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Inflation Targeting in Latin America: Toward a Monetary Union?

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July 29, 2009

Abstract

In recent years, five of the main economies in Latin America –Brazil, Chile, Mexico, Colombia and Peru– have adopted Inflation Targeting regimes. In the context of these converging monetary strategies, would the IT nations in the region be better off adopting a common currency? Would they be better off if they dollarize? Would a common currency be a better alternative than dollarization? The answers to these questions are yes, yes and maybe.

Keywords: Monetary Union, Inflation Targeting, Latin America, Monetary Policy.
JEL classification: E31, E32, E42, E58.

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Inflación objetivo en América Latina:
¿Hacia una unión monetaria?

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Julio 29, 2009

Resumen

En los últimos años, cinco de las principales economías de América Latina han adoptado esquemas de inflación objetivo. Se trata de Colombia, México, Brasil, Perú y Chile. En el contexto de estrategias monetarias convergentes entre esos cinco países, este artículo se hace las siguientes tres preguntas: desde el punto de vista económico, ¿tendría sentido para estas economías formar una moneda común? ¿Tendría sentido que dolarizaran? ¿Sería una moneda común una mejor alternativa que una dolarización? Las respuestas a estas preguntas son, sí, sí y quizás, respectivamente.

Palabras clave: unión monetaria, inflación objetivo, América Latina, política monetaria.

Clasificación JEL: E31, E32, E42, E58.

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Convergence on regional monies is a no-brainer
Dornbusch (2001)

1 Introduction

Since the early 90s, a growing number of industrialized and developing economies have adopted inflation targeting (IT) regimes operated by independent and more transparent central banks. Rose (2006) has labeled this a New International Monetary System—in his words "Inflation Targeting is Bretton Woods, reversed." In Latin America (LA), five of the main economies have adopted IT, Brazil, Chile, Colombia, Mexico and Peru. These five countries hold more than 380 million people and collectively make up 70% of Latin America and the Caribbean's GDP. Close to three quarters of the total trade of LAC takes place in these five countries. Since 2000, each has kept inflation in single digits, a notable achievement given LA's inflation history of the last 40 years.

Within the context of the converging monetary strategies of these five nations, a natural question to ask is whether they would be better off adopting a common currency –i.e., forming a Latin American Monetary Union, LAMU. My response to this first question is yes.

During the late 90s, in both academic and policy circles, the idea of dollarization (rather than LAMU) in LA was seriously considered, especially after Argentina's president proposed such a policy. The idea was extensively discussed at the IMF, the IADB and even at the FED and in the US Congress (IMF, 1999). Nevertheless, only Ecuador and El Salvador gave up their monetary autonomy in favor of the dollar. In the aftermath of the discussions, it became clear that building political support for dollarization in LA is difficult. Indicative of this was a popular quote at the time, which noted that Argentina would adopt the dollar when the US put Eva Peron on the dollar bill. I believe that the political barriers confronting a multilateral Latin American monetary union would be much weaker that those faced by dollarization. That said, in the empirical part of this paper, I also analyze the economic pros and cons of the unilateral adoption of the US dollar by each inflation targeter in LA. I find that giving up monetary autonomy –in this case, in favor of the dollar– would leave respective countries better off from an economic standpoint.

Having found that both monetary union and dollarization make economic sense, we then ask which of the two strategies is preferable. The results are mixed. I find that LAMU is preferable to dollarization in the

cases of Chile, Peru and Brazil. The opposite, however, is true for Mexico, while in Colombia, the net benefits are similar for both common currency arrangements.

The paper pursues a twofold strategy. On the one hand, I build a simple policy model that captures several costs and benefits for a group of IT countries considering forming a monetary union. Then, using the results from the model and from the large literature on monetary unions, I report estimates on the benefits and costs associated with LAMU and unilateral dollarization.

The paper also makes a methodological contribution by proposing a way to compare some of the consequences of common currencies measurable in terms of GDP (e.g., consequences via increased trade or the foregone seignorage collection) with other traditionally more intangible consequences, such as the potential increase in volatility. I use self-reported satisfaction surveys to build country specific indifference curves between volatility and growth; these put in perspective the relative importance of the volatility exacerbation that the adoption of a common currency could entail.

The rest of the paper is organized as follows. Section 2 briefly describes the IT adoption dates and the inflation characteristics of the inflation targeters in LA. Section 3, examines the theoretical model. Section 4, considers the empirical aspects and provides several quantifications, one at a time, for each of the costs and benefits of LAMU and dollarization, respectively. Section 5 pulls the empirical results together, while section 6 concludes and offers further discussion.

2 Inflation Targeting in Latin America

From a theoretical standpoint, proponents of IT claim several benefits associated with this monetary policy framework. These include lower inflation and inflation variability, solving the classic time inconsistency problem faced by central banks, and anchoring lower inflationary expectations, among others. At the empirical level, economists have also studied the impact of IT on macroeconomic aggregates. Using a sample of industrialized nations, both Ball and Sheridan (2005) and Lin and Ye (2007), show that the recent disinflation and the reduction in inflation volatility are not attributable to the adoption of IT. Nevertheless, Gonçalves and Salles (2008) and Lin and Ye (2009) find that IT did play a relevant role in driving down inflation and growth volatility in emerging economies.

Recently, five of the main economies in LA adopted inflation targeting

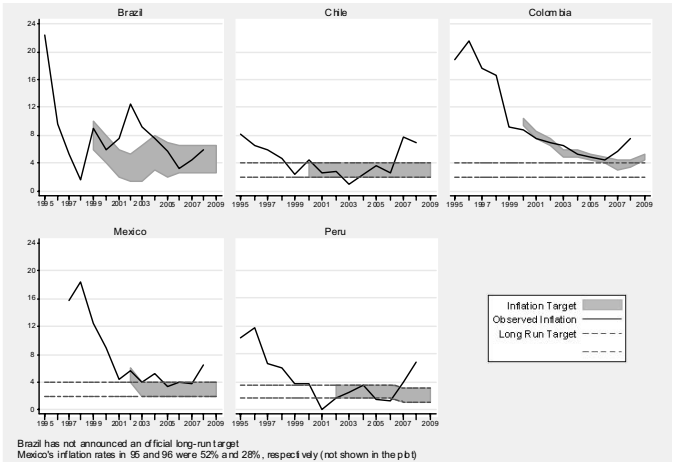

Figure 1: Inflation and inflation targets in Latin American IT countries.

regimes. Figure 1 depicts the recent inflation history of these countries, along with respective inflation targets and long-run inflation goals.

Colombia, Chile and Mexico all have long-run inflation targets set at 3%, while Peru's is set at 2.0% (starting in 2007). For all of these cases, the target is set with a $\pm 1\%$ margin. Brazil has not officially announced its long run goal and its short term targets are announced with a wider band than in the rest of the countries. This has allowed Brazil to exhibit inflation rates falling within the target band, even in 2007 and 2008 when inflationary pressures caused inflation to deviate form targets in the remaining IT countries.

3 The Model

I follow a modelling approach similar to the one proposed in Alesina and Grilli (1992) in evaluating the costs and benefits of joining a monetary union. Unlike them, I explicitly incorporate the IT strategies that characterize the monetary policy framework of the countries proposed for the initial LAMU. In the model, both the members of the potential union and the union's central bank target inflation.

I first describe the problem of the union's central bank and analyze the welfare implications for individual countries joining the union. I then ask what happens if countries retain monetary autonomy. Finally, I analyze the convenience of giving up monetary autonomy by comparing respective

welfares under these two scenarios.

Union's problem: Suppose there is a single Latin American central bank setting policy so as to minimize a loss function a la Barro-Gordon –i.e., a function trading off unemployment and inflation in the union. In addition to the traditional Barro-Gordon elements, the Latin American central bank uses an inflation targeting strategy. Thus, the union's central bank minimizes

$$\mathcal{L}_u = \frac{\lambda}{2}(U_u - \overline{U_u})^2 + \frac{1}{2}(\pi_u - \pi^*)^2 + \frac{h}{2}(\pi_u - \pi_u^T)^2 \tag{1}$$

where λ represents the relative weight put on unemployment fluctuations, U_u represents the unemployment rate of the union, π_u is the union's inflation rate, π^* is the optimal inflation rate (which can be thought of as the *long run* target), π_u^T is the bank's (short run) inflation target, and h is the weight given by the central bank to the deviation of inflation from its target. $\overline{U_u}$ is the unemployment target measured relative to the natural unemployment rate,–i.e., if the bank targets an unemployment rate below the natural rate, then $\overline{U_u} < 0$. The natural unemployment rate has been normalized to zero.

The Union's central bank minimizes this expression by choosing π_u, subject to a Phillips curve given by:

$$U_u = -(\pi_u - \pi_u^e) + \varepsilon \tag{2}$$

where π_u^e represents expected inflation and ε is a supply shock. This is a standard expectations-augmented Phillips curve, where the natural rate of unemployment is again normalized to zero.

The solution to this problem, setting for now $h = 0$ (i.e., without an inflation targeting strategy), leads to the following inflation rate for the union:

$$\pi_u = -\lambda\overline{U_u} + \pi_u^* + \frac{\lambda}{1+\lambda}\varepsilon \tag{3}$$

The first term represents the well known inflation bias (recall that $\overline{U_u} < 0$, as long as the central bank targets unemployment rates below the natural rate), which grows with the gap between the natural and target levels of unemployment and with the weight given by the central bank to unemployment relative to inflation stabilization. This is the traditional Barro-Gordon result, where the impossibility for the central bank to credibly commit to lower inflation rates generates persistent inflation above the optimal rate.

Under inflation targeting ($h \neq 0$), the inflation rate of the union will be

$$\pi_u = \frac{-\lambda}{1+h}\overline{U_u} + \pi^* + \frac{h}{1+h}\Theta + \frac{\lambda}{1+\lambda+h}\varepsilon \tag{4}$$

where $\Theta = \pi_u^T - \pi^*$. Several well-known results emerge. If $\Theta = 0$, i.e., if the Central Bank targets the optimal long-run rate, the inflation bias will be smaller than if there were no inflation targeting (thus augmenting welfare); at the same time the reaction to supply shocks will diminish (negatively affecting welfare). This is technically analogous to Rogoff's (1985) conservative central banker problem, where in the optimal h is positive. An inflation-targeting central bank increases welfare when $\Theta = 0$.

