case of Ecuador (Calvo, 2002). In fact, a shared long-run pattern in the inflation rates of the United States and Ecuador does not necessarily mean that their short-run trends will match or that severe problems will not arise in the event of deflation. The hypothesis that business cycles are not symmetric, i.e., contractions are shorter and sharper than expansions (Morley and Piger, 2012), adds to the deflation issue, so negative trends can be more harmful than positive ones. Although this issue falls outside the scope of this article, it should nonetheless be considered.

In short, full dollarization allowed Ecuador to import credibility from the United States and stabilize its prices. In addition, the inflation rates of the United States and Ecuador appear to be converging, which would be a clear advantage. One disadvantage of full dollarization is potential high vulnerability to United States policy changes. Section IV.2 sheds some light on this.

2. Ecuadorian vulnerability to United States monetary policy changes

To compare the pre- and post-dollarization responses of selected Ecuadorian macroeconomic variables to changes in the United States Federal Funds Effective Rate, we perform the preliminary exercise illustrated below. Figure 3A displays the impulse-response functions for the post-dollarization period and figure 3B does the same for pre-dollarization. A response is significant if its confidence interval does not include the zero axis. Table 3 displays the forecast error variance decomposition.

Figure 3
Impulse-response functions of Ecuadorian macroeconomic variables to an increase of 1 percentage point in the United States Federal Funds Effective Rate

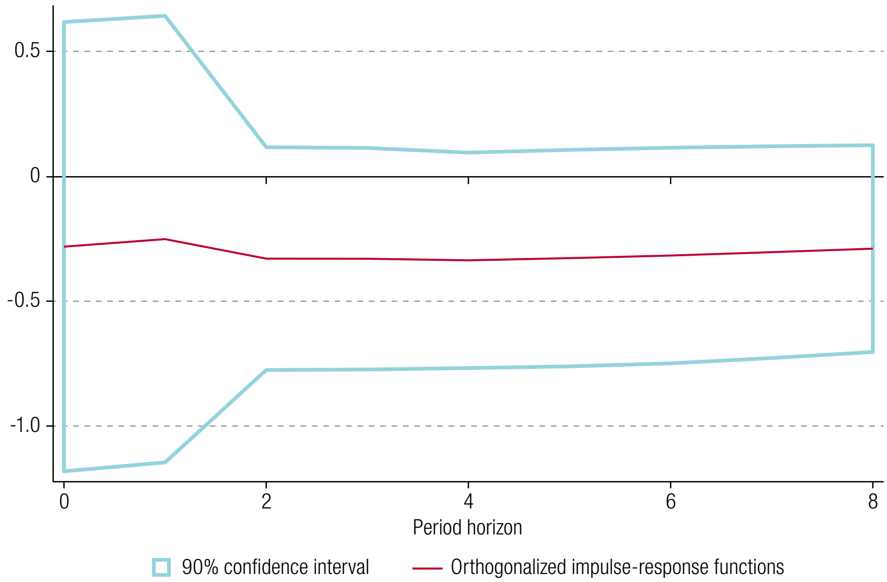


B. Pre-dollarization

$X_t^T = (r_{fed}, \pi_{ec})$

r_{fed}, π_{ec}

Inflation



Source: Prepared by the authors, on the basis of Federal Reserve Bank of St. Louis, "Consumer price index: total all items for the United States (CPALTT01USM657N)", Federal Reserve Economic Data (FRED), 2023 [online] https://fred.stlouisfed.org/series/CPALTT01USM657N. National Institute of Statistics and Census (INEC), "Índice de precios al consumidor", 2023 [online] https://www.ecuadorencifras.gob.ec/indice-de-precios-al-consumidor/ and Ecuadorian Central Bank, "Boletín de Cuentas Nacionales Trimestrales", 2023 [online] https://contenido.bce.fin.ec/documentos/PublicacionesNotas/Catalogo/CuentasNacionales/Anuales/Dolares/IndiceCtasNac.htm.

Note: Graphs are by impulse variable and response variable.

Table 3

Forecast error variance decomposition after an increase in the United States Federal Funds Effective Rate

Horizon	Pre-dollarization January 1970–December 1999	Post-dollarization January 2005–December 2021	
	Ecuadorian inflation rate π_{ec}	Ecuadorian real GDP Δy_{ec}	Ecuadorian inflation rate π_{ec}
1	0.003402	0.049005	0.036289
2	0.005795	0.115473	0.089977
3	0.009481	0.112185	0.088817
4	0.013376	0.111568	0.086639

Source: Prepared by the authors, on the basis of Federal Reserve Bank of St. Louis, "Consumer price index: total all items for the United States (CPALTT01USM657N)", Federal Reserve Economic Data (FRED), 2023 [online] https://fred.stlouisfed.org/series/CPALTT01USM657N. National Institute of Statistics and Census (INEC), "Índice de precios al consumidor", 2023 [online] https://www.ecuadorencifras.gob.ec/indice-de-precios-al-consumidor/ and Ecuadorian Central Bank, "Boletín de cuentas nacionales trimestrales", 2023 [online] https://contenido.bce.fin.ec/documentos/PublicacionesNotas/Catalogo/CuentasNacionales/Anuales/Dolares/IndiceCtasNac.htm.

