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DOLLARIZATION AND ECONOMIC PERFORMANCE: WHAT DO WE REALLY KNOW?

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ABSTRACT

In this paper we analyse the macroeconomic record of dollarized economies. In particular, we investigate whether, as its supporters claim, dollarization is associated with lower inflation and faster growth. We analyse this issue by using a matching estimator technique developed in the training evaluation literature. Our findings suggest that inflation has been significantly lower in dollarized nations than in non-dollarized ones. We also find that dollarized nations have had a lower rate of economic growth than non-dollarized ones. Finally, we find that macroeconomic volatility is not significantly different across dollarized and non-dollarized economies. We conjecture that the lower rate of economic growth in dollarized countries is due, at least in part, to these countries' difficulties in accommodating external disturbances, such as major terms of trade and capital flows shocks. Copyright © 2003 John Wiley & Sons, Ltd.

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1. INTRODUCTION

The recurrence of currency crises in emerging countries has generated an intense debate on exchange rate policies. Pegged-but-adjustable exchange rate regimes have rapidly lost adepts, while hard pegs and freely floating rates have gained in popularity (see Summers, 2000; Fischer, 2001). A growing number of economists have gone as far as arguing that (many) emerging nations should completely give up their national currencies, and adopt an advanced nation's currency as legal tender. This policy proposal has come to be known by the general name of *dollarization*. Recently, some emerging countries have, indeed, decided to officially dollarize their economies. In 2000, for example, and in the midst of a major crisis, Ecuador abolished its currency, the sucre, and adopted the US dollar. El Salvador adopted the dollar during 2001; and in May 2001, the dollar became legal tender in Guatemala.[1] In other countries, however, politicians have systematically refused to consider dollarization, even in the face of major and costly financial crises. This was the case, for instance, of Argentina during late 2001 and early 2002.

Supporters of dollarization have argued that countries that give up their currency will be unable to engage in monetary and macroeconomic mismanagement. Public finances will stay in balance, macroeconomic policy (or what is left of it) will be credible, and the external accounts will move within reasonable bounds. According to this view, dollarization will have two major positive effects on economic performance. First, inflation will be lower in dollarized than in non-dollarized nations. Alesina and Barro (2001, p. 382), for instance, have argued that adopting another nation's currency 'eliminates the inflation-bias problem of discretionary monetary policy'. Second, countries that give up their currency will tend to grow faster than non-dollarized countries. This growth effect is supposed to take place through two

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channels: (a) dollarization will mean lower interest rates, higher investment, and faster growth (Dornbusch, 2001); and (b), by eliminating exchange rate volatility, dollarization is supposed to encourage international trade and this, in turn, will result in faster growth. Rose (2000), and Rose and van Wincoop (2001), among others, have emphasized this trade channel.[2] Other authors, however, have voiced scepticism regarding the alleged positive effects of dollarization on growth and overall macroeconomic performance. According to Eichengreen (2001) the evidence on the relationship between monetary regimes and growth is inconclusive, and does not support the claim that dollarization—or any exchange rate regime, for that matter—is an important determinant of growth.[3] The traditional view, on the other hand, is that in countries with a hard peg it is difficult to accommodate external shocks, including terms of trade and world interest rate disturbances. This, in turn, will be translated into greater instability and lower economic growth (Fischer, 1977). Frankel (1999) has argued that there is no unique recipe on exchange rate policy; while some countries will benefit from hard pegs, for other countries a floating regime will be more appropriate.

Surprisingly, until very recently there have been no formal empirical studies on the economic consequences of dollarization. In particular, international comparative studies on alternative exchange rate and monetary regimes have traditionally ignored dollarized countries. For instance, the comprehensive study on exchange rate regimes, growth and inflation by Gosh *et al*. (1995) does not include nations that do not have a currency of their own. Likewise, the IMF (1997) study on alternative exchange rate systems excludes dollarized countries, and the recent paper by Levy-Yeyeti and Sturzenegger (2001) on exchange rates and economic performance excludes nations that do not have a central bank. This lack of empirical evidence means that countries that are contemplating dollarization have very little information on how other countries have historically performed under this monetary regime. Most existing evidence on dollarization is based on the experience of Panama, a country that has used the US dollar as legal tender since 1904.[4] Rose and Engel (2000) provided an early empirical analysis of economic performance in countries with no currency of their own. Their analysis, however, does not emphasize 'dollarized' countries—that is countries that use an advanced nation's currency—instead it focuses mostly on currency unions, or countries whose common currency is *not* the currency of an advanced nation, but rather the union's own currency. In fact, the Rose and Engel (2000) data set includes 26 countries that do not have a currency of their own, and have data on real GDP per capita. Of these 23 countries, only one—Panama—corresponds to a strictly dollarized nation; the other 25 countries in the data set correspond to currency unions.