If Θ is positive, i.e., if the central bank targets an inflation rate above the long-run optimal rate, then the inflation targeting strategy could diminish welfare. In practice, this could happen in a scenario where the central bank disinflates using a gradualist strategy to bring inflation down to its long-run optimal rate. Finally, note that under strict inflation targeting, as proposed by Svensson (1997) –i.e., if $h \longrightarrow \infty$– both the inflation bias and the reaction to supply shocks disappear.

The welfare implications of membership: To analyze welfare, and assuming the absence of a *political* union, each member country j, should evaluate the outcomes of membership based on its own *social* loss function

$$\mathcal{L}_j = \frac{\lambda_j}{2}(U_j - \overline{U_j})^2 + \frac{1}{2}(\pi_u - \pi^*)^2 \tag{5}$$

and a country-specific Phillips curve given by

$$U_j = -(\pi_u - \pi_u^e) + \varepsilon_j \tag{6}$$

Each country in the union can have different preferences, unemployment rates and face idiosyncratic shocks; nevertheless, each country's inflation rate will be the same as that of the union.[1] The *society's* loss function does not include the inflation targeting term; the latter is a policy strategy of the central bank, but not part of the social preferences.

The expected loss of membership can be found by substituting expressions (6) and (4) into (5), and taking expectations. The resulting expression

[1] Alesina and Grilli (1992) explore the case where $\pi_u \neq \pi_j$, in a model without IT.

is

$$E\mathcal{L}_j^{mem} = \frac{\lambda_j}{2}\left[\left(\frac{\lambda}{1+\lambda+h}\right)^2\sigma_\varepsilon^2 + \sigma_{\varepsilon_j}^2 - \frac{2\lambda}{1+\lambda+h}\sigma_{\varepsilon\varepsilon_j} + \overline{U_j}^2\right] + \frac{1}{2}\left[\left(\frac{\lambda}{1+h}\right)^2\overline{U_u}^2 + \left(\frac{h\Theta}{1+h}\right)^2 - \frac{2\lambda h\Theta\overline{U_u}}{(1+h)^2} + \left(\frac{\lambda}{1+\lambda+h}\right)^2\sigma_\varepsilon^2\right] \quad (7)$$

where σ_ε^2 and $\sigma_{\varepsilon_j}^2$ are the respective variances of ε and ε_j, and $\sigma_{\varepsilon\varepsilon_j}$ is the covariance between ε and ε_j.

Autarky: If each country were to retain autonomy over its monetary policy, it would minimize

$$\mathcal{L}_j = \frac{\lambda_j}{2}(U_j - \overline{U_j})^2 + \frac{1}{2}(\pi_j - \pi^*)^2 + \frac{h_j}{2}(\pi_j - \pi_j^T)^2 \quad (8)$$

subject to a Phillips curve as in (6), but with country specific inflation rates. I allow for an idiosyncratic target –i.e., π_j^T is not necessarily equal to π^T. Nevertheless, the optimal inflation rate (π^*) is assumed to be equal for the union and across the union's individual members. The problem and the solution are similar to those for the union. I omit the details.

The welfare implications of autarky: The expected loss when retaining monetary autonomy –obtained by replacing the solution to the problem in autarky into the country-specific social loss function– is

$$E\mathcal{L}_j^{aut} = \frac{\lambda_j}{2}\left[\left(\frac{1+h_j}{1+\lambda_j+h_j}\right)^2\sigma_{\varepsilon_j}^2 + \overline{U_j}^2\right] + \frac{1}{2}\left(\frac{\lambda_j}{1+h_j}\right)^2\overline{U_j}^2 + \frac{1}{2}\left[\left(\frac{h_j\Theta_j}{1+h_j}\right)^2 - \frac{2\lambda_j h_j\Theta_j\overline{U_j}}{(1+h_j)^2} + \left(\frac{\lambda_j}{1+\lambda_j+h_j}\right)^2\sigma_{\varepsilon_j}^2\right] \quad (9)$$

where $\Theta_j = \pi_j^T - \pi^*$.

Membership vs autarky: The difference between the two loss functions represents the key expression for analyzing the costs and benefits of

joining a union versus retaining monetary autonomy:

$$
\begin{aligned}
E\mathcal{L}_j^{mem} - E\mathcal{L}_j^{aut} = \frac{1}{2}\left[\left(\frac{\lambda}{1+h}\right)^2 \overline{U_u}^2 - \left(\frac{\lambda_j}{1+h_j}\right)^2 \overline{U_j}^2\right] \\
+ \frac{(1+\lambda_j)}{2}\left[\left(\frac{\lambda}{1+\lambda+h}\right)^2 \sigma_\varepsilon^2 - \left(\frac{\lambda_j}{1+\lambda_j+h_j}\right)^2 \sigma_{\varepsilon_j}^2\right] \\
+ \frac{1}{2}\left[-2\lambda_j\left(\frac{\lambda}{1+\lambda+h}\sigma_{\varepsilon\varepsilon_j} - \frac{\lambda_j}{1+\lambda_j+h_j}\sigma_{\varepsilon_j}^2\right)\right] \\
+ \frac{1}{2}\left[\left(\frac{h\Theta}{1+h}\right)^2 - \left(\frac{h_j\Theta_j}{1+h_j}\right)^2 - 2\left(\frac{\lambda h\Theta\overline{U}}{(1+h)^2} - \frac{\lambda_j h_j \Theta_j \overline{U_j}}{(1+h_j)^2}\right)\right] \quad (10)
\end{aligned}
$$

The differences in welfare between participating in a monetary union versus remaining autonomous come from two sources: preferences and shocks. I analyze each source of differences, one at a time, focusing on long-run scenarios, specifically, those where the inflation target is equal to optimal inflation ($\Theta_j = \Theta = 0$). This is the most relevant scenario given that before the union is implemented, respective countries would agree to first achieve similar inflation rates, likely close to their long-run target. Nevertheless, the short-run model, wherein targets and optimal inflation rates might differ, provides interesting insights with respect to the implementation of gradual disinflation. I develop these insights in the appendix.

3.1 Differences in Preferences

Let the shocks be identical across the economies –i.e., $\varepsilon = \varepsilon_j$, so that $\sigma_\varepsilon^2 = \sigma_{\varepsilon_j}^2 = \sigma_{\varepsilon\varepsilon_j} = \sigma^2$. Moreover, the long-run assumption implies that $\Theta_j = \Theta = 0$. Expression (10) then collapses to

$$
\begin{aligned}
E\Delta\mathcal{L}_j = \frac{1}{2}\left[\left(\frac{\lambda}{1+h}\right)^2 \overline{U_u}^2 - \left(\frac{\lambda_j}{1+h_j}\right)^2 \overline{U_j}^2\right] \\
+ \frac{\sigma^2}{2}\left(\frac{\lambda}{1+\lambda+h} - \frac{\lambda_j}{1+\lambda_j+h_j}\right)\left(\frac{(1+\lambda_j)\lambda}{1+\lambda+h} - \lambda_j - \frac{\lambda_j h_j}{1+\lambda_j+h_j}\right) \quad (11)
\end{aligned}
$$

where $E\Delta\mathcal{L}_j = E\mathcal{L}_j^{mem} - E\mathcal{L}_j^{aut}$.

A1. Let $\overline{U_j} \neq \overline{U_u}$; $\lambda_j = \lambda$, $h_j = h$. $E\Delta\mathcal{L}_j$ can then be written as

$$
\frac{1}{2}\left(\frac{\lambda}{1+h}\right)^2 \left(\overline{U_u}^2 - \overline{U_j}^2\right) \quad (12)
$$

As long as $|\overline{U_j}| > |\overline{U_u}|$, the expression is negative –i.e., a country with incentives to high inflation will benefit from the monetary union. The credibility the monetary union bestows positively affects welfare. Under strict inflation targeting, the effect disappears, as the inflation bias is removed, both for the union and for country j.

A2. Let $\lambda_j \neq \lambda$; $\overline{U_j} = \overline{U_u}$, $h_j = h$. $E\Delta\mathcal{L}_j$ can then be written as

$$\frac{1}{2}\left(\frac{\overline{U_u}}{1+h}\right)(\lambda^2 - \lambda_j^2) + \frac{\sigma^2}{2}\left(\frac{\lambda}{1+\lambda+h} - \frac{\lambda_j}{1+\lambda_j+h}\right)\left(\frac{(1+\lambda_j)\lambda}{1+\lambda+h} - \lambda_j - \frac{\lambda_j h}{1+\lambda_j+h}\right) \quad (13)$$

The interpretation of the first term is traditional in the literature; the union is welfare enhancing as long as $\lambda < \lambda_j$. Again, the intuition is that the union confers credibility to a country that has greater incentives to inflate.

The second line is positive (if $\lambda < \lambda_j$) –i.e., it favors maintaining an autonomous monetary policy. The whole expression is premultiplied by the variance of the shocks. The economic interpretation is simple: while the monetary union has less incentives to inflate when $\lambda < \lambda_j$, it will also react less strongly to supply shocks, thus reducing welfare.

A3. Let $h_j \neq h$; $\overline{U_j} = \overline{U_u}$, $\lambda_j = \lambda$. $E\Delta\mathcal{L}_j$ can then be written as

$$\frac{\lambda^2\overline{U_u^2}}{2}\left(\frac{1}{(1+h)^2} - \frac{1}{(1+h_j)^2}\right) + \frac{\sigma^2\lambda}{2}\left(\frac{1}{1+\lambda+h} - \frac{1}{1+\lambda+h_j}\right)\left(\frac{-h}{1+\lambda+h} - \frac{h_j}{1+\lambda+h_j}\right) \quad (14)$$

Consider the case where $h_j < h$ –i.e., the union's Central Bank attaches a higher priority to the inflation target than country j. Correspondingly, the first term is negative. This is because the union reduces the inflation bias by focusing more strongly on the inflation target. The second line is positive. It is premultiplied by σ^2 and captures the fact that the union's bank smooths activity variations to a lesser extent –a negative impact on welfare due to joining the union.