Note: Only bold results are statistically different from zero. The reported values refer to the fraction of the total forecast-error variance of each Ecuadorian series that is attributable to a 1 percentage point increase (shock) in the Federal Funds Effective Rate.

The r_{fed}, Δy_{ec}, π_{ec} series are stationary and Akaike information criterion (AIC) and Bayesian information criterion (BIC) suggest that L should be set to 2 in (2) and (3). The estimated SVAR stability tests and impulse-response functions graphs are included in annexes A2 and A3.

There is a clear difference between pre- and post-dollarization results. Pre-dollarization, the Ecuadorian inflation rate does not react to changes in the Federal Funds Effective Rate. However, post-dollarization, the Ecuadorian inflation rate does significantly decrease when the Federal Funds Effective Rate increases (see figure 3A). Moreover, post-dollarization, there is evidence that Ecuador's real GDP growth rate immediately lightly decreases one period after an increase in the Federal Funds rate. This a short-duration impact, because it becomes zero in period 2 (see figure 3A). Thus, there is preliminary evidence of inflation synchronization ex-post adoption of the informal monetary union. Consequently, monetary policy changes by the United States do affect patterns in Ecuadorian macroeconomic variables. However, when examining the extent to which forecast-error variance of Ecuadorian series are attributed to the error in the United States Federal Funds Effective Rate equation, we found weak impacts. As shown in table 3, post-dollarization, 11.54% of the Ecuadorian real GDP growth rate variation and around 9% of the change in the Ecuadorian inflation rate are explained by the Federal Funds Effective Rate increase. Therefore, the dollarized Ecuadorian economy does appear to be vulnerable to United States policy changes, but this must be confirmed with further research.

V. Conclusions

The findings of this study clearly show that full dollarization of Ecuador did change its monetary relation with the United States. Post-dollarization, not only did the inflation rates of the United States and Ecuador start to synchronize, they also converged. The Ecuadorian economy also appears to have become vulnerable to United States monetary policy changes.

The finding of convergence of the inflation rates of the United States and Ecuador is crucial for Ecuadorian monetary policy. Even though full dollarization entails a limitation of monetary autonomy, non-conventional monetary tools exist that can be implemented, because of money endogeneity (Missaglia, 2021). In fact, full dollarization of Ecuador works as a fractional reserve scheme: only a portion of the total liquidity of the Ecuadorian economy is in United States dollars, the other part is in currencies that are convertible to dollars or records denominated in dollars (secondary money) (Villalba, 2019). Consequently, monetary expansion is possible by increasing secondary money through the money multiplier. Some Ecuadorian monetary policymakers would like to use such non-conventional monetary tools, but, if United States monetary policy does succeed in stabilizing inflation, what is the incentive for Ecuador to change monetary policy? This is an ongoing debate. Some argue that trying to intervene is futile, because, for instance, Ecuador is not a disciplined country, so, not having a monetary tool is better than using it badly (Krugman, 2000) and that its fiscal policy is sustainable and might be enough (Marí Del Cristo and Gómez-Puig, 2016). There are also those who call for some degree of monetary autonomy for Ecuador, one reason being vulnerability to United States shocks. In any case, a monetary policy tool is useful beyond stabilizing prices. Macroeconomic policy is needed to smooth the business cycle, making it an important tool for labour market and welfare policies.

This study did find some evidence of Ecuadorian vulnerability to United States monetary policy changes. However, the transmission channels permitting Ecuador to import United States monetary policy credibility are the same ones that make the Ecuadorian economy vulnerable to United States shocks, or are similar to them. In essence, it is the price to pay for a benefit. This is also an ongoing debate on these channels to which we shall not contribute here (see, for instance, Calvo (2002), Vernengo and Bradbury (2011) or Anderson (2016)). Our aim in this article has been to demonstrate that OCA theory is useful for analysing fully dollarized economies. We argue that full dollarization can be studied as an informal monetary union and shed some light on how by performing two econometrical exercises, the results of which are in line with those in Castillo, Truong and Rodríguez (2021). There is, of course, a great deal more to investigate on this subject.

