

Monetary Unions and Economic Performance:

A Literature Review and Empirical Exercise

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Abstract: In this paper we examine the link between monetary unions and economic performance. The evidence found in the published literature is mixed. Utilizing a pooled time-series and cross-sectional data set comprising 98 countries we estimate the conditional convergence growth model. A dummy variable is used to determine the effects of monetary unions. It is found that there is a substantial positive effect of monetary unions on the long-run level of GDP per worker. Furthermore, evidence of a direct impact on income is found. The results are statistically significant although the predicted magnitudes are questionable.

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I. Introduction

Ever since the collapse of the post-war gold standard of the international monetary system (IMS) in 1971, there has been vigorous debate as to which currency regime is best for the IMS, and for individual nations. Some authors, following Friedman (1953), have argued that flexible exchange rate regimes are essential for a sound economy. Others, following Mundell (1961) and Grubel (1970), have argued that monetary unions lead to improved economic performance. It is the link between monetary unions and economic performance that we study in this paper.

The debate over currency regimes was revitalized in the 1990s, a decade of considerable turbulence for the IMS. It was struck by a number of currency crises (Mexican crisis in 1994, Asia in 1997, Russia and Brazil in 1998) that destabilized the IMS and brought about the floating of many national currencies (Desai, 2003, p. 215). This coincided with the implementation of the European Economic and Monetary Union (EMU) towards the end of the decade (European Central Bank, 2007).

After the decade of the nineties, a different trend took place in Latin America that also sparked further research and debate on the subject, *viz.* the dollarization of several countries in the early years of the new century. Ecuador dollarized its economy in 2000, followed by El Salvador and Guatemala in 2001 (Edwards and Magendzo, 2001, p. 1). They joined Panama, which had been dollarized since its independence from Colombia in 1903 (CIA World Fact Book, 2007).

These events sparked a number of authors to focus on optimal currency area (OCA) theory. Much of the literature has focused on the advantages and disadvantages of one currency regime over the other, based on observational criteria. Several authors, such as Frankel and Rose

(2002), and Edwards and Magendzo (2001, 2006), have, however, based their work on empirical evidence. While their work on the subject matter has been an important contribution to the literature, the lack of consensus and disparity in their results stimulates further research and exploration. It is the work of these authors that motivated this paper.

In this paper we utilize Time Series and Cross-Sectional (TSCS) data, compiled from the Penn World Tables 6.2 (PWT6.2), and a dummy variable for monetary unions. The compilation of this dummy variable is part of the contribution of this paper. With the use of Least Squares (LS), and Two-Stage Least Squares (2SLS) estimation, evidence is found that belonging to a monetary union improves the long run level of income. This result is consistent with the empirical evidence of Frankel and Rose (2002) and the analysis of Grubel (1970). Furthermore, we find evidence that this is a direct impact on income.

The paper will be divided into four parts. In section II we present a literature review on the theory of OCA, currency regimes, and the work of Edwards and Magendzo, and Frankel and Rose. In Section III, economic growth theory and convergence is discussed. Section IV provides details on the data set, the methodology, and the results obtained from our LS and 2SLS regressions. The conclusion will tie in the results to policy alternatives and trends, as well as to suggest possibilities for further research.

II. Literature Review

II.1. The Theory of Optimal Currency Areas: An Overview

Robert Mundell essentially defined the concept of OCA in 1961. His work on the subject contributed to his eventual receipt of the Nobel Prize in 1999 (Dean, 2001, p. 52-3). It is appropriate, then, to start by summarizing Mundell's view of OCA.

Mundell's most basic definition of a currency area is "a domain within which exchange rates are fixed" (Mundell, 1961, p. 657). Similarly, Grubel (1970) defines a currency area as "a territory with one or several currencies whose relative values are fixed permanently but whose common external value is determined in markets free from official intervention" (p. 318). By these definitions we can find many examples of currency areas. For instance, the post-war Bretton Woods arrangement of fixed exchange rates could be regarded as a currency area. Other examples, by this definition, are countries such as Argentina before the collapse of its currency board, many of the Asian countries prior to the 1997 crisis, and even China today with its peg to the U.S. dollar. These are not, however, necessarily what Mundell (1961) would see as "optimal" currency areas. As he states, "the optimum currency area is not the world" (p. 659), which would eliminate an arrangement such as the Bretton Woods accord from being an OCA.

What then defines an "optimum" currency area? To answer this question Mundell used the example of a world composed of only the economies of the U.S. and Canada, two countries separated by a north-south border with independently run monetary policies and currencies. He assumed, appropriately so, that the economic regions were such that the division was not north-south, but east-west; the east producing cars, while the west produced lumber (p. 659). He then postulated that if there were excess demand for lumber and an excess supply of cars it would not

be possible to correct imbalances in the balance-of-payments between the two regions under a flexible exchange rate regime (p. 659-60).

This indeed would be impossible since the hypothetical situation would cause unemployment in the east and drive up inflation rates in the west. This situation would lead monetary authorities in both countries to react. Since the east-west pressures would be felt individually in both countries, any decision taken would benefit one region while further harming the other. For example, if Canada, with its present emphasis on inflation targeting, wanted to control inflation in the west, it would have to utilize contractionary monetary policy, thus raising interest rates. This rise in interest rates would be national, and while inflation in the west would be controlled, the east would likely suffer from continued or increased unemployment.