3.2 Differences in Shocks

Let the objective functions be identical for all j economies ($\overline{U_j} = \overline{U_u}$, $\lambda_j = \lambda$, $h_j = h$, $\Theta_j = \Theta$), but allow for differences in shocks –i.e., $\varepsilon \neq \varepsilon_j$. Expression

(10) then collapses to

$$\frac{1}{2}\left(\frac{\lambda}{1+\lambda+h}\right)^2\left((1+\lambda)(\sigma_\epsilon^2+\sigma_{\varepsilon_j}^2-2\rho\sigma_\varepsilon\sigma_{\varepsilon_j})-2h(2\rho\sigma_\varepsilon\sigma_{\varepsilon_j}-\sigma_{\varepsilon_j}^2)\right) \quad (15)$$

where ρ is the correlation coefficient between ε and ε_j.[2]

B1. Consider the case where shocks differ in size, but are nonetheless perfectly correlated –i.e., $\rho = 1$. In that case, (15) is simply

$$\frac{1}{2}\left(\frac{\lambda}{1+\lambda+h}\right)^2\left((1+\lambda)(\sigma_\epsilon-\sigma_{\varepsilon_j})^2+2h(\sigma_{\varepsilon_j}^2-\sigma_\varepsilon\sigma_{\varepsilon_j})\right) \quad (16)$$

Note that $(\sigma_\epsilon - \sigma_{\varepsilon_j})^2$ is always positive. This is the Alesina-Grilli result, whereby differences in output (unemployment) variances make entering the union less attractive. The intuition is that, relative to an autonomous bank, the monetary union would under- or over stabilize.

The expression $(\sigma_{\varepsilon_j}^2 - \sigma_\varepsilon\sigma_{\varepsilon_j})$ is negative if $\sigma_\varepsilon > \sigma_{\varepsilon_j}$–i.e., if the variance of the union is higher than that for country j, joining the union will improve welfare in country j. Why is that? Note that the latter expression is premultiplied by h, the weight given to the inflation target. Recall moreover that countries targeting inflation react less strongly to supply shocks, a welfare reducing feature of IT. Consequently, if $\sigma_\varepsilon > \sigma_{\varepsilon_j}$, then the variance of shocks for the union is of greater magnitude than that for country j and the inflation targeting union will react more strongly to the fully correlated shocks than the autonomous bank would. In this scenario, the negative implication of IT –namely that it reacts less strongly to supply shocks– is mitigated from the perspective of country j. Note that if the variance of economic activity in country j is larger than that for the union, the opposite implication results.

B2. Consider $\sigma_\varepsilon = \sigma_{\varepsilon_j} = \sigma$, but with $\rho \neq 1$. In that case, (15) is simply

$$\frac{\lambda^2}{1+\lambda+h}\sigma^2\,(1-\rho) \quad (17)$$

The less correlated the shocks, the less incentive there is to join the union. In the extreme case, where $\rho = -1$ the union's central bank would implement expansionary policies even though contractions were needed in country j.

[2] The expression does not depend on Θ. The welfare implications of the shocks will be analogous over the long and short run.

Nevertheless, note that the expression is mitigated by the presence of h, the weight given to the inflation target. Given that an IT regime reacts less strongly to economic activity fluctuations, the fact that the union's bank reacts to not fully correlated shocks does less harm from the perspective of country j than it might otherwise.

4 LAMU, Autonomy or Dollarization? A First Look

This section provides several quantifications, *one at a time*, of each of the costs and benefits of LAMU (or dollarization) identified in the model. It also provides quantifications of a couple of relevant aspects left out of the model. Later, section 5 combines most of these empirical results.

While the model highlights several elements for evaluating the convenience of joining a monetary union, it also leaves out several relevant considerations. For instance, the literature highlights that the reduction in transaction costs resulting from joining a union increases trade, and could have an impact on GDP in the long-run . Moreover, if the union is a unilateral policy (i.e., a dollarization), member countries give up their present and future seignorage collection. Both of these effects are estimated and discussed later in this section. There are other relevant elements left out of in this analysis. For instance, LAMU may constitute a pivotal element in the economic integration process of LA. The economic benefits are part of a larger story, one where the long-run political gains of putting in place the building blocks of a Latin American nation might outweigh economic considerations.[3] These aspects should be part of any future discussion regarding a monetary union, but go beyond the objectives of this paper.

Two additional caveats: I evaluate the costs and benefits of LAMU as if it were to occur only among the current inflation targeters in LA. Nevertheless, if the process turns out to be successful, it is conceivable that other countries in the region will want to join it, as happened with the Euro. Finally, when analyzing dollarization, the results should be read as the consequence of each country dollarizing unilaterally, not as if all the inflation targeters were simultaneously adopting the dollar.

I divide the rest of the section into three parts. 4.1 deals with volatility and credibility; 4.2 quantifies the seignorage forgone if countries dollarize; and 4.3 analyzes the trade effects. Later, in section 5, I propose a methodology for quantifying the net impact of several of these effects.

[3] See, for instance, Krugman (1989) for a similar discussion about the European Union.

4.1 Volatility and Credibility

According to the model, one undesirable characteristic of unions is that they potentially exacerbate economic volatility. The model suggests that this side-effect is attenuated if the business cycles are highly correlated and/or the respective country has a smaller variance of shocks relative to that of the union. The model also suggests that countries with higher incentives to inflation benefit more from a union. I apply these ideas to the data to see which countries would benefit more relative to others; where appropriate, I state whether union or dollarization would be more convenient. I begin with the latter effect and then turn to the volatility aspects.

(i) Credibility: I use two proxies for incentives to inflate under autonomy; one is the actual behavior of inflation during the recent past; the other consists of measures of central bank independence, taken from Jácome and Vázquez (2005) –the GMT index, ranging from 0 to 15, with 15 indicating maximum independence; and the Cukierman and modified Cukierman indices, ranging from 0 to 1, with 1 representing the highest degree of independence (see the appendix for details).

To summarize the information contained in the two proxies, I build a credibility index representing the average of an inflation index and the Modified Cukierman Index (the preferred CBI index according to Jácome and Vasquez, 2005). The inflation index, is constructed as follows: $(\pi_{\max} - \pi_i)/(\pi_{\max} - \pi_{\min})$, where $\pi_{\max}$ is the highest average inflation rate for the period 2000 to 2007 within LA; $\pi_{\min}$ is the lowest inflation in the region for the same period; and π_i is the average inflation rate for country i for the same period. Thus, the country with the smallest inflation rate in LA will have an *inflation* index of 1, while the country with the largest inflation rate in LA will have an index of 0. To construct the *credibility* index, I average this outcome with the Modified Cukierman Index. The closer the number to 1, the better the respective country's credibility, and, the less gains then to be expected in that respect from joining a monetary union or dollarizing. (Note that dollarization and LAMU cannot be compared to one another from the perspective of credibility, unless I make specific assumptions as to the credibility changes that each monetary arrangement would bestow. I do not do that in this paper).

The results are reported in Table 1. From the credibility's perspective, Brazil and Colombia would benefit the most from a union while Chile and Peru would benefit the least. Moreover, IT countries in LA exhibit lower inflation rates and higher CBI indices –and thus credibility indexes– compared to non-IT countries in the region.

	Central Bank Independence Indexes**			Average Inflation 2000-2007	Credibility Index
	GMT	Cukierman Index	Modified Cukierman		
Brazil	10	0,47	0,50	7,16%	0,61
Chile	14	0,84	0,85	3,27%	0,89
Colombia	10	0,78	0,83	5,95%	0,81
Mexico	13	0,75	0,81	4,34%	0,84
Peru	13	0,86	0,86	1,99%	0,93
Average IT in LAC	12,0	0,74	0,77	4,54%	0,81
Average non- IT in LAC*	10,6	0,71	0,69	9,53%	0,64

* Countries included are: Argentina, Bolivia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Paraguay, Uruguay, Venezuela

** Source: Any Link Between Legal Central Bank Independence and Inflation? Evidence from Latin America and the Caribbean. Luis I. Jácome and Francisco Vásquez. IMF Working Paper. 2005.

Table 1

(ii) Correlation: The model suggests that countries would like to have business cycles that correlate as much as possible with those of the union. I begin by reporting the correlation of the GDP growth rates of each IT nation in LA with those of the union and of the US.[4] Specifically, Figure 2 plots 10-year rolling correlations of growth rates and shows that respective correlations of individual countries with a potential LAMU are considerably higher than corresponding correlations with the US. The only exception is Mexico, where the correlation with the US is similar to that with the union's. Nafta likely plays a large role in explaining this outcome. In any case, by 2007, the average growth correlation for the five IT countries in LA with a potential union reached 0.72, while that with the US was only 0.02. On the correlation front, the advantage of LAMU over dollarization is great.

The comparison across IT countries shows that Brazil has the highest correlations with LAMU. This is not surprising given that Brazil is the largest economy in the region and therefore plays a large role in driving the joint business cycles of the five inflation targeters in LA. In this sense, it plays a role similar to that of Germany within the Euro area.

(iii) Standard deviation of the shocks: Alesina-Grilli's model calls for shocks as similar as possible in size. Our model stresses that assuming IT, having a standard deviation of shocks below that of the union favors joining the union. In Figure 3, I report the 10-year rolling standard deviation ratios of the growth rate for country j relative to the LAMU or the US, minus 1. One would like this statistic to be as close to zero (the Alesina-

[4] The model was expressed in term of unemployment, but analogous results are obtained if the loss function and the Phillips curve are expressed in terms of output. I use output given that unemployment statistics are not comparable across LAC countries.

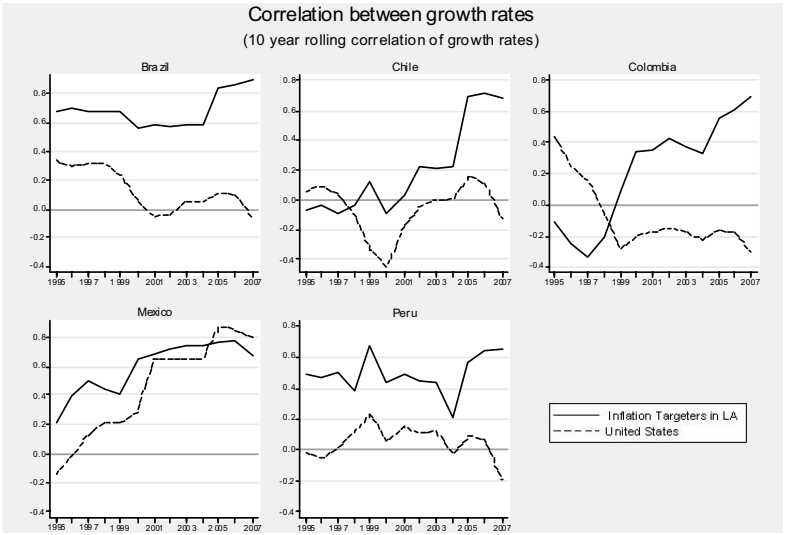

Figure 2:

Grilli argument) or negative (the additional effect due to IT) as possible. Interestingly, for all of the countries analyzed, the ratio for the union is always below the ratio for the US. Here LAMU also seems preferable to unilateral dollarization.