In sum, we present preliminary evidence that inflation synchronization occurred ex-post adoption of full dollarization by Ecuador (what we have called an informal monetary union). Consequently, monetary policy changes by the United States do affect patterns in Ecuadorian macroeconomic variables. Our analysis suggests vulnerability of the dollarized country in this regard, which needs to be confirmed with future research. Irrespective, OCA theory may be a useful framework to study fully dollarized economies. Lastly, our results suggest that macro-econometric modelling applied to Ecuador should include the United States interest rate to better capture time series patterns.

Bibliography

Alesina, A. and R. J. Barro (2001), "Dollarization", *American Economic Review*, vol. 91, No. 2, May.

Alesina, A. and others (2002), "Fiscal policy, profits, and investment", *American Economic Review*, vol. 92, No. 3, June.

Anderson, A. (2016), "Dollarization: a case study of Ecuador", *Journal of Economics and Development Studies*, vol. 4, No. 2, June.

Balassa, B. (1961a), *The Theory of Economic Integration*, Routledge.

___(1961b), "Towards a theory of economic integration", *Kyklos*, vol. 14, No. 1, February.

Barro, R. J. and D. B. Gordon (1983), "A positive theory of monetary policy in a natural rate model", *Journal of Political Economy*, vol. 91, No. 4, August.

Berg, A. and E. Borensztein (2000), "The pros and cons of full dollarization", *IMF Working Paper*, No. WP/00/50, International Monetary Fund (IMF).

Bonilla-Bolaños, A. (2021), "A step further in the theory of regional integration: a look at the South American integration strategy", *Journal of International Development*, vol. 33, No. 5, July.

Buiter, W. (1995), "Macroeconomic policy during a transition to monetary union", *Discussion Paper*, No. 261, Centre for Economic Performance, August.

Busetti, F. and others (2007), "Inflation convergence and divergence within the European Monetary Union", *International Journal of Central Banking*, vol. 3, No. 2, June.

Calvo, G. A. (2002), "On dollarization", *Economics of Transition and Institutional Change*, vol. 10, No. 2, July.

Calvo, G. A. and C. M. Reinhart (2002), "Fear of floating", *The Quarterly Journal of Economics*, vol. 117, No. 2, May.

Castillo, R., B. Truong and M. L. Rodríguez (2021), "Dollarization and economic interdependence: the case of Ecuador", *Revista de Análisis Económico*, vol. 36, No. 1, April.

Chang, R. (2000), "Dollarization: a scorecard", *Economic Review*, vol. 85, No. 3, Federal Reserve Bank of Atlanta.

Cheung, Y.-W. and K. S. Lai (1995), "Lag order and critical values of the augmented Dickey-Fuller test", *Journal of Business & Economic Statistics*, vol. 13, No. 3, July.

Central Bank of Ecuador (2023), "Boletín de cuentas nacionales trimestrales", 2023 [online] https://contenido.bce.fin.ec/documentos/PublicacionesNotas/Catalogo/CuentasNacionales/Anuales/Dolares/IndiceCtasNac.htm.

Collins, S. M. (1996), "On becoming more flexible: exchange rate regimes in Latin America and the Caribbean", *Journal of Development Economics*, vol. 51, No. 1, October.

Corden, W. M. (1972), "Monetary integration", *Essays in International Finance*, No. 93, Princeton University.

De Grauwe, P. and F. Mongelli (2005), "Endogeneities of optimum currency areas", *Working Paper Series*, No. 468, European Central Bank, April.

Dickey, D. A. and W. A. Fuller (1979), "Distribution of the estimators for autoregressive time series with a unit root", *Journal of the American Statistical Association*, vol. 74, No. 366, June.

Dorrucci, E. and others (2004), "The link between institutional and economic integration: insights for Latin America from the European experience", *Open Economies Review*, vol. 15, No. 3, July.

Edwards, S. (1996), "Exchange rates and the political economy of macroeconomic discipline", *The American Economic Review*, vol. 86, No. 2, January.

Essien, E. B. and M. Dickson (2014), "Economic integration among the less developed countries: myth and the new international realities", *Developing Country Studies*, vol. 4, No. 12.

Federal Reserve Bank of St. Louis (2023a), "Consumer price index: total all items for the United States (CPALTT01USM657N)", Federal Reserve Economic Data (FRED) [online] https://fred.stlouisfed.org/series/CPALTT01USM657N.

___(2023b), "Federal Funds Effective Rate (FEDFUNDS)" [online] https://fred.stlouisfed.org/series/FEDFUNDS.

Feldstein, M. S. (1997), "The costs and benefits of going from low inflation to price stability", *Reducing Inflation: Motivation and Strategy*, C. D. Romer and D. H. Romer (eds.), University of Chicago Press.