The purpose of this paper is to analyse the historical macroeconomic record of dollarized economies. More specifically, we are interested in investigating whether, as its supporters argue, dollarization is associated with superior macroeconomic performance, as measured by lower inflation, faster growth and lower growth volatility. Performing this type of international comparison, however, is not easy. The problem is how to define an appropriate 'control' group with which to compare the dollarized nations. Since dollarization is not a 'natural experiment', using a broad control group of all non-dollarized emerging countries is likely to result in biased estimates. In this paper we tackle this issue by using a matching estimator technique developed in the training evaluation literature (Heckman *et al*., 1997).

In this paper we concentrate on countries and territories that use an advanced nation's currency, or countries that have a strictly dollarized system. That is, we exclude from the analysis territories and countries that join a monetary union that has a currency of its own (i.e. the East Caribbean Currency Area or the CFA area in Africa). The reason for focusing on strictly dollarized countries is rather simple: to a large extent the policy debate in the emerging world, and especially in Latin America, is whether these countries ought to adopt an 'advanced' country's currency, as a way of achieving credibility. In Argentina, for instance, it is very different to delegate the running of monetary policy to the Federal Reserve than to delegate it to a MERCOSUR central bank that would be run by Brazilians and Argentines. Argentine politicians and economists rightly ask whether the latter would have any more credibility than their own embattled central bank.

Before proceeding, it is useful to point out the ways in which our analysis differs from other related work in this general area. First, we use a 'matching' methodology to define the appropriate control group. Second, we focus directly on the most important macroeconomic variables—real GDP growth, inflation

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and growth volatility. Other studies, in contrast, have analysed performance in an indirect fashion, and have focused on ancillary variables such as the level of international trade and/or interest rates. For instance, Rose and Frankel (2002) have analysed the way in which currency unions affect bilateral trade and, through this channel, economic growth.[5] Edwards (1998) and Powell and Sturzenegger (2000) have investigated the way in which the exchange rate/monetary regime affects interest rate behaviour, and the cost of capital. And third, in the current paper we are particularly interested in estimating the actual magnitude of the 'dollarization effect'. That is we want to know, as precisely as possible, by how many percentage points countries under a certain regime have outperformed countries with an alternative regime. We believe that, by dealing with the 'treatment bias', the matching methodology used in this paper is particularly appropriate for this purpose.

The results reported in this paper suggest quite strongly that inflation has been significantly lower in dollarized nations than in non-dollarized ones. We also find that dollarized nations have had a lower rate of economic growth than non-dollarized ones. Statistically speaking, however, this result is not as strong as our finding on inflation differentials. Finally, we find that macroeconomic instability—measured by the degree of volatility of GDP growth—is not significantly different across dollarized and non-dollarized economies. We conjecture that the lower rate of economic growth in dollarized countries is due, at least in part, to these countries' difficulties in accommodating external disturbances, such as major terms of trade and capital flows shocks. Unfortunately, the lack of data precluded us from investigating this issue formally. Preliminary results for the case of Panama reported in Edwards (2001) and Edwards and Levy-Yeyati (2002), however, provide some support for this view. The rest of the paper is organized as follows. In Section 2 we provide a preliminary analysis of historical experiences with 'dollarization'. In Section 3 we present our empirical analysis using matching estimators. In Section 4 we provide some concluding remarks.

2. DOLLARIZATION EXPERIENCES DURING 1970–1998

2.1. Historical experiences

Countries that use a foreign currency as legal tender can be divided into two groups. The first one corresponds to *independent* nations, while the second group includes territories, colonies or regions within a national entity. Panama is an example of the first type of country, while Puerto Rico belongs to the second group. Table 1 contains a list of countries (Panel A) and territories (Panel B) that have had an official dollarized system at any time during the 1970–1998 period.[6] We have included information on population, and on the currency (or currencies) used as legal tender. As may be seen, the countries and territories that have had a dollarized monetary system are very small indeed. Many are city-states well integrated into their neighbours' economies—Monaco, Lichtestein, the Vatican and Andorra are good examples. Some of them are not only tiny, but also have an exciting and romantic origin. This is the case of Pitcairn Island, the place where a group of English mutineers and Tahitian women settled in 1790. Many of the dollarized economies are so small that they do not have data on basic economic indicators such as inflation or growth. We have been able to collect data on growth for 12 of the 13 independent countries, and for 3 of the territories. Inflation data are available for 9 of the independent countries and for the same 3 territories (see Table 1). This lack of readily available data may explain why most studies on currency unions have only included one or two strictly dollarized countries in the empirical analysis.