A Business Cycle Index: To put results (ii) and (iii) in perspective, I build an *ad-hoc* business cycle index, defined as $(\sigma_i/\sigma - 1) + (1 - \rho_i)$, where σ_i/σ is the relative standard deviation and ρ_i is the growth correlation. Our model suggests that the first term should be small or even negative in order for the union to be beneficial, while the second term should be as close to zero as possible. The evolution of the index over time for each IT country in our sample is reported in Figure 4.

The results show that, based on this *ad-hoc* business cycle index, LAMU is preferable, that is, volatility would increase more under dollarization than under LAMU. The differences are large in all cases except for that of Mexico. Even though this index is completely *ad hoc*, I doubt that –with the exception of the Mexican case– the adoption of an alternative model for averaging the two business cycle dimensions will change the main conclusion –for this category, LAMU is better than dollarization. Later, in section 5, I further develop the measurement of the costs associated with the potential exacerbation of volatility due to relinquishing monetary autonomy.

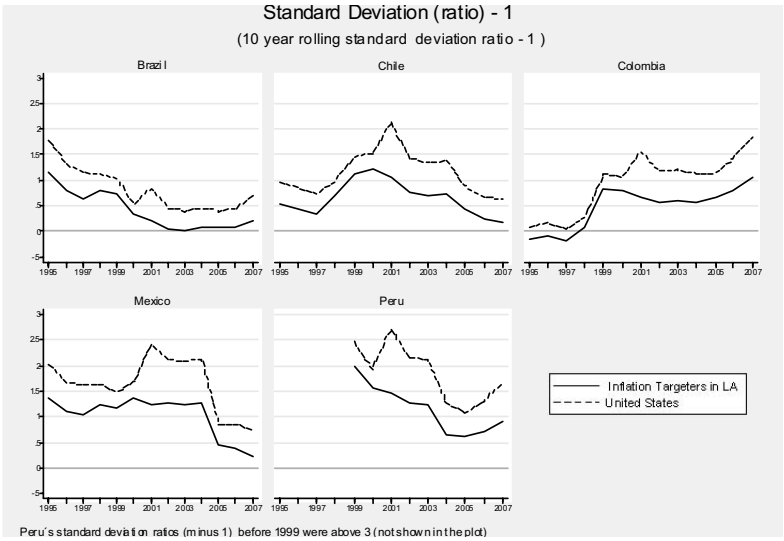

Figure 3:

4.2 Seignorage

If the five inflation targeters in LA were to form a monetary union, they would likely agree on a formal sharing rule of the stream of seignorage revenue. Conversely, if any of them were to dollarize, it is unlikely that the US would agree to discuss a seignorage sharing rule. Thus, in a cost-benefit analysis of union versus dollarization, it is important to assess the size of present and future seignorage revenues that would be lost when choosing to dollarize. In calculating these costs, I follow closely the framework proposed by Schmitt-Grohé and Uribe (1999).

Let B_0 be the monetary base at time 0 of the country dollarizing, denominated in dollars. Suppose that all foreign reserves are held in US Treasury Bills, yielding a constant nominal interest rate, i. At the time that the country implements dollarization, it sells B_0 of its foreign reserves to the US in exchange for dollar bills, which it then uses to buy the entire monetary base. The loss of reserves equals B_0, such that the amount of seignorage income forgone in period 0 is iB_0.

For $t > 0$, the demand for monetary assets grows over time both because of inflation (π) and domestic real growth (g); for simplicity's sake, these are assumed constant. Furthermore, I assume a unitary income elasticity of real money balances, so that domestic dollar holdings for any period $t \geq 0$

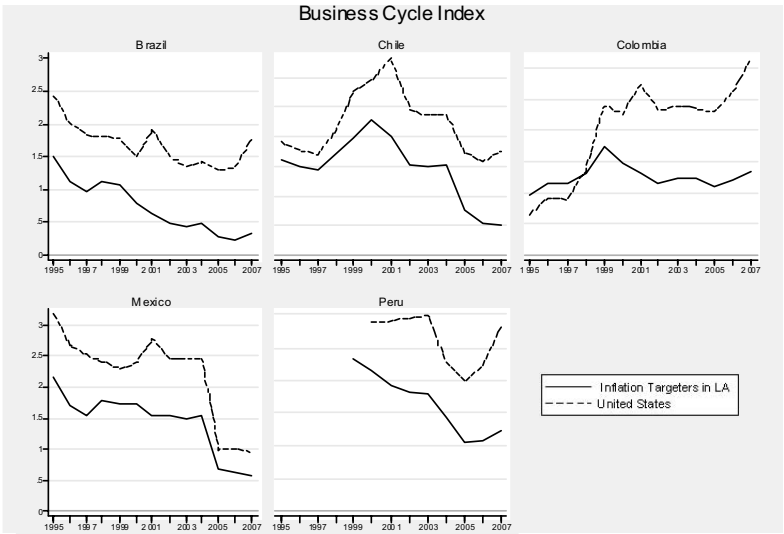

Figure 4:

will be $D_t = [(1+g)(1+\pi)]^t B_0$. Finally, citing Schmitt Grohe and Uribe (1999), "Under dollarization the way in which the increase in the domestic country's money holdings, $D_t - D_{t-1}$, is brought about is through transfers of real resources from the domestic economy to the U.S. government in exchange for U.S. dollars. The U.S. government in turn can earn interest on these real resources.[...] the stream of income earned by the U.S. government in each period $t \geq 0$ is given by iD_t." Thus, the present discounted value of seignorage income lost (earned by the US) is

$$S = \sum_{t=0}^{\infty} \left(\frac{1}{1+i}\right)^t i\left[(1+g)(1+\pi)\right]^t B_0$$

If $r > g$ and $(1+i) = (1+r)(1+\pi)$, S converges to $iB_0\frac{(1+r)}{r-g}$.[5] Under column (1) in Table 2, I report estimates of S as a % of 2007 GDP of each of the IT countries for baseline values of π, r and g of 3%, 5% and 4%, respectively. The results suggest that the seignorages forgone as a % of one year's GDP are large –they range from 43% to as high as 114%.

[5] $r > g$ is a standard steady-state condition in optimizing growth models. If $g > r$, S goes to infinity.

Present discounted value of seignorage income forgone as a % of GDP. Estimates based on 2007 data.										
	Baseline	Sensitivity analysis								
	π=3%, r=5%, g=4%	π=2%	π=4%	π=5%	r=4.5%	r=5.5%	r=6.5%	g=2%	g=3%	g=4.5%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Brazil	83%	72%	94%	105%	155%	59%	40%	28%	42%	166%
Chile	88%	77%	100%	111%	164%	63%	43%	29%	44%	176%
Colombia	78%	68%	88%	98%	145%	55%	37%	26%	39%	155%
Mexico	43%	38%	49%	55%	81%	31%	21%	14%	22%	87%
Peru	114%	99%	129%	143%	213%	81%	55%	38%	57%	228%
Average	81%	71%	92%	102%	152%	58%	39%	27%	41%	163%

Table 2

Under columns (3) through (10), I report the results using alternative values of π, r and g. The seignorage foregone obviously grows with inflation and GDP growth and falls with increases in the real interest rate. The results are particularly sensible to changes in the real growth rate, with column (10) reporting estimates 6 times larger than column (8).

4.3 The Trade Effect

In a very influential paper, Rose (2000) estimates that belonging to a currency union triples trade with other union members. This surprising result sparked a lot of research, with skeptical economists seeking arguments that would shrink the effects estimated by Rose (for an excellent summary of the related literature, see Baldwin, 2006). Nevertheless, even those skeptical of Rose's results –among them Baldwin– estimate the effect of currency unions on trade to be very large. In describing the effect of the Euro adoption on trade in Euroland, Baldwin claims "the number is between 5% and 10% to date. Most of the evidence suggests that this number may grow as time passes, maybe even doubling." In other words, even a critic of Rose's results finds it plausible that a currency union could increase trade by a factor of 1,2. Rose and Stanley (2005) in their *meta-analysis* from 34 studies on the subject, conclude that currency unions increase bilateral trade by between 30% and 90%.

In a subsequent paper, Frankel and Rose (2002) estimate the effect of common currencies on long run income (via trade). They find that a 1% increase in the ratio of trade to GDP increases GDP per capita by one third of a percent over the long run.

I estimate the benefits via increased trade, and indirectly via increases in long run GDP, of a union among the five inflation targeters and contrast it with respective unilateral dollarization by each. I estimate the impact of currency unions under two alterative scenarios: a pessimistic scenario,

where trade 'only' increases by a factor of 1,2, consistent with Baldwin's view and roughly coinciding with Rose and Stanley's lower bound; and a more optimistic one—though still conservative when compared with Rose's original results—where the common currency increases trade by a factor of 2, roughly consistent with Rose and Stanley's upper bound. I then use Frankel and Rose's results to estimate the effect of increased trade on long run GDP for each of these scenarios.

Table 3 reports the results. Columns (1) to (3) report the actual data for the five inflation targeters in LA. It is notable how trade has gained importance as a % of GDP. From an average of 27% in 1990, it reaches 46% by 2007.

Columns (4) and (5) report the estimated impact of dollarization both on trade and GDP per capita. Columns (4) and (5) are each broken down into two sub-columns. For each, the left reports the findings for the pessimistic scenario, and the right those for the optimistic one. For instance, the number for Brazil in 1990 under the left sub-column (4) is obtained by multiplying the numbers under columns (1) and (2) times 1,2. The number under the left sub-column (5) is simply a third of the number in the left sub-column (4) –i.e., a 1% increase in overall trade raises GDP by one third of a percent. Columns (6) and (7) report the same information as (4) and (5), only for a union of the inflation targeters in LA.

On average, trade would rise by between 18% and 29% under dollarization. As a consequence, the impact on GDP per capita would be a 6% to 10% boost over 20 years.[6] The same statistics for LAMU indicates that trade would gain between 6 and 10% points while GDP per capita would increase by 2% to 3%. As noted by Frankel and Rose, the effects are large even using conservative estimates.