Fleming, J. M. (1971), "On exchange rate unification", *The Economic Journal*, vol. 81, No. 323, September.

Frankel, J. A. (2004), "Real convergence and euro adoption in Central and Eastern Europe: trade and business cycle correlations as endogenous criteria for joining EMU", *Faculty Research Working Paper Series*, No. RWP04-039, Harvard University.

___(1999), "No single currency regime is right for all countries or at all times", *Working Paper*, No. 7338, National Bureau of Economic Research (NBER).

Frankel, J. A. and A. K. Rose (1998), "The endogeneity of the optimum currency area criteria", *The Economic Journal*, vol. 108, No. 449, July.

___(1997), "Is EMU more justifiable ex post than ex ante?", *European Economic Review*, vol. 41, No. 3–5, April.

Friedman, M. (1966), "The methodology of positive economics", *Essays in Positive Economics*, Chicago, University of Chicago Press.

García-Albán, F., M. González-Astudillo and C. Vera-Avellán (2021), "Good policy or good luck? Analyzing the effects of fiscal policy and oil revenue shocks in Ecuador", *Energy Economics*, vol. 100, August.

Haberler, G. (1970), "The international monetary system: some recent developments and discussions", *Approaches to Greater Flexibility of Exchange Rates*, C. F. Bergsten and others, Princeton University Press.

INEC (National Institute of Statistics and Census) (2023), "Índice de precios al consumidor" [online] https://www.ecuadorencifras.gob.ec/indice-de-precios-al-consumidor/.

Ingram, J. C. (1962), *Regional Payments Mechanisms: The Case of Puerto Rico,* University of North Carolina Press.

Ishiyama, Y. (1975), "The theory of optimum currency areas: a survey", *Staff Papers*, vol. 22, No. 2, International Monetary Fund (IMF).

Issing, O. (2011), "The crisis of European Monetary Union: lessons to be drawn", *Journal of Policy Modeling*, vol. 33, No. 5, September-October.

Jácome, L. and Å. Lönnberg (2010), "Implementing official dollarization", *IMF Working Paper*, No. WP/10/106, International Monetary Fund (IMF).

Kawai, M. (1987), "Optimum currency areas", *The New Palgrave: A Dictionary of Economics*, New York, Stockton Press.

Kenen, P. (1969), "The theory of optimum currency areas: an eclectic view", *Monetary Problems of the International Economy*, R. Mundell and A. Swoboda (eds.), Chicago, University of Chicago Press.

Krugman, P. (2000), "Dollars and desperation", *The New York Times*, 19 January [online] https://archive.nytimes.com/www.nytimes.com/library/opinion/krugman/011900krug.html.

Kwiatkowski, D. and others (1992), "Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root?", *Journal of Econometrics*, vol. 54, No. 1–3, October–December.

Kydland, F. and E. Prescott (1977), "Rules rather than discretion: the inconsistency of optimal plans", *Journal of Political Economy*, vol. 85, No. 3, June.

Lin, P.-C. and C.-S. Wu (2012), "Exchange rate pass-through in deflation: the case of Taiwan", *International Review of Economics & Finance*, vol. 22, No. 1, April.

Lucas, R. E. (1976), "Econometric policy evaluation: a critique", *Carnegie-Rochester Conference Series on Public Policy*, vol. 1.

Marí Del Cristo, M. L. and M. Gómez-Puig (2016), "Fiscal sustainability and dollarization: the case of Ecuador", *Applied Economics*, vol. 48, No. 23.

McKinnon, R. I. (1963), "Optimum currency areas", *The American Economic Review*, vol. 53, No. 4, September.

Meade, E. E. (2009), "Monetary integration", *Harvard International Review*, vol. 30, No. 4.

Mintz, N. (1970), *Monetary Union and Economic Integration*, C. J. Devine Institute of Finance, New York University Press.

Missaglia, M. (2021), "Understanding dollarisation: a Keynesian/Kaleckian perspective", *Review of Political Economy*, vol. 33, No. 4.

Mongelli, F. P. (2008), *European Economic and Monetary Integration, and the Optimum Currency Area Theory*, Directorate-General for Economic and Financial Affairs, European Commission.

___(2002), "'New' views on the optimum currency area theory: what is EMU telling us?", *Working Paper*, No. 138, European Central Bank.

Morley, J. and J. Piger (2012), "The asymmetric business cycle", *The Review of Economics and Statistics*, vol. 94, No. 1, February.