The largest dollarized countries in Panel A are Liberia and Panama. Only the latter, however, remains dollarized today; Liberia abandoned the system in the 1980s, when the government of President Samuel Doe decided to issue local currency as a way of avoiding the constraints imposed on policy by the dollarized system.[7] The largest dollarized territory is Puerto Rico with a little under 4 million people, and the smallest is Pitcairn Island with 50 people. In 1998 the median population in the independent dollarized countries was 63,000 people; the median population in the territories was even smaller, at 19,000 people. Another characteristic of these economies is that they are extremely open. In most of them there are no controls on

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Table 1. Dollarized countries and territories: Experiences and data availability

Country	Population	Currency	Data availability	
			Growth	Inflation
(A) Independent countries				
Andorra	73,000	France, Spain	1971–1998	—
Kiribati (1980)	82,000	Australia†	1971–1998	1983–1997
Liberia	2,900,000	USA	1971–1981	1971–1981
Lichtenstein	31,000	Switzerland	1971–1998	1971–1997
Marshall Inds. (1987)	61,000	USA	1971–1998	1982–1997
Micronesia	130,000	USA	1971–1998	1987–1998
Monaco	32,000	France	1971–1998	—
Nauru	10,000	Australia	1971–1998	1989–1998a
Palau (1995)	17,000	USA	1971–1998	—
Panama	2,700,000	USA	1971–1998	1971–1997
San Marino	26,000	Italy†	1971–1998	1985–1998
Tuvalu (1979)	11,000	Australia†	1971–1998	1983–1998
Vatican City	900	Italy	—	—
(B) Non-independent territories				
American Samoa	65,000	USA	—	
Cocos Islands	600	Australia	—	
Cook Island	20,200	New Zealand	1971–1998	1983–1998
Greenland	60,000	Denmark	1987–1997	1971–1998
Guam	150,000	USA	—	
Niue	2,000	New Zealand	—	
Norfolk Islands	1,900	Australia	—	
N. Mariana Inds.	70,000	USA	—	
Pitcairn Island	50	New Zealand, USA	—	
Puerto Rico	3,880,000	USA	1971–1998	1974–1998
Saint Helena	7,000	UK	—	
Tokelau	1,500	New Zealand	—	
Turks & Caicos	17,000	USA	—	
UK Virgin Inds.	19,000	USA	—	
US Virgin Inds.	120,000	USA	—	

Notes: [a]Consumer Price Index for Nauru is not available for the years 1994–1996.
† Also own coins in circulation.
Sources: Bogetic (2000), CIA Fact Book, US Congress Joint Economic Committee, October 2001 and The Statesman's Yearbook. Other recently dollarized countries and territories include East Timor (US dollar), Ecuador (US dollar), El Salvador (US dollar) and Kosovo (German mark).

capital mobility or on any type of financial transactions. So much so that, in 2001, 6 out of the 13 independent dollarized nations are in the OECD list of 'Unfair Tax Havens', or countries whose lax financial regulations, according to the OECD, allow individuals and corporations to evade taxes. These fundamental characteristics of the dollarized economies—very small and extremely open—already suggest that using a broad control group of *all non-dollarized* countries, which are much larger and not as open, may indeed generate biased results.[8]

2.2. Comparative analysis with an unadjusted control group

In Table 2 we present, for the dollarized economies for which we have information, summary statistics on inflation, per capita GDP growth, and the standard deviation of growth. In order to put things in perspective we also present data on these three variables for an 'unadjusted' control group that includes all countries with a currency of their own. This unadjusted control group contains 4910 observations. In column (C) we present data on mean and median differences between dollarized and non-dollarized

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Table 2. Inflation, growth and volatility in dollarized and non-dollarized economies (unadjusted control group)

	(A) Dollarized countries[a]	(B) Non-dollarized countries[b]	(C) Difference* (A)−(B)
Inflation			
Mean	4.30	59.42	−55.11
			(−11.34)
Median	3.80	9.00	5.20
			(−13.31)
Per capita GDP growth			
Mean	0.58	1.26	−0.69
			(−1.96)
Median	0.44	1.85	−1.41
			(−4.73)
Volatility of Growth			
Mean	6.45	5.58	0.87
			(0.99)
Median	5.72	4.85	0.87
			(2.77)

Note: [a]Number of observations is 386.
[b]Number of observations is 4910.
*Numbers in parentheses are *t*-statistics.