For dollarization, Mexico is the country that would benefit the most; its large trade with the US makes the benefits of the transactions cost reduction more relevant. In the long run, its output would increase by up to 27%. The country that would gain the least with dollarization is Brazil, with a 2% boost on its long run GDP under the more optimistic scenario. This is a consequence of Brazil having a very large economy with a smaller relative size of trade relative to the other IT nations in LA. For LAMU, Chile and Peru would benefit the most from the perspective of trade. Their long run GDPs would raise by up to 6 and 5%, respectively.

[6] The results from Frankel and Rose should be interpreted this was –i.e., once the impact on trade settles in, it takes 20 years for the estimated impact on GDP to take hold.

		Trade (% of GDP)	% of trade with the US	% of trade with other IT in LA	Effects (% of GDP) of dollarizing		Effects (% of GDP) of "LAMU"	
					On Trade	On GDP	On Trade	On GDP
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Brazil	**1990**	12%	23%	4%	[3% 5%]	[1% 2%]	[1% 1%]	[0% 0%]
	1995	13%	21%	5%	[3% 6%]	[1% 2%]	[1% 1%]	[0% 0%]
	2000	18%	24%	6%	[5% 8%]	[2% 3%]	[1% 2%]	[0% 1%]
	2005	22%	19%	7%	[5% 8%]	[2% 3%]	[2% 3%]	[1% 1%]
	2007	21%	16%	7%	[4% 7%]	[1% 2%]	[2% 3%]	[1% 1%]
Chile	**1990**	49%	18%	10%	[11% 18%]	[4% 6%]	[6% 10%]	[2% 3%]
	1995	43%	19%	13%	[10% 17%]	[3% 6%]	[7% 11%]	[2% 4%]
	2000	46%	18%	14%	[10% 17%]	[3% 6%]	[8% 13%]	[3% 4%]
	2005	58%	16%	15%	[11% 19%]	[4% 6%]	[11% 18%]	[4% 6%]
	2007	66%	14%	15%	[11% 19%]	[4% 6%]	[12% 19%]	[4% 6%]
Colombia	**1990**	31%	40%	7%	[15% 25%]	[5% 8%]	[2% 4%]	[1% 1%]
	1995	26%	35%	9%	[11% 18%]	[4% 6%]	[3% 5%]	[1% 2%]
	2000	30%	42%	10%	[15% 25%]	[5% 8%]	[4% 6%]	[1% 2%]
	2005	34%	35%	13%	[15% 24%]	[5% 8%]	[5% 9%]	[2% 3%]
	2007	37%	31%	14%	[13% 22%]	[4% 7%]	[6% 10%]	[2% 3%]
Mexico	**1990**	21%	69%	2%	[18% 29%]	[6% 10%]	[0% 1%]	[0% 0%]
	1995	53%	79%	2%	[50% 84%]	[17% 28%]	[1% 2%]	[0% 1%]
	2000	59%	81%	1%	[57% 95%]	[19% 32%]	[1% 2%]	[0% 1%]
	2005	57%	69%	3%	[47% 79%]	[16% 26%]	[2% 3%]	[1% 1%]
	2007	62%	66%	3%	[49% 81%]	[16% 27%]	[2% 4%]	[1% 1%]
Peru	**1990**	23%	25%	13%	[7% 11%]	[2% 4%]	[3% 6%]	[1% 2%]
	1995	24%	22%	16%	[6% 11%]	[2% 4%]	[5% 8%]	[2% 3%]
	2000	27%	26%	15%	[8% 14%]	[3% 5%]	[5% 8%]	[2% 3%]
	2005	37%	25%	17%	[11% 19%]	[4% 6%]	[8% 13%]	[3% 4%]
	2007	44%	19%	17%	[10% 17%]	[3% 6%]	[9% 15%]	[3% 5%]
Average 1990		27%	35%	7%	[11% 18%]	[4% 6%]	[3% 4%]	[1% 1%]
Average 1995		32%	35%	9%	[16% 27%]	[5% 9%]	[3% 5%]	[1% 2%]
Average 2000		36%	38%	9%	[19% 32%]	[6% 11%]	[4% 6%]	[1% 2%]
Average 2005		42%	33%	11%	[18% 30%]	[6% 10%]	[5% 9%]	[2% 3%]
Average 2007		46%	29%	11%	[18% 29%]	[6% 10%]	[6% 10%]	[2% 3%]

Source of (1), (2) and (3): United Nations Commodity Trade Statistics Database (UN COMTRADE)- http://comtrade.un.org/db and World Development Indicators (WDI), http://devdata.worldbank.org/dataonline/

(4) and (6): Left column assumes that the common currency increases trade by 20%. Right column assumes that the common currency doubles trade with other members.

(5) and (7): We use Frankel and Rose's estimate, namley that a 1% increase in trade, incrases GDP by one third of a percent.

Table 3

An alternative way of grasping the size of these effects –one that will prove useful later when all of the elements are considered together–is to calculate the present discounted value of the additional GDP due to the trade effect. Let us call x the % impact on long run GDP estimated under columns 5 and 7 in Table 3. The present discounted value of the *additional* GDP due to the trade effect, expressed as a % of initial output, can thus be written as

$$\frac{PDV(Y^T)}{Y_0} = \frac{1}{Y_0}\sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t Y_0(1+g)^t x$$

$$= x\frac{(1+r)}{r-g}\ , \ \text{ if } r > g \tag{18}$$

where r is the real interest rate, Y_0 is the real GDP for period 0 and, g is the growth rate of output. In Table 4, I report the estimates for equation

18. In the baseline cases, I use the same baseline values for r and g as in the seignorage estimates reported earlier, 5 and 4% respectively. As for x, I use the upper and lower limits reported in Table 3 for 2007, as well as a simple average between the two. These results are reported under columns (1) through (3). Under columns (4) through (9), I explore the sensibility of the results by estimating the expression for alternative values of r and g.

Present discounted values of trade effect on GDP expressed as a % of GDP 2007 GDP									
	LAMU								
	Baseline: r=5%, g=4%			Sensibility: x=mean(x), g=4%			Sensibility: x=mean(x), r=5%		
	x=mean(x)	x=Low(x)	x=high(x)	r=4.5%	r=5.5%	r=6.5%	g=2%	g=3%	g=4.5%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brazil	83%	62%	103%	165%	55%	34%	28%	41%	165%
Chile	539%	405%	674%	1074%	361%	219%	180%	270%	1079%
Colombia	289%	217%	362%	576%	194%	117%	96%	145%	579%
Mexico	101%	76%	126%	201%	68%	41%	34%	51%	202%
Peru	412%	309%	515%	821%	276%	167%	137%	206%	825%
Average	285%	214%	356%	567%	191%	116%	95%	142%	570%
	Dollarization								
	Baseline: r=5%, g=4%			Sensibility: x=mean(x), g=4%			Sensibility: x=mean(x), r=5%		
	x=mean(x)	x=Low(x)	x=high(x)	r=4.5%	r=5.5%	r=6.5%	g=2%	g=3%	g=4.5%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brazil	188%	141%	236%	375%	126%	76%	63%	94%	377%
Chile	536%	402%	670%	1067%	359%	218%	179%	268%	1072%
Colombia	627%	470%	783%	1247%	420%	254%	209%	313%	1253%
Mexico	2277%	1708%	2847%	4533%	1526%	924%	759%	1139%	4555%
Peru	463%	347%	578%	921%	310%	188%	154%	231%	925%
Average	818%	614%	1023%	1629%	548%	332%	273%	409%	1636%

Table 4

The results show that the effect is very large. First take the case of LAMU. Even under the pessimistic scenario in terms of the impact of a common currency on trade (Low(x)), and considering the country that benefits the least given that it has the lowest ratio of trade with the remaining LAMU countries (Brazil), the result suggests that the benefit is over 50% of one year of GDP.

The strength of these results could hinge on the implicit assumption with regard to the timing of the effects –I assume that trade and GDP receive an immediate boost following the adoption of a common currency. I check what happens if the trade effects on GDP only occur 20 years after the monetary union is put in place. Table 5 reports the results. The numbers are obviously smaller than in Table 4, but the effect is still very large.

Present discounted value of the trade effect on GDP expressed as a % of 2007 GDP, if effect ocurrs from year 21 onwards									
	LAMU								
	Baseline: r=5%, g=4%			Sensibility: x=mean(x), g=4%			Sensibility: x=mean(x), r=5%		
	x=mean(x)	x=Low(x)	x=high(x)	r=4.5%	r=5.5%	r=6.5%	g=2%	g=3%	g=4.5%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brazil	68%	51%	85%	149%	42%	21%	15%	28%	150%
Chile	445%	334%	557%	975%	271%	136%	101%	184%	981%
Colombia	239%	179%	299%	523%	146%	73%	54%	98%	526%
Mexico	83%	63%	104%	183%	51%	25%	19%	34%	184%
Peru	341%	255%	426%	746%	207%	104%	77%	140%	750%
Average	235%	176%	294%	515%	143%	72%	53%	97%	518%
	Dollarization								
	Baseline: r=5%, g=4%			Sensibility: x=mean(x), g=4%			Sensibility: x=mean(x), r=5%		
	x=mean(x)	x=Low(x)	x=high(x)	r=4.5%	r=5.5%	r=6.5%	g=2%	g=3%	g=4.5%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brazil	156%	117%	195%	341%	95%	48%	35%	64%	343%
Chile	443%	332%	553%	970%	270%	135%	100%	182%	975%
Colombia	517%	388%	647%	1133%	315%	158%	117%	213%	1139%
Mexico	1881%	1411%	2351%	4119%	1146%	575%	425%	775%	4140%
Peru	382%	286%	477%	836%	233%	117%	86%	157%	841%
Average	676%	507%	845%	1480%	412%	206%	153%	278%	1487%

Table 5

5 LAMU, Dollarization or Autonomy?

The previous section dealt with the three main areas that would be affected by the adoption of a common currency –business cycles, trade and seignorage. In this section, I take steps toward compiling the evidence –i.e., I discuss the relative importance of these areas.[7] In doing this, policy implications emerge.