Mundell, R. A. (1973), "Uncommon arguments for common currencies", *The Economics of Common Currencies*, H. G. Johnson and A. K. Swoboda (eds.), London, George Allen & Unwin.

___(1961), "A theory of optimum currency areas", *The American Economic Review*, vol. 51, No. 4, September.

Oikawa, K. and K. Ueda (2018), "The optimal inflation rate under Schumpeterian growth", *Journal of Monetary Economics*, vol. 100, December.

Onur Tas, B. K. and S. Togay (2015), "Efectos de la dolarización oficial en una pequeña economía abierta: el caso de Ecuador", *Investigación Económica*, vol. 73, No. 290.

Sax, C. and D. Eddelbuettel (2018), "Seasonal adjustment by X-13ARIMA-SEATS in R", *Journal of Statistical Software*, vol. 87, No. 11, December.

Sims, C. A. (1986), "Are forecasting models usable for policy analysis?", *Quarterly Review*, vol. 10, No. 1, Federal Reserve Bank of Minneapolis.

___(1980), "Macroeconomics and Reality", *Econometrica*, vol. 48, No. 1, January.

Tower, E. and T. Willett (1976), *The Theory of Optimum Currency Areas and Exchange-rate Flexibility*, Princeton University.

Vernengo, M. (ed.) (2006), *Monetary Integration and Dollarization: No Panacea*, Cheltenham, Edward Elgar Publishing.

Vernengo, M. and M. Bradbury (2011), "The limits to dollarization in Ecuador: lessons from Argentina", *Journal of World-Systems Research*, vol. 17, No. 2, August.

Villalba, M. (ed.) (2019), *Dolarización: dos décadas después*, Quito, Consorcio de Gobiernos Autónomos Provinciales del Ecuador (CONGOPE)/Ediciones Abya Yala/Incidencia Pública del Ecuador/Instituto de Trabajo y Economía (ITE).

Wyplosz, C. and D. Cohen (eds.) (1989), "The European Monetary Union: an agnostic evaluation", *Discussion Papers*, No. 306, Centre for Economic Performance.

Annex A1

Box A1.1
Optimum currency area (OCA) theory

An OCA is defined as "the optimal geographic domain of a single currency, or of several currencies, whose exchange rates are irrevocably pegged and might be unified" (Mongelli, 2002, p. 7).[a] This common or pegged currency can fluctuate only with those of the rest of the world. The optimal character of an OCA is determined based on a number of properties or "criteria", including mobility of factors of production, price and wage flexibility, economic openness, diversification of production and consumption, similarity of inflation rates, fiscal integration and political integration. These properties reduce the effectiveness of nominal exchange rate adjustments within the currency area by promoting internal and external balance, thus reducing the impact of certain shocks.

The traditional OCA criteria, developed during the "pioneer phase" of OCA theory (Mongelli, 2002), are as follows:[b]

- The existence of nominal prices and wage flexibility within countries sharing a currency reduces the need for exchange-rate adjustments after a disturbance, because it is unlikely to be associated with sustained unemployment in one country and inflation in another (Friedman, 1966; Kawai, 1987).
- High mobility of factors of production can reduce the need to alter real factor prices and nominal exchange rates between countries in response to disturbances, owing to the reallocation created by factor market integration (Mundell, 1961). Although labour mobility is usually low in the short run, because of migration and retraining costs, it could be higher in the medium and long run, facilitating adjustment after permanent disturbances (Corden, 1972).
- Financial market integration allows temporary adverse disturbances to be softened by capital inflows, thereby reducing the need for exchange-rate adjustments (Ingram, 1962).
- The higher the degree of economic openness, the less useful the nominal exchange rate is as an adjustment instrument, because the higher openness is: (i) the more changes in international prices impact domestic prices directly and indirectly; and (ii) devaluation would be transmitted more rapidly to the price of tradable goods and the cost of living, negating its intended effects (McKinnon, 1963).
- Greater diversification of production and consumption (i.e., in the jobs portfolio, and in imports and exports) decreases the possible impacts of shocks specific to an individual sector, thus reducing the need for changes in the terms of trade (Kenen, 1969).
- When countries have similar (and low) inflation rates, the terms of trade would remain relatively stable, in turn, fostering more balanced current account transactions and trade, and thus reducing the need for nominal exchange-rate adjustments (Fleming, 1971).
- Political integration. Willingness within a group of countries contemplating adoption of a single currency, among other effects, fosters compliance with joint commitments, sustains cooperation on various economic policies, and encourages more institutional linkages (Mintz, 1970). A currency area needs a reasonable degree of policy and preference compatibility to succeed (Haberler, 1970; Tower and Willett, 1976).
- The similarity of supply and demand shocks and business cycles is the "metaproperty" because it captures the interaction between several properties. In fact, membership of a monetary union entails forgoing national exchange-rate and monetary policy. In this case, adjustment costs depend directly on the asymmetry of the shocks each economy faces: if all member countries of a monetary union face the same shocks, there are no costs of having a common policy. Thus, the above conditions (e.g. fiscal integration, wage and price flexibility) are not necessary (Wyplosz and Cohen, 1989; Corden, 1972; Ishiyama, 1975; Mundell, 1973; Tower and Willett, 1976).