countries for each of the three macroeconomic variables of interest. The numbers in parentheses are *t*-statistics for the significance of these differences. The test for the mean differences is a standard *t*-statistic, while the median differences test is a *t*-test obtained using a bootstrapping procedure. These results indicate that the difference in inflation means is very large and statistically significant; on average inflation in dollarized nations has been 55 percentage points lower than in non-dollarized countries. The difference in inflation medians is still negative, much smaller (−5 percentage points), and still statistically significant. The difference in GDP growth means is −0.7 percentage points, and statistically significant; the difference in medians is −1.4 percentage points, and is also statistically significant. The results for growth volatility are mixed: while the difference in medians is statistically negative, the difference in means is not statistically different from zero. We also computed a non-parametric Kruskal–Wallis χ^2 test on the equality of the distributions of the dollarized and non-dollarized groups. These tests indicate that the two groups had different distributions during the period under study. Using a slightly narrower control group comprised of emerging markets only did not alter the conclusions in Table 2.

As pointed out earlier, a potential limitation of these comparisons is that the control group may not be the appropriate one. If this is the case, the results presented in Table 2 may be subject to a 'treatment bias'.[9] In Section 3 we deal with this issue in detail, and report new results obtained using a technique aimed at defining appropriate control groups.

3. DOLLARIZATION AND PERFORMANCE: A MATCHING ESTIMATOR APPROACH

3.1. Methodological issues

Comparative macroeconomic analyses have traditionally relied on regression equations of the following type:

$$y_{jt} = \beta x_{jt} + \gamma D_{jt} + \varepsilon_{jt} \tag{1}$$

where y is the variable of interest—GDP growth, say—x is a vector of controlling variables, D is the 'event' or 'treatment' dummy (dollarization, for example), and ε is an error term. In this setting, the analyst is

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interested in estimating parameter γ, which captures the effect of the 'treatment' on the outcome variable y.[10] A potential problem with this approach, however, is that the 'treatment'—the decision to dollarize, in our case—may not be the result of a random experiment. If this is the case, the estimated conditional effect of the 'treatment' on y will be a biased estimator of the 'true' effect. The reason for this is that some of the covariates (x) may affect the outcome (y) in a non-linear fashion. If this non-linear term is excluded from the regression, we will face an 'omitted variable' bias (see Maddala, 1983; Heckman *et al.*, 2001 for details on the 'treatment' bias).

One way of dealing with this problem is by using non-parametric methods, including the *matching estimators* technique developed in the training evaluation literature (see Blundell and Costa Dias, 2000).[11] This approach consists of using the available data to re-establish the conditions of a natural experiment. A general advantage of this non-parametric method is that no particular specification of the underlying model has to be assumed. We can restate the question at hand—what is the effect of dollarization on performance—in the following way:

$$\Psi = E(y_1 - y_0/x, \;\; D = 1) \tag{2}$$

where y_1 is, say, per capita GDP growth in countries that receive the dollarization 'treatment', y_0 is per capita GDP growth in those that have not received the treatment, and the x are observable covariates. As before, D is a dummy variable that takes the value of one if the observation is subject to the treatment, and the value of zero otherwise. In words, equation (2) captures the mean effect of dollarization on the dollarized countries' performance. The analyst's problem, however, is that he does not have data to estimate $E(y_0/x, D = 1)$, the 'outcome' in dollarized countries, had they not dollarized[12]. Matching estimators use the existing data to construct an appropriate sample counterpart for the missing information. This is done by pairing each dollarized country with countries from the non-dollarized group (Blundell and Costa Dias, 2000). If the sample is large enough, for each treated (dollarized) observation we can find, in principle, at least one untreated observation with exactly the same characteristics. Each of these properly selected untreated observations provides the required counterfactual for our comparative analysis.[13] The problem is that under most general conditions it is not possible to find an *exact* match between a treated and untreated observation. The matching estimator method focuses on estimating an average version of the parameter of interest.[14] That is, the matching estimator consists of obtaining the difference in outcome as an average of the differences with respect to 'similar'—rather than identical—untreated outcomes. The matching estimator $\hat{M}$ can be written as:[15]

$$\hat{M}(S) = \sum_{i \in T} w_i \left(y_i - \sum_{j \in C} W_{ij} y_j \right) \tag{3}$$

where T and C are respectively the sets of treated and untreated countries, W_{ij} are weights attached to each untreated observation j that is 'matched' with treated country i, and w_i are the weights that allow us to reconstruct the outcome distribution for the treated sample.