I first discuss whether inflation targeters in Latin America should retain monetary autonomy or form a common currency. The main conclusion is that each would be better off in a monetary union. I then tackle the case of dollarization versus autonomy, concluding again that giving up monetary autonomy is the preferred strategy. Finally, I deal with the case of unilateral dollarization versus LAMU. Here, the results are mixed. For reasonable calibrations, LAMU is strictly preferred for Chile, Peru and Brazil, while dollarization is the preferred strategy for Mexico; the results are ambiguous for Colombia.

5.1 Autonomy or LAMU?

Embarking on a LAMU –compared to retaining monetary autonomy– entails one large benefit, namely the impact on trade and GDP discussed in the previous section. There should be no relevant consequences in terms of

[7] The previous section also discussed credibility aspects. Nevertheless, as mentioned, this paper makes no assumptions as to the level of credibility that dollarization would bestow compared to LAMU. Thus, the credibility category is not included in this section.

seignorage, provided that the union agreement includes a seignorage sharing rule. On the downside, the adoption of a common currency can exacerbate the volatility of economic activity. How costly is volatility in terms of its impact on welfare?

This question has been actively debated in the literature, especially since Lucas (1987) claimed that business cycle fluctuations have a negligible impact on welfare. More recently, Wolfers (2003) has used subjective wellbeing data from developed nations to show that unemployment volatility has a negative and relatively large impact on wellbeing. Here, I use an empirical strategy inspired by Wolfers' contribution to estimate whether the observed volatility in economic activity had any impact on the self-reported wellbeing statistics for the five IT nations in LA. Later, based on these results, I propose a methodology for answering the following question: is the potential increase in volatility (due to giving up monetary autonomy) large enough to overcome the benefits via trade of LAMU?

I use data from Latinobarometro, an annual survey that has been performed in a number of Latin-American nations since 1995. The specific question I am interested in is: *In general terms, would you say that you are satisfied with your life? Would you say that you are: very satisfied, fairly satisfied, not very satisfied, or not at all satisfied?* This question was asked in the years 1997, and 2000 through 2007.[8] I focus on the surveys performed in the five IT nations in LA. The dataset covers nine years and 5 countries –45 country-years– and contains 52650 valid responses. I build three alternative Life Satisfaction measures for country c at year t.

(i) *LS1:* Following Di Tella et al. (2001) and Wolfers (2003), the life satisfaction questions are coded as: 1 = "not at all satisfied"; 2 = "not very satisfied"; 3 = "fairly satisfied" and 4 = "very satisfied." The simple average across individuals for any country c for any year t gives the first country-year Life Satisfaction measure.

(ii) *LS2*: Following Wolfers (2003), I run an ordered probit regression on individual characteristics and a full set of dummy variables for each country for each year, with standard errors clustered at the country-year level. If wellbeing is an unobserved normally distributed variable within each country-year, this procedure will estimate the cut-points between different categorizations. As Wolfers puts it "this [...] estimates numerical values for each qualitative response that are most likely given the sample proportions

[8] In 2002, a similar question appeared: *In general, would you say that you are very happy, fairly happy, not very happy or not at all happy?* Wolfers (2003) reports that the answers to these questions are highly correlated in the Eurobarometer data. We assume that the same is true in the LAC case.

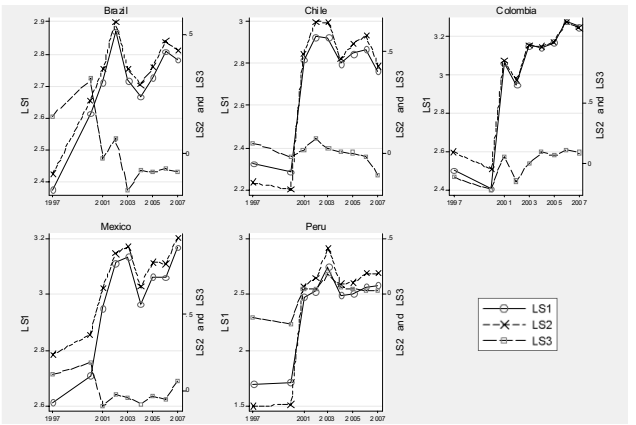

Figure 5: LS measures over time.

in the data and the assumption that the true underlying distribution of happiness is normally distributed." After obtaining the linear prediction of the latent variable for each individual, I take the average across individuals for each country-year obtaining LS2.

(iii) *LS3*: Following Di Tella et al. (2001), I run LS1 on micro controls and country and year effects.[9] The average error for each country in each year –i.e., the part of LS not explained by individual characteristics– is LS3. The three LS measures over time are depicted in Figure 5.

I then examine whether volatility in the economic activity undermines wellbeing. To do this, I estimate the convexity in preferences over growth and inflation. Specifically, I regress Life satisfaction measures against contemporaneous inflation, growth and quadratic terms for both variables. The regressions include a full set of dummy variables for each country and each year. The results are reported in Table 6.[10]

Inflation exhibits the expected negative sign in all cases and is significant at the 10% level in two of the three specifications. The quadratic term seems irrelevant. Consistent with the results obtained by Di Tella et al. (2001) and Wolfers (2003) for developed nations, increases in inflation seem to undermine self-reported satisfaction indexes. Moreover, increases in growth rates go hand in hand with increases in self-reported satisfaction levels, although

[9] The first stage results are not reported, but are available from the author upon request.

[10] The specification in Table 6 only makes sense if there are no negative growth rates. In our sample, there is one negative growth rate, but the absolute value of the number is the smallest figure in the sample. Dropping this observation does not alter the conclusions.

with marginally decreasing effects. Although the coefficient is imprecisely estimated, the growth-related variables are jointly significant.

	LS1	LS2	LS3
Inflation	-0.046*	-0.065*	-0.039
	(0.025)	(0.036)	(0.026)
Inflation Squared	0.0016	0.0022	0.0013
	(0.001)	(0.001)	(0.001)
Growth	0.036	0.048	0.055
	(0.035)	(0.049)	(0.038)
Growth Squared	-0.00025	-0.00022	-0.00174
	(0.0035)	(0.0050)	(0.0037)
Constant	2.87***	0.59**	-0.05
	(0.17)	(0.25)	(0.19)
R-squared	0.93	0.93	0.31
Adj R-squared	0.89	0.88	-0.09
# of obs	45	45	45
Joint Significance (p_values) of:			
Inflation related variables	0.13	0.13	0.20
Growth related variables	0.06	0.08	0.04
Note: Robust standard errors are in parentheses. Regressions include year and country dummies.			

Table 6.

The results in Table 6 can be expressed in terms of the mean and the variance of inflation and growth. In particular, abstracting from the constants and the error term, and defining g as the output growth rate and $\bar{x}$ as the mean of x, the expected value of LS, can be written as

$$\begin{aligned} E(LS) &= E[a\pi + b\pi^2 + cg + dg^2] \\ &= b[E\pi^2 - (E\pi)^2] + b(E\pi)^2 + aE\pi + d[Eg^2 - (Eg)^2] + d(Eg)^2 + cEg \\ &= bVar(\pi) + (b\overline{\pi} + a)\overline{\pi} + dVar(g) + (d\overline{g} + c)\overline{g} \end{aligned}$$

This allows us to estimate indifference curves, relations between output volatility and growth that leave LS unaltered. In Figure 6, I plot indifference curves based on the results from Table 6. The shape of the indifference curve implies that as volatility goes up, agents need to be compensated with increasingly higher growth rates in order to leave LS unaltered.

How much would average volatility increase with the adoption of a monetary union? Even though there is no clear answer in the literature to this question, economists have argued that there are forces associated with the monetary union that should attenuate increases in volatility over time, as the trade among the union's members increases and their policies converge. Indeed, Frankel and Rose (1997) show that the synchronization of business cycles increases with trade links; consequently, a monetary union will *ex-post* yield more tightly correlated business cycles. Moreover, a convergence in monetary and fiscal policies has recently been shown to have a quantitative impact comparable to the trade effect on business cycle synchronization

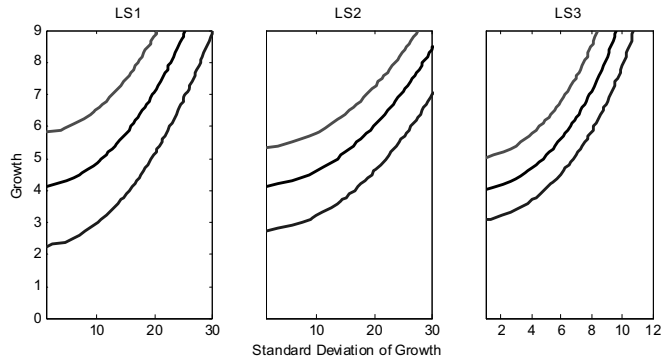

Figure 6: Indifference curves. The lines in the middle pass through the sample mean of growth and standard deviation of growth.

(Inklaar et al., 2008). Thus, even though economists are unsure as to how large the increase in volatility would be, the evidence suggests that the increase due to the monetary union should dissipate over time.

As explained earlier, these indifference curves are a means for approaching the following question: Is the impact of an increase in volatility potentially large enough to overcome the benefits via trade of LAMU? To answer this question, I use the following counterfactual: what increase in volatility is needed to offset the benefits via trade of LAMU? Here are the detailed steps for implementing an empirical strategy aimed at answering the question.

- On the one hand, I estimate the present discounted value of GDP, inclusive of the effect of trade. In the baseline, I focus on the case where trade increases GDP 20 years after a common currency is adopted. The present discounted value of GDP if LAMU is adopted in period 0, inclusive of the benefits of trade, can be written as

$$PDV(Y^{Tr}) = \sum_{t=0}^{19} \left(\tfrac{1}{1+r}\right)^t Y_0(1+g)^t + \sum_{t=20}^{\infty} \left(\tfrac{1}{1+r}\right)^t Y_0(1+g)^t(1+x)$$

- I then ask what increase in growth (later converted to an equivalent increase in volatility via indifference curves) is needed to match these benefits. In the baseline, I assume that an increase in volatility occurs as soon as a common currency is adopted and lasts for 20 years. The expression I am interested in is

$$PDV(Y^{\sigma}) = \sum_{t=0}^{19} \left(\frac{1}{1+r}\right)^t Y_0(1+g+\varepsilon)^t + \sum_{t=20}^{\infty} \left(\frac{1}{1+r}\right)^t Y_0(1+g)^t$$

where ε is the additional growth (again, later converted to additional volatility) needed to match the benefits of trade. I estimate ε numerically. Note that for each country, I have specific x's and thus specific ε's.