Source: A. Bonilla-Bolaños, "A step further in the theory of regional integration: a look at the Unasur's integration strategy", *Working Paper*, No. 1617, Groupe d'Analyse et de Théorie Economique Lyon St-Étienne (GATE Lyon St-Étienne), University of Lyon, May 2016, on the basis of F. P. Mongelli, "'New' views on the optimum currency area theory: what is EMU telling us?", *Working Paper*, No. 138, European Central Bank, 2002; M. Friedman, "The methodology of positive economics", *Essays in Positive Economics*, Chicago, University of Chicago Press, 1966; M. Kawai, "Optimum currency areas", *The New Palgrave: A Dictionary of Economics*, New York, Stockton Press, 1987; R. A. Mundell, "A theory of optimum currency areas", *The American Economic Review*, vol. 51, No. 4, September 1961; W. M. Corden, "Monetary integration", *Essays in International Finance*, No. 93, Princeton University, 1972; J. C. Ingram, *Regional Payments Mechanisms: The Case of Puerto Rico*, University of North Carolina Press, 1962; R. I. McKinnon, "Optimum currency areas", *The American Economic Review,* vol. 53, No. 4, September 1963; P. Kenen, "The theory of optimum currency areas: an eclectic view", *Monetary Problems of the International Economy*, R. Mundell and A. Swoboda (eds.), Chicago, University of Chicago Press, 1969; J. M. Fleming, "On exchange rate unification", *The Economic Journal*, 81, No. 323, September 1971; N. Mintz, *Monetary Union and Economic Integration*, C. J. Devine Institute of Finance, New York University Press, 1970; G. Haberler, "The international monetary system: some recent developments and discussions", *Approaches to Greater Flexibility of Exchange Rates*, C. F. Bergsten and others, Princeton University Press, 1970; E. Tower and T. Willett, *The Theory of Optimum Currency Areas and Exchange-rate Flexibility*, Princeton University, 1976; C. Wyplosz and D. Cohen (eds.), "The European Monetary Union: an agnostic evaluation", *Discussion Papers*, No. 306, Centre for Economic Performance, 1989; W. M. Corden, "Monetary integration", *Essays in International Finance*, No. 93, Princeton University, 1972; Y. Ishiyama, "The theory of optimum currency areas: a survey", *Staff Papers*, vol. 22, No. 2, International Monetary Fund (IMF), 1975; R. A. Mundell, "Uncommon arguments for common currencies", *The Economics of Common Currencies*, H. G. Johnson and A. K. Swoboda (eds.), London, George Allen & Unwin, 1973; A. Alesina and others, "Fiscal policy, profits, and investment", *American Economic Review*, vol. 92, No. 3, June 2002; G. A. Calvo and C. M. Reinhart, "Fear of floating", *The Quarterly Journal of Economics*, vol. 117, No. 2, May 2002; F. Kydland and E. Prescott, "Rules rather than discretion: the inconsistency of optimal plans", *Journal of Political Economy*, vol. 85, No. 3, June 1977; R. J. Barro and D. B. Gordon, "A positive theory of monetary policy in a natural rate model", *Journal of Political Economy*, vol. 91, No. 4, August 1983; J. A. Frankel and A. K. Rose, "Is EMU more justifiable ex post than ex ante?", *European Economic Review*, vol. 41, No. 3–5, April 1997; J. A. Frankel, "No single currency regime is right for all countries or at all times", *Working Paper*, No. 7338, National Bureau of Economic Research (NBER), 1999; P. De Grauwe and F. Mongelli, "Endogeneities of optimum currency areas", *Working Paper Series*, No. 468, European Central Bank, April 2005; W. Buiter, "Macroeconomic policy during a transition to monetary union, *Discussion Paper*, No. 261, Centre for Economic Performance, August 1995; S. M. Collins, "On becoming more flexible: exchange rate regimes in Latin America and the Caribbean", *Journal of Development Economics*, vol. 51, No. 1, October 1996; S. Edwards, "Exchange rates and the political economy of macroeconomic discipline", *The American Economic Review*, vol. 86, No. 2, January 1996.