Rosenbaum and Rubin (1983) have shown that an efficient and simple way to perform this comparison is to rely on a *propensity score*, defined as the probability of participation or treatment: $P(x) = \Pr(D = 1/x)$. In our case, this is the probability of a country being dollarized. This reduces a multi-dimensional problem to a one-dimensional problem, provided that we can estimate $P(x)$. Instead of matching countries directly on all of their characteristics, we can compare countries with similar probability of dollarizing.

In this paper, and in order to explore the robustness of the results, we use two alternative methods for computing matching estimators. First, we use a *simple average nearest-neighbour* estimator. According to this method, for each treated observation, we select a predetermined number of untreated nearest neighbour(s). The nearest neighbours of a particular treated observation i are defined as those untreated observations that have the smallest difference in propensity score with respect to i. If we choose to use nn nearest neighbors, we set $W_{ij} = 1/nn$ for the observations that have been selected; for other observations we set $W_{ij} = 0$. We applied the above method to both one nearest neighbour and five nearest neighbours. The second method consists of using *local linear regressions* to identify each matching observation (Fan, 1993).

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3.2. Results

In this section we present the basic results from the computation of matching estimators for inflation, growth and growth volatility for the period 1970–1998. The section is organized as follows: we first present the results from a probit model of dollarization, which we use to compute the propensity scores. We then report the results obtained from the calculation of matching estimators proper.

Propensity scores. We used a 199-country unbalanced panel data set to estimate a random-effect probit model on the probability of a country being dollarized at a particular point in time.[16] The dependent variable takes a value of one if country j is dollarized in year k. Although many of the dollarized economies do not collect extensive data, we were able to obtain information on a number of covariates that capture geographical, economic and political characteristics of the countries in the sample. The following independent variables were used in the probit estimation. (a) Initial GDP, taken as a measure of the country's economic size. (b) Population measured in millions of people, as an alternative index of size. (c) An indicator that measures the degree of openness of the economy. For the majority of countries and years we used the Sachs and Warner (1995) openness index, that takes a value of one if the country in question is open to international trade, and zero otherwise. We used data from a variety of sources to supplement the Sachs–Warner index for those countries and years not covered in their sample.[17] (d) A dummy variable that takes the value of one if the country in question is an island. (e) A dummy variable that takes the value of one if the country has a common border with a nation whose currency is defined by the IMF as a 'convertible currency'. (f) A variable that measures the country's geographical location, as captured by its latitude. And (g), a dummy variable that takes the value of one if the economy in question is an independent nation.[18] The data set covers 1970 through 1998, and has a total of 5290 observations, of which 386 correspond to dollarized economies. The results obtained are summarized in Table 3, and provide useful information on the probability of a country being dollarized. For example, according to these results smaller, non-independent economies are more likely to be dollarized. Also, more open economies that have a common border with a country with a convertible currency have a higher probability of being dollarized. As may be seen, the fit is quite satisfactory, with the pseudo R^2 exceeding 0.43. The estimated probabilities of being dollarized obtained from this equation were used to define the matching observations in the computation of alternative matching estimators.[19]

Nearest-neighbour matching estimators. We computed nearest-neighbour estimators 'with replacement' and 'without replacement'. In the *with replacement* case an observation for an untreated country may be selected

Table 3. Probit estimate of propensity score

	Coefficient	Std. Err.	Z	$P>z$
GDP_0	1.14	5.53	0.21	0.837
POP	−4.31	3.81	−11.30	0.000
BORDER	0.87	0.10	8.60	0.000
ISLAND	−1.10	0.09	−1.18	0.237
LATITUDE	−2.94	0.30	−9.86	0.000
OPEN	1.65	0.10	16.30	0.000
INDEP	−0.44	0.08	−5.38	0.000
Constant	−0.38	0.12	−3.20	0.001
Number of obs.	5290			
LR $\chi^2(7)$	1192.17			
Prob$>\chi^2$	0.000			
Log likelihood	−785.92			
Pseudo R^2	0.43			

Note: Dependent variable is 1 if a country uses a foreign currency during that year. For a description of the independent variables see the text.

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as the nearest neighbour for several dollarized countries. In the *without replacement* case each untreated country observation may be the nearest neighbour to only one dollarized country in a particular year. This option requires more data points but reduces the risk of using too few comparison countries. In terms of number of neighbours, we considered both one nearest neighbour as well as five nearest neighbours. In total, then, we use four 'adjusted' control groups:

- One nearest neighbour, with replacement;
- One nearest neighbour, without replacement;
- Five nearest neighbours, with replacement;
- Five nearest neighbours, without replacement.