This example used by Mundell drives the main point in his argument of OCAs, which is that an OCA is 'regional' and not national. OCAs cut across national borders and economies. This is why Mundell is largely against 'national' currencies and favours regional currencies. As he has suggested, there are three OCAs in the world, those being tied to the Yen, the Euro and the U.S. dollar (Mundell, 2003, p. 21-2).

In the analysis by Mundell, he concludes that OCAs are regional. But what determines if a region constitutes an OCA? Several criteria have been suggested and extrapolated from Mundell's work. These have been summarized in Seccareccia (2001), and Stein *et al* (1999):

- 1) The degree of symmetry of shocks and business cycles;
- 2) Wage flexibility;
- 3) High degree of labour mobility within the region;
- 4) The degree of openness to trade within the region;

- 5) The existence of a transfer system within regions; and
- 6) A high degree of institutional and policy convergence

Alesina and Barro (2001) suggest that countries that are ideal candidates for a currency area should have an additional two characteristics: 1) A history of high and variable inflation and 2) “reasonably stable relative prices with respect to the potential anchor”, the anchor being, for example, the U.S. and the U.S. dollar (p. 384). Establishing these criteria, as Seccareccia (2001) points out, has made the theory of OCA “empirically operational” (p. 6). In fact, this is what Stein *et al* (1999) have done in their investigation of the Central American and Caribbean region and its feasibility of comprising an OCA with the U.S. dollar. Stein *et al* (1999) examine systematically each OCA criterion for the nations in the region in order to determine their compatibility with the U.S. as an anchor for a monetary union.

Mundell’s (1961) view was the following: “If the world can be divided into regions within each of which there is factor mobility and between which there is factor immobility, then each of these regions should have a separate currency which fluctuates relative to all other currencies” (p. 663). This statement by Mundell is likely why many authors, as James W. Dean has written, have used Mundell’s 1961 analysis to justify flexible exchange rates, further fueling debate (Dean, 2001, p. 54). What then are viewed in the literature as the main advantages and disadvantages of a flexible exchange rate regime vis-à-vis fixed rates?

II.1.1. Flexible vs. Fixed Exchange rates

Dehejia and Rowe (2004) argue that posing this debate in the framework of “flexible vs. fixed” is misleading because “flexible” exchange rates can represent a wide range of

arrangements (p. 2). However, “fixed” regimes can also be diverse. Countries with “fixed” regimes might employ a currency board, their central bank might intervene in the markets to maintain the exchange rate, countries may be dollarized, or be part of official monetary unions. For this reason, in discussing the advantages and disadvantages of currency regimes, the traditional formulation of “flexible vs. fixed” is maintained.

The popularity of flexible exchange rates stems in large part from Milton Friedman’s ‘insulation hypothesis.’ As summarized by Dehejia (2004), the idea evolves from the ability of nations to pursue independent monetary policy, which by doing so can counteract and insulate the domestic economy from external shocks. The adjustments take place through nominal exchange rates (p. 5).

Friedman (1953) suggested that the exchange rate is an “extremely sensitive price” and that “changes in it occur rapidly, automatically and continuously and so tend to produce corrective movements before tensions can accumulate and crisis develop” (p. 163). Friedman (1953) also identified disadvantages of flexible exchange rates such as instability, uncertainty in prices for importers and exporters (transaction costs), destabilizing speculation, and uncertainty in the internal economy (inflation). Yet he emphasized that these disadvantages were not caused strictly by flexible rates, or that they could be managed. For example, he suggested that transaction costs and uncertainty could be hedged in futures markets and that “instability of exchange rates is a symptom of instability in the underlying economic structure” (p. 158).

Friedman (1953) also believed that flexible exchange rates were “absolutely essential...[to] the achievement and maintenance of a free and prosperous world community engaging in unrestricted multilateral trade” (p. 157). His idea was that flexible exchange rate regimes would lead to greater trade and incomes.

However, Hausmann (1999) has concluded that “floating regimes have not delivered much in the areas they were supposed to help: They have failed to provide more exchange rate autonomy, they have not facilitated more stabilizing monetary policies, and they have not led to an increased ability to absorb shocks” (p. 7). Also, as shown by Rose and Van Wincoop (2001), Glick and Rose (2001) and Frankel and Rose (2002), membership in monetary unions is highly beneficial to international trade. This contradicts Friedman’s ‘insulation hypothesis’.

In addition, Grubel (1970) identified four reasons why the pegging of exchange rates influences the productivity of factors of production:

- Firms can take advantage of greater economies of scale due to the elimination of uncertainty in prices and enlarged effective marketing regions.
- The elimination of uncertainty in exchange rates allows for more efficient allocation of capital.
- Increase in price stability reduces the cost of valuation and portfolio management.
- Pegging of exchange rates makes those currencies practically perfect substitutes. This allows both firms and individuals to hold assets in both currencies while avoiding the costs associated with exchanging from one currency to the other (p. 323).

Through these influences on productivity, Grubel (1970) concludes that fixing exchange rates between countries will raise the level of income (p. 323). If this indeed were the case, then it would be logical to move away from flexible regimes, and embrace the idea of OCAs.

The issue of dollarization is unique in that it is not an official monetary union, where countries agree and cooperate with monetary policy concerning the region. Rather, a nation adopts unilaterally the currency of another nation. Proponents of dollarization generally argue

that