[a] The domain of an OCA is given by the sovereign countries choosing to adopt a single currency or to peg their exchange rates irrevocably.

[b] The "new" OCA theory deals with, among others, the effectiveness of monetary policy (Alesina, and others, 2002; Calvo and Reinhart, 2002), credibility of monetary policy (Kydland and Prescott, 1977; Barro and Gordon, 1983), endogeneity versus specialization hypothesis of OCAs (Frankel and Rose, 1997; Frankel, 1999; De Grauwe and Mongelli, 2005), the character of shocks (Buiter, 1995), synchronization of business cycles and political factors (Collins, 1996; Edwards, 1996).

Annex A2

Structural vector autoregression (SVAR) stability tests

Table A2.1
Pre-dollarization SVAR model: lag order selection criteria

Lag	Log-likelihood (LL)	Likelihood ratio (LR)	Degrees of freedom (df)	p-value (p)	Akaike information criterion (AIC)	Bayesian information criterion (BIC)
0	-323.680				10.46	10.53
1	-258.360	190.66	4	0.000	7.78	7.97
2	-248.880	18.96	4	0.001	7.61[a]	7.94[a]
3	-246.650	4.45	4	0.348	7.66	8.12
4	-245.690	1.94	4	0.747	7.75	8.34
5	-241.697	7.98	4	0.092	7.75	8.47

Source: Prepared by the authors.
[a] Optimal lag, 68 observations.

Table A2.2
Pre-dollarization SVAR model: SVAR eigenvalue stability condition and autocorrelation

Stability condition		Lagrange-multiplier test			
Eigenvalue	Modulus	Lag	chi^2	Degrees of freedom (df)	Prob > chi^2
0.9453	0.9453	1	56.7387	4	0.00000
0.5953	0.5953	2	2.6592	4	0.61637
-0.3715	0.3715				
0.0344	0.0344	Ho: no autocorrelation at lag order			

Source: Prepared by the authors.
Note: All eigenvalues lie inside the unit circle: stability condition is satisfied.

Table A2.3
Post-dollarization SVAR model: lag order selection criteria

Lag	Log-likelihood (LL)	Likelihood ratio (LR)	Degrees of freedom (df)	p-value (p)	Akaike information criterion (AIC)	Bayesian information criterion (BIC)
0	-358.97				10.65	10.68
1	-242.50	232.93	9	0.000	7.49	7.64
2	-214.07	56.86	9	0.000	6.91	7.19[a]
3	-205.83	16.49	9	0.057	6.94	7.32
4	-189.82	32.02	9	0.000	6.73[a]	7.23
5	-184.98	9.67	9	0.378	6.85	7.47

Source: Prepared by the authors.
[a] Optimal lag, 68 observations.

Table A2.4
Post-dollarization SVAR model: SVAR Eigenvalue stability condition and autocorrelation

Stability condition		Lagrange-multiplier test			
Eigenvalue	Modulus	Lag	chi^2	Degrees of freedom (df)	Prob > chi^2
0.81633 + 0.9282i	0.81633	1	14.8878	9	0.09406
0.81633 - 0.9282i	0.81633	2	26.1740	9	0.00191
0.68988	0.68988				
-0.12759 + 0.4476i	0.46541				
-0.12759 - 0.4476i	0.46541	Ho: no autocorrelation at lag order			
-0.43680	0.43680				