In Table 4 we summarize some key data for the 'adjusted' control groups constructed using the propensity scores methodology. For comparison purposes we also present data on the dollarized economies, and on all non-dollarized economies—the latter group is the 'unadjusted' control group used in the previous section. Simple inspection reveals that the new adjusted control groups have a greater degree of similarity with the dollarized nations than the original unadjusted control group. For example, the new control groups include economies that are smaller, more open and have a higher initial income per capita than the average for the unadjusted sample. This table also reflects the fact that the 'adjusted' control groups have a significantly smaller number of observations (or 'controls') than the unadjusted control group made up of all non-dollarized economies.

The results from the matching estimators are presented in Table 5. For each variable of interest—inflation, growth and volatility—we report data on (a) the number of countries and number of observations in the control group; (b) the *mean difference* calculated as the mean of the differences, for each variable, of the dollarized economies and the corresponding non-dollarized control group; and (c) the *median difference* calculated as the median of the differences of the dollarized economies and the corresponding non-dollarized control group. For both the mean and the median difference we present, in parentheses, a *t*-statistic for their statistical significance. As in Table 2 the test for the mean difference is a standard *t*-statistic, while that for the difference in median was calculated using a bootstrapping procedure. Finally, and for comparison purposes, we report again the mean and median differences obtained when the unadjusted control group of all dollarized countries is used. We refer to these differences as 'unadjusted comparisons'.

Our results may be summarized as follows. First, for every one of the matching indicators both the mean and median differences in inflation are negative and significantly different from zero. This indicates that the dollarized economies have had significantly lower yearly rate of inflation than the non-dollarized countries. According to these results, however, the mean difference in inflation is much *smaller* than the simple, uncorrected comparisons would suggest. Indeed, while according to the results reported in Table 2 the 'unadjusted mean difference' in inflation is -55 percentage points per year, the mean difference obtained using matching estimators ranges from -3.5 to -5.7 percentage points per year. These differences are partially due to the fact that, while the unadjusted control group includes hyperinflation episodes, the 'matching' control groups exclude hyperinflation. But, as the results for 'median differences' in Table 2 indicate, hyperinflation is not the only reason.[20] Indeed, our matching results indicate that the median difference in inflation between non-dollarized and dollarized countries ranges from 1.92% to 4.45% per year. These median differences reported in Table 5 are significantly smaller than the 5.2% difference in medians obtained when the non-adjusted control group of non-dollarizers was used (Table 2).

Second, for every one of the matching indicators the GDP per capita growth differences—both for means and medians—are negative. And they are significantly negative in seven out of the eight matching estimators reported in Table 5; the only exception is for the mean difference using one nearest neighbour. Overall we interpret these results as providing fairly strong evidence that, once appropriate control groups are defined, the dollarized economies have tended to experience lower GDP per capita growth than the non-dollarized ones. This conclusion is, in fact, supported by the local linear regression results reported below. In terms of magnitudes, the results from the matching analysis indicate that dollarized countries underperformed non-dollarized countries by a wider margin than simple comparisons suggest. The

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Table 4. Dollarized and non-dollarized countries: descriptive statistics*

	Population (millions)		Initial GDP (US dollars)		Openness (0 to 1 index)		Latitude (0 to 1 index)		Indep. %	Comm border %	Island %	Number of countries	Number of observations
Group	Mean	Med	Mean	Med	Mean	Med	Mean	Med					
(*a*) *Dollarized countries*													
All	0.457	0.030	7594	2928	0.53	1.00	0.25	0.10	67	33	60	15	386
(*b*) *Non-dollarized countries*													
All	26.630	5.113	3968	1638	0.22	0.00	0.28	0.23	92	18	26	184	4910
M1R	0.976	0.671	7636	1816	0.36	0.00	0.15	0.14	100	20	58	29	386
M1N	0.281	0.589	7518	4206	0.46	0.23	0.18	0.18	69	26	73	35	386
M5R	0.872	0.365	7194	2254	0.35	0.00	0.17	0.18	79	25	67	40	1930
M5N	1.213	0.483	5349	1848	0.23	0.00	0.23	0.19	81	17	55	79	1930

Note: *M1R refers to one nearest neighbour, with replacement. M1N refers to one nearest neighbour, without replacement. M5R refers to five nearest neighbours, with replacement. M5N refers to five nearest neighbours, without replacement.