- Having country-specific ε's, I use the indifference curves to calculate the implied increase in volatility for each country needed to offset the benefits of a common currency via trade.[11] The indifference curves are also country specific in the sense that each passes through the respective growth and standard deviation means. Table 7 reports the ε's and respective implied increases in volatility.

For the baseline case, the average ε is 1,3% and the implied volatility increase –averaged across the LS estimations– is 507%, a very large figure. To put it in perspective, Blanchard and Simon (2001) document that the variability of quarterly growth in real output in the US (as measured by its standard deviation) declined by half since the mid-1980s. A similar phenomena occurred in many countries around the world in a the process that has been dubbed the Great Moderation. If such a striking process was able to cut volatility by half over three decades, increasing volatility by almost 500% through the monetary union–with the relatively high correlation of business cycles identified earlier–seems implausible. Under the baseline scenario, the trade effect has a larger impact than the increase in volatility.

In the same Table, I perform a couple of robustness checks. On the one hand, I report results assuming that the trade effect takes its lowest value. On the other hand, I also check the outcomes if the trade effect only takes place 30 years later and if the volatility increase lasts 30 years. On average, both cases suggest that the implied volatility increase still needs to be (too) large in order to offset gains on the trade front. The country with the smallest implied increase in volatility is Mexico. Nonetheless, the implied average increase is above 100%. Moreover, Mexico is, after Brazil, the largest economy in Latin America. The joint business cycle of the five IT nations and the policy decisions of LAMU's central bank, would be highly

[11] In comparing $PDV(Y^{\sigma})$ and $PDV(Y^{Tr})$, I use the baseline value for g, 4%. Later, estimating the increase in volatility, I use country specific indifference curves– the ones that cross through the average growth and standard deviation of each country. Robustness checks, not reported here, show that none of the conclusions in the section are altered if we try alternative values for g in the first step of the estimation of the volatility increase.

dependent on the Mexican cycle. Thus, is unlikely that the union would increase Mexican volatility by over 100%.

Baseline

	ε (%)	Implied increase in volatility (%)			
		LS1	LS2	LS3	Average
Brazil	0.4	388	502	123	338
Chile	2.4	1200	1524	408	1044
Colombia	1.4	573	737	184	498
Mexico	0.5	255	335	74	221
Peru	1.9	505	654	147	435
Average	1.3	584	750	187	507

x=low(x)

	ε (%)	Implied increase in volatility (%)			
		LS1	LS2	LS3	Average
Brazil	0.3	327	425	101	284
Chile	1.9	1047	1332	355	912
Colombia	1.0	491	633	155	426
Mexico	0.4	212	281	59	184
Peru	1.5	434	564	124	374
Average	1.0	502	647	159	436

Volatility increase lasts 30 years

	ε (%)	Implied increase in volatility (%)			
		LS1	LS2	LS3	Average
Brazil	0.2	228	301	65	198
Chile	1.1	771	986	256	671
Colombia	0.6	351	457	105	304
Mexico	0.2	144	194	37	125
Peru	0.8	309	405	83	266
Average	0.6	361	469	109	313

Table 7

To sum up, the results suggest that the potential increase in volatility that each member country might face when forming a monetary union does not have a first order impact on well-being–at least not relative to the positive impact of trade. These results suggest that LAMU is preferable to monetary autonomy.

5.2 Dollarization or Autonomy?

To study the convenience of dollarizing, I use the same methodology as in the previous subsection. There are two differences however: if a country dollarizes, it will face both a loss of seignorage and potentially greater volatility exacerbation. As for the loss of seignorage, I subtract from the trade effect of dollarizing the present discounted value of lost seignorage. I then ask what increase in volatility would offset the gains on the trade front resulting from dollarizing, net of the lost seignorage. The results are reported in Table 8, for the same baseline case and using the same robustness checks as in Table 7.

The predicted increases in volatility needed to offset the gains derived from trade net of lost seignorage are very large. Even though, with the

exception of Mexico, we should expect greater volatility exacerbation when dollarizing than when joining LAMU, the numbers obtained in Table 8 are out of line. For the baseline case, on average, volatility should grow by a factor of almost 8, an implausible figure. The robustness checks suggest figures too large to be reasonably expected. For instance, the country were volatility would have to increase the least, Brazil, in the third panel of Table 8, would have to see its volatility almost triple in order to offset the net gains derived from trade. Thus, the conclusion is again that giving up monetary autonomy, this time in favor of the dollar, makes economic sense.

Baseline

	ε (%)	Implied increase in volatility (%)			
		LS1	LS2	LS3	Average
Brazil	0.4	402	519	129	350
Chile	2.0	1077	1370	366	938
Colombia	2.4	779	996	257	677
Mexico	7.3	1167	1488	370	1009
Peru	1.5	445	578	127	383
Average	2.7	774	990	250	671

x=low(x)

	ε (%)	Implied increase in volatility (%)			
		LS1	LS2	LS3	Average
Brazil	0.2	251	330	73	218
Chile	1.4	897	1143	302	780
Colombia	1.7	656	841	214	570
Mexico	5.9	1049	1338	342	910
Peru	1.0	348	456	96	300
Average	2.1	640	821	205	556

Volatility increase lasts 30 years

	ε (%)	Implied increase in volatility (%)			
		LS1	LS2	LS3	Average
Brazil	0.2	219	289	62	190
Chile	0.8	677	868	222	589
Colombia	1.0	487	629	153	423
Mexico	3.5	790	1009	264	688
Peru	0.6	261	345	68	225
Average	1.2	487	628	154	423

Table 8

5.3 Dollarization or LAMU?

The benefits via trade of dollarizing are greater than those of LAMU, with the exception of Chile. On the downside, dollarizing implies a loss of seignorage and a potentially greater exacerbation of volatility. Here, I take a look at the relative importance of these effects under alternative scenarios. I begin with trade and seignorage, and later turn to volatility issues.

In Table 9, I report the present discounted value of the trade effect from dollarizing on GDP, net of the same effect if the country in question adopts LAMU. Both trade effects are calculated as if the impact of the common currency on trade and GDP occurred instantaneously. To this *net* trade effect, I subtract the seignorage foregone if a country dollarizes, again the

present discounted value measured as a % of GDP in 2007. If the numbers in the Table are positive, dollarization is preferred to LAMU. The opposite is true if the numbers are negative.

Under the baseline case (1), Chile and Peru show negative numbers. For the rest of the countries, the benefits of dollarization are greater than those of LAMU if only trade and seignorage are taken into account. The positive/negative split changes in Brazil when either the trade effects are low or when inflation (seignorage) picks up.

Impact of a common currency: the trade effects of dollarization - the trade effects of Lamu - seignorage foregone under dollarization. The effects reported are present discounted values (% of GDP in 2007)

	r=5%, g=4%, π=3%			x=mean(x), g=4%, π=3%			x=mean(x), r=5%, π=3%			x=mean(x), r=5%, g=4%			x=low(x), r=5%, g=4%		
	x=mean(x)	x=Low(x)	x=high(x)	r=4.5%	r=5.5%	r=6.5%	g=2%	g=3%	g=4.5%	π=2%	π=4%	π=5%	π=2%	π=4%	π=5%
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**
Brazil	23%	-4%	49%	55%	12%	3%	8%	11%	45%	33%	12%	1%	7%	-15%	-25%
Chile	-91%	-91%	-92%	-171%	-65%	-44%	-30%	-46%	-183%	-80%	-103%	-114%	-79%	-102%	-113%
Colombia	260%	175%	344%	527%	171%	99%	87%	130%	519%	270%	250%	240%	185%	165%	155%
Mexico	2133%	1589%	2677%	4251%	1427%	862%	711%	1067%	4266%	2139%	2127%	2122%	1595%	1583%	1578%
Peru	-64%	-76%	-51%	-113%	-48%	-35%	-21%	-32%	-128%	-49%	-79%	-93%	-62%	-91%	-106%
Average	452%	319%	585%	910%	299%	177%	151%	226%	904%	462%	442%	431%	329%	308%	298%

Table 9

The previous Table made the unreasonable assumption that the trade effects occur as soon as the common currency is adopted. Table 10 reports the results if the trade effects occur 20 years after the monetary union is formed. Obviously, negative numbers continue to show up for Chile and Peru. In Brazil, 2/3 of the columns now show up with negative numbers, reenforcing the notion that LAMU might be preferable to dollarization under alternative, reasonable scenarios. Colombia and Mexico are the only cases where, when trade and seignorage are the sole concerns when comparing LAMU and dollarization, the latter consistently appears as the preferred strategy. This is mostly the consequence of Mexico and Colombia being the countries with the highest proportion of trade with the US.

Impact of a common currency: the trade effects of dollarization - the trade effects of Lamu - the seignorage foregone under dollarization, with trade effects taking place from year 21 onwards. The effects reported are present discounted values (% of GDP in 2007)

	r=5%, g=4%, π=3%			x=mean(x), g=4%, π=3%			x=mean(x), r=5%, π=3%			x=mean(x), r=5%, g=4%			x=low(x), r=5%, g=4%		
	x=mean(x)	x=Low(x)	x=high(x)	r=4.5%	r=5.5%	r=6.5%	g=2%	g=3%	g=4.5%	π=2%	π=4%	π=5%	π=2%	π=4%	π=5%
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**
Brazil	4.2%	-18%	26%	36%	-6%	-13%	-8%	-6%	26%	15%	-7%	-17%	-7%	-28%	-39%
Chile	-91%	-90%	-92%	-170%	-64%	-43%	-30%	-45%	-182%	-79%	-102%	-114%	-79%	-102%	-113%
Colombia	201%	131%	271%	465%	114%	48%	37%	76%	458%	211%	191%	181%	141%	121%	111%
Mexico	1754%	1305%	2203%	3855%	1064%	528%	392%	719%	3870%	1760%	1748%	1743%	1310%	1299%	1293%
Peru	-73%	-83%	-62%	-122%	-56%	-42%	-29%	-40%	-137%	-58%	-87%	-102%	-68%	-98%	-112%
Average	359%	249%	469%	813%	210%	95%	72%	141%	807%	370%	349%	338%	259%	239%	228%

Table 10

To sum up, with trade and seignorage taken into consideration, I have two cases where LAMU is always the preferred strategy (Chile and Peru), two cases where dollarization seems more appropriate (Colombia and Mexico) and one case where there is no clear-cut favorite (Brazil).