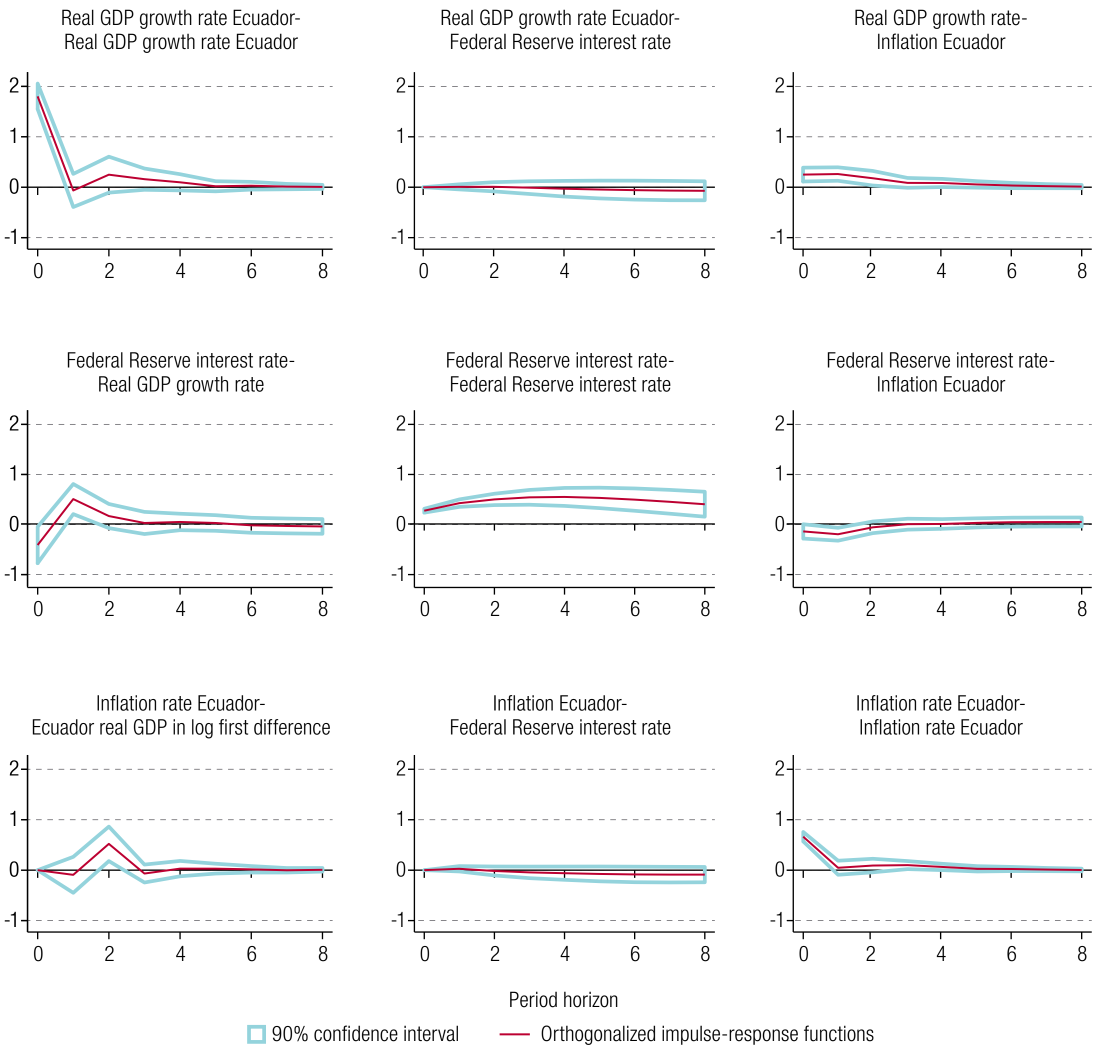
Source: Prepared by the authors.
Note: All eigenvalues lie inside the unit circle: stability condition is satisfied.

Annex A3

Figure A3.1
Impulse response functions

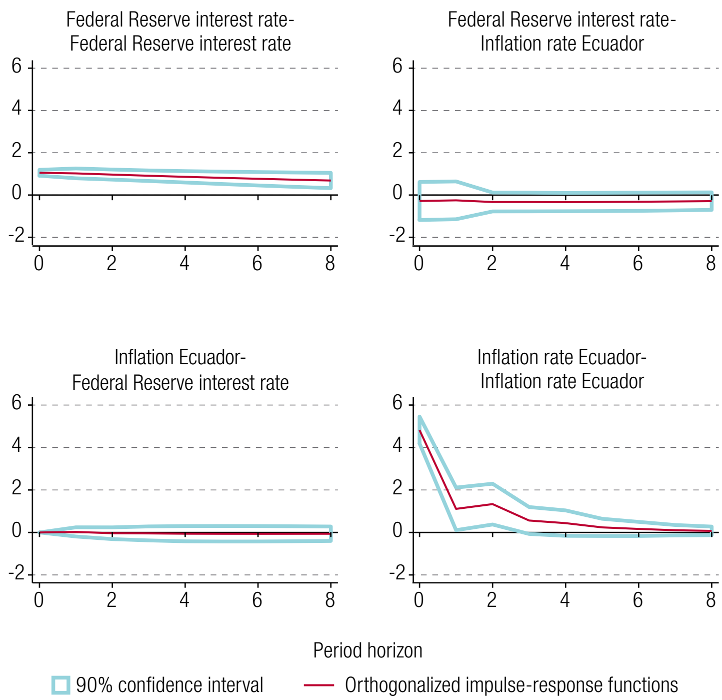
A. Post-dollarization

$X_t^T = (r_{fed}, \Delta y_{ec}, \pi_{ec})$



B. Pre-dollarization

$X_t^T = (r_{fed}, \Delta\pi_{ec})$



Source: Prepared by the authors.
Note: Graphs are by impulse variable and response variable.