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Table 5. Matching estimators: inflation, GDP per capita growth and volatility*

	Number of control countries	Number of control observations	Mean difference	Median difference
Inflation				
M1R	22	197	−3.53	−3.15
			(−5.68)	(−4.00)
M1N	28	197	−3.39	−1.92
			(−5.01)	(−2.82)
M5R	31	985	−3.89	−4.45
			(−9.03)	(−9.89)
M5N	53	985	−5.68	−4.42
			(−5.98)	(−8.41)
GDP per capita growth				
M1R	29	386	−0.28	−1.05
			(−0.47)	(−3.03)
M1N	35	386	−1.56	−1.53
			(−2.78)	(−3.88)
M5R	40	1930	−1.12	−1.01
			(−2.48)	(−3.34)
M5N	79	1930	−1.19	−1.30
			(−2.78)	(−2.71)
Volatility of growth				
M1R	12	386	0.86	0.42
			(0.63)	(0.24)
M1N	16	386	0.62	1.29
			(0.40)	(0.51)
M5R	71	1930	0.72	1.59
			(0.74)	(0.86)
M5N[a]	–	–	–	–

Note: *M1R refers to one nearest neighbour, with replacement. M1N refers to one nearest neighbour, without replacement. M5R refers to five nearest neighbours, with replacement. M5N refers to five nearest neighbours, without replacement. Numbers in parentheses are *t*-statistics.

[a] Not computed because the number of observations was too small.

(statistically significant) mean differences in GDP per capita growth in Table 5 range from −1.56% per year to −1.12% per year; the unadjusted mean difference in Table 2 is only −0.69%. The median differences in GDP per capita growth in Table 5 range from −1.53% per year to −1.01% per year; the unadjusted mean difference in Table 2 is −1.41%.

Third, statistically speaking, the matching results reported in Table 5 indicate there are no differences (either in the means or medians) in volatility in dollarized and non-dollarized economies. This contrasts with the results obtained from the raw comparisons, which suggested that volatility was significantly higher in the dollarized nations (see Panel C in Table 2).

3.3. Extensions: local linear regressions

The results reported in Table 5 were obtained using an average nearest neighbour approach. An alternative method for computing matching estimators consists of using local linear regressions (LLR), a non-parametric technique similar to traditional kernel regression.[21] When using local linear regressions, the weights in equation (3) are given by:

$$W_{ij} = \frac{K_{ij}\sum_{k\in C} K_{ik}(P_K - P_i)^2 - \left(K_{ij}(P_j - P_i)\right)\left(\sum_{k\in C} K_{ik}(P_K - P_i)\right)}{\sum_{j\in C} K_{ij}\sum_{k\in C} K_{ik}(P_K - P_i)^2 - \left(\sum_{k\in C} K_{ik}(P_K - P_i)\right)^2} \tag{4}$$

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where

$$K_{ij} = K\left(\frac{P_i - P_j}{h_n}\right) \quad \text{and} \quad P_i = P(x_i)$$

As before, $P(x) = \Pr(D = 1/x)$, is the propensity score, defined as the probability of participation or treatment.

An alternative, but equivalent, way of implementing LLR is the following. For each treated observation we run a weighted least-square regression of the outcomes on the differences of the propensity scores. The intercept from this weighted regression is a good estimate of $E(y_{0i}/x_i, \ D = 1)$—see Fan (1992, 1993). The weights can be chosen using any standard kernel function and selecting an adequate bandwidth. LLR can be interpreted as solving the following problem:

$$\min_{a,b} \ \sum \big(y_{0j} - a - b(P(x_j) - P(x_i))\big)^2 K\left(\frac{P(x_j) - P(x_i)}{h_n}\right)$$

where a and b are parameters, j indexes untreated observations and i refers to treated observations. The results obtained when this LLR matching method was used confirmed those presented in Table 5. What is particularly important in terms of this paper is that these estimates indicate that GDP per capita growth has indeed been significantly lower in the dollarized countries than in the non-dollarized ones. The estimated mean difference in GDP growth per capita using the LLR is -1.16, with a t-statistic of -5.34. The estimated difference in medians is -1.32 with a t-statistic of -8.31.

4. CONCLUDING REMARKS

In the aftermath of the currency crises of the 1990s some economists have argued that the emerging economies should give up their domestic currencies, and adopt an advanced nation's currency as legal tender. Interestingly, there have been no systematic comparative studies on the performance of countries that, indeed, officially use another nation's currency. Most of the literature on the subject has been based on case studies of Panama. This lack of empirical analysis has resulted in policy debates that, until now, have been based on conjectures and not on hard historical evidence.

The purpose of this paper has been to analyse, from a comparative perspective, economic performance in 'dollarized' economies. We have argued that the main difficulty in performing this type of comparison refers to defining the correct 'control group' with which to compare the performance of the dollarized countries. In this paper we tackled this issue by using the 'matching estimators' technique developed in the training evaluation literature. We found that the matching estimators technique yields somewhat different results than raw comparisons using a large control group of all non-dollarized countries. More specifically, we found that dollarized countries have had a significantly lower rate of inflation than non-dollarized ones. The mean difference ranged from 3.4% to 5.7% per year. We also found that dollarized countries have had a statistically lower rate of GDP per capita growth than non-dollarized ones. Both the mean and median growth differences are approximately 1% per year. Finally, we found that there has been no statistical difference in macroeconomic volatility between dollarized and non-dollarized economies.