Would these conclusions change if I take into account the effects of volatility? For the Mexican case, the answer is clearly no. On the one hand, the Mexican business cycle index (Figure 4) with LAMU and with the US is almost identical; thus, one should not expect significantly different increases in volatility when comparing dollarization with LAMU. On the other hand, the *net* gains via trade of dollarizing, even after taking into account seignorage losses, are very large. No reasonable change in volatility could offset those gains.

As for Chile and Peru, even without considering volatility, LAMU is the preferred strategy. Since the increase in volatility would be worse under dollarization than LAMU, this only makes LAMU more attractive vis-a-vis dollarization.

As for Brazil, while in Table 10 several negative signs show up –i.e., LAMU is preferable to dollarization– some columns show positive signs. What increase in volatility is needed to offset the advantage of dollarization under the *worst* scenario from the point-of-view of LAMU (column 4)? Using the indifference curve strategy outlined above, the answer is a 38.1% average increase in volatility.[12] Given that Brazil is the main driver of the business cycle of LAMU, and that its correlation with the US is very low, this relative increase in volatility seems plausible. This, together with the fact that negative numbers show up in Table 10 (without taking into account the volatility factors), leads us to conclude that for reasonable calibrations, the large gains on the trade front under dollarization are surpassed by the sum of the trade gains under LAMU, the seignorage foregone and the relative volatility increase under dollarization.

As for Colombia, to counter the relative advantage of dollarization in the baseline case in Table 10, one would need an average increase in volatility of 131%. Even though Colombia has a very low business cycle synchronization with the US, a 131% increase in volatility seems too large a number to be reasonably expected. Nevertheless, if I focus on the average of the two lowest figures for Colombia in Table 10 and calculate what increase in volatility would counter it, the answer is a 30.8%. Such an increase in volatility if Colombia were to dollarize –considering the very low synchronization of its business cycle with the US– seems plausible. I conclude that, even though in

[12] That is, vis-a-vis a zero threshold increase in volatility in the case of LAMU.

most calibrations for Colombia dollarization seems to have the edge, there are plausible combinations were the choice is a close call.

Thus, there are three countries, Chile, Peru and Brazil, where LAMU seems a better alternative; one case where LAMU and dollarization are close to equal, Colombia; and one case where dollarization is clearly preferable, Mexico. In al cases, a common currency strategy, be it dollarization or LAMU, is preferable to monetary autonomy. As Dornbusch once stated, convergence on regional monies is a no-brainer.

6 Concluding Remarks

The policy lessons that emerge from this paper are clear: IT nations in Latin America should consider more seriously giving up monetary autonomy. The fact that the paper has focuses exclusively on IT nation in the region, is not a coincidence; a successful monetary union needs converging monetary institutions, both in terms of goals and strategies. From the point of view of trade, a monetary union between Argentina and Brazil or between Colombia and Venezuela would make sense. Nevertheless, the monetary institutions, strategies and goals of Venezuela and Argentina are very distant from the IT framework that Colombia and Brazil share. That is why non-IT countries are not considered in this paper.

A topic that this paper has not considered concerns the political barriers confronting the relinquishing of monetary autonomy. National currency is part of national identity; even if there were no debate regarding the economic benefits of abandoning it, there would always be public opinion resistant to monetary union. If a consensus among policy-makers emerges regarding the economic benefits of a LAMU, a careful strategy aimed at explaining to the public the costs-benefit analysis should be planned. The European experience has shown that this is not an easy task. As mentioned in the introduction, overcoming resistance to giving up monetary autonomy in favor of a new Latin American currency seems more plausible than adopting the dollar. In many sectors of the region, anti-Amercanism remains high and often appears as a useful political tool.

For the policy implications of this paper to become part of the regional agenda, an active engagement on the part of Brazil is essential. During the last few years, Brazil has become the indisputable political leader in the region and the main economic force. Without the regional leader's active engagement, this agenda has no political future. Recently, there have been some signs that Brazil might be willing to move along the lines suggested

in this paper. President Lula has been pushing to allow trade transactions between countries in the region and Brazil to be paid for in local currencies rather than US dollars. Of course, this will not eliminate exchange rate uncertainty and seems designed to weaken the role of the dollar in the region rather than bolster trade. Still, this could be read as constituting preliminary steps towards taking more seriously the policy lessons from this paper.

Additional research on the topic is certainly needed. There are several areas where our knowledge is still weak. For instance, this paper has not addressed two important issues regarding currency unions–labor mobility and flexibility and the role played by fiscal rules. I hope this paper will spark interest among economists on this important topic so that in the near future, the robustness of the policy implications of this paper can be more fully assessed.

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Appendix

Differences in Preferences: the Short-Run

Let the shocks be identical across the economies, i.e., $\varepsilon = \varepsilon_j$ so that $\sigma_{\varepsilon}^2 = \sigma_{\varepsilon_j}^2 = \sigma_{\varepsilon\varepsilon_j} = \sigma^2$. Here I do *not* assume that $\Theta_j = \Theta = 0$; precisely, the goal is to explore the role of Θ_j and Θ in determining the welfare implications of joining a union. Then, $E\Delta\mathcal{L}_j$ can be written as

$$E\Delta\mathcal{L}_j = (11)+ \\ \frac{1}{2}\left[\left(\frac{h\Theta}{1+h}\right)^2 - \left(\frac{h_j\Theta_j}{1+h_j}\right)^2 - 2\left(\frac{\lambda h\Theta\overline{U}_u}{(1+h)^2} - \frac{\lambda_j h_j\Theta_j\overline{U_j}}{(1+h_j)^2}\right)\right] \quad (19)$$

where the sign of the new line depends on the relative size of the other parameters in the model. I explore differences in each of them, one at a time.

A1. Let $\overline{U_j} \neq \overline{U_u}$; $\lambda_j = \lambda$, $h_j = h$, $\Theta_j = \Theta$. Then $E\Delta\mathcal{L}_j$ can be written as

$$(12) - \frac{\lambda h \Theta}{(1+h)^2}\left(\overline{U_u} - \overline{U_j}\right) \tag{20}$$

The new term is negative if $\left|\overline{U_j}\right| > \left|\overline{U_u}\right|$ and if $\Theta > 0$. That is, if the inflation target is above the optimal rate and country j has more ambitious unemployment goals, joining a monetary union will be even more welfare increasing for j. The credibility the monetary union bestows has a higher impact on welfare when the union occurs among inflation targeters.

A2. Let $\lambda_j \neq \lambda$; $\overline{U_j} = \overline{U_u}$, $h_j = h$, $\Theta_j = \Theta$. Then $E\Delta\mathcal{L}_j$ can be written as

$$(13) - \frac{h\Theta\overline{U}_u}{(1+h)^2}\left(\lambda - \lambda_j\right) \tag{21}$$

The new term is again negative as long as $\Theta > 0$ and $\lambda < \lambda_j$. The interpretation is analogous to the previous case.

A3. Let $h_j \neq h$; $\overline{U_j} = \overline{U_u}$, $\lambda_j = \lambda$, $\Theta_j = \Theta$. Then $E\Delta\mathcal{L}_j$ can be written as

$$(14) + \frac{\Theta^2}{2}\left(\left(\frac{h}{1+h}\right)^2 - \left(\frac{h_j}{1+h_j}\right)^2\right) - \Theta\lambda\overline{U}_u\left(\frac{h}{(1+h)^2} - \frac{h_j}{(1+h_j)^2}\right) \tag{22}$$

For interpretation purposes, I consider the case where $h_j < h$, namely a scenario where the Union's Central Bank attaches a higher priority to the achievement of the inflation target. The two new terms are positive as long as $\Theta > 0$. The message they convey is intuitively clear: if the union's Central Bank attaches a greater weight to the inflation target and the latter is above the optimal rate, then joining the union decreases welfare.

A4. Let $\Theta_j \neq \Theta$; $\lambda_j = \lambda$; $\overline{U_j} = \overline{U_u}$, $h_j = h$. Then $E\Delta\mathcal{L}_j$ can be written as

$$\frac{1}{2}\left(\frac{h}{1+h}\right)^2\left(\Theta^2 - \Theta_j^2\right) - \frac{2h\lambda\overline{U}_u}{(1+h)^2}\left(\Theta - \Theta_j\right) \tag{23}$$

The expressions says that the higher Θ_j with respect to Θ the greater are the gains of joining the union. By joining the union, country j adheres to a Central Bank that targets an inflation rate closer to the optimal, reducing the bias generated by the discrepancy between the target and the optimal rate. In this scenario, joining the union will unambiguously be welfare improving.

About the Indexes of Central Bank Independence (CBI)[13]:

[13] This part is based on the description provided in Jacome and Vazquez (2005).

GMT comes from the work of Grilli, Masciandaro and Tabellini (1991). GMT observes 15 criteria each one with a score of zero or one. The overall index is obtained by addition. A higher score indicates higher CBI. In this index, political independence is defined in terms of central bank responsibilities, procedures for appointing central bank government bodies and the level of government control over monetary instruments. Economic independence is defined in terms of restrictions to finance fiscal deficits and the role the central bank plays in banking supervision.

The **Cukierman index** is based on 16 criteria of political and economic independence. The index uses a continuous scale from zero to one. The overall index is obtained using a weighted average of the individual criteria. Political independence is based on the characteristics of the appointment and dismissal of the central bank's governor and the independence for policy formulation. In terms of economic independence, a central bank is better rated if the provisions for monetization of the fiscal deficit are restrictive. In addition, the index is higher if there is a legal mandate to focus on price stability.

The **Modified Cukierman Index (MCI)** changes some of the 16 criteria considered by the Cukierman index. MCI maintains the four general classification criteria of the Cukierman index but adds a new category for central bank accountability. There are four main changes in the index: i) MCI assesses characteristics of the appointment and dismissal of the entire board of directors of the central bank. ii) MCI includes the CBI in terms of exchange rate policy. iii) Two additional criteria are included: central bank faculties as governing lender of last resort and provisions that secure central bank financial autonomy. For example MCI rewards the existence of limits to the central bank involvement in banking crises. iv) MCI adds criteria for accountability. For example, MCI rewards legal provisions that force central banks to report on a regular basis their policy targets and achievements. Also, a better MCI is obtained if the central bank financial statements are published on a regular basis.