The results reported here do not imply that dollarization is an inferior monetary arrangement for all countries. Indeed, our results only refer to an historical comparison of the performance of economies that have had an official dollarized regime. As data from more recent experiences with 'dollarization' become available, it will be possible to gain further insights into the performance of countries that adopt this monetary regime. In particular, the recent cases of Ecuador, El Salvador and Guatemala will provide information on how mid-size economies fare under this regime.

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NOTES

1. By 'officially dollarized' countries, we mean countries that use another nation's currency. This 'other currency' need not be the US dollar, however. We have excluded countries that use a common supranational currency, such as the euro. On the selection of exchange rate regimes see, for example, Frankel (1999). On analytical aspects of dollarization see Calvo (2001) and Eichengreen and Haussmann (1999). On currency unions see Frankel and Rose (1998).
2. On analytical aspects of dollarization see Calvo (2001) and Eichengreen and Haussmann (1999).
3. Other authors have been sceptical regarding the benefits of dollarization, including Corbo (2001) and Willet (2001). For a defence of dollarization see Hausmann (1999).
4. Goldfajn and Olivares (2000) use econometrics to evaluate Panama's experience with dollarization. Moreno-Villalaz (1999) provides a detailed analysis of the Panamanian system. Bogetic (2000) describes several aspects of dollarization in a number of countries. As far as we know, Rose and Engel (2000) and Edwards (2001) are the first two papers to provide a statistical and econometric analysis of economic performance in dollarized countries and/or currency unions.
5. See Klein (2002) for a discussion on dollarization and trade, including a comprehensive bibliography on the subject.
6. We follow the US Congress Joint Economic Committee, and concentrate on those territories that have a high degree of administrative autonomy. There are some borderline cases, however, that may generate some controversies.
7. It is not easy to date unequivocally Liberia's abandonment of the dollarized system. In July 1974 the National Bank of Liberia (NBL) was opened. In 1982 the NBL began issuing five-dollar coins, and in 1989 it began issuing five-dollar notes. On Liberia's dollarization experience see Berkeley (1993).
8. The median population of all non-dollarized emerging nations is over 100 times larger than that of the dollarized economies.
9. See Maddala (1983).
10. In standard regression analysis the coefficient γ captures the mean effect of the 'event' on y. It is perfectly possible, however, to estimate the effect of the event on the median (or any other quantile) of the dependent variable. In the empirical results presented below we focus both on mean and median differences of the dependent variables.
11. Lalonde (1986) is the classic paper on training evaluation.
12. If we estimate the equation above using all non-treated observations the selection bias is given by:

$$B(x) = E(u_0/x,\ \ D = 1) - E(u_0/x,\ \ D = 0)$$

13. In order to guarantee that all treated agents have such a counterpart in the population (not necessarily in the sample) we also need to assume that $0 < \Pr(D = 1/x) < 1$.
14. This averaged version is given by:

$$M(S) = \frac{\int_S E(y_1 - y_0/x,\ \ D = 1)dF(x/D = 1)}{\int_S dF(x/D = 1)}$$

where S is a subset of the support of x given $D = 1$.
15. See Blundell and Costa Dias (2000). Persson (2001) has used matching estimators in a study of monetary unions and trade.
16. We will use the term 'country' to refer both to independent nations as well as to territories. On propensity scores see, for example, Drake (1993) and Rosenbaum and Rubin (1983).
17. See the original Sachs–Warner (1995) article for a specific list of requirements for a country to qualify as 'open'.
18. Unfortunately, only three of the dollarized economies have data on other variables of interest, including terms of trade, investment, the fiscal balance and interest rates.
19. As an alternative method, for each dollarized country we restricted the matching observations to correspond to the same non-dollarized country for every year in the sample. In order to do this, the propensity scores were recalculated from a cross-country probit regression for 1970. The results obtained from these country-to-country matching estimators are very similar to those reported in Table 5 and are not reported due to space considerations. They are available on request.
20. By using medians we make sure that outliers do not drive our results.
21. This estimator improves on kernel regression in two ways: (a) the bias of the LLR estimator does not depend on the design density of the data (i.e. on the density $f(P(x))$; and (b) the order of convergence is the same at the boundary points as at the interior points. For details see Fan (1992, 1993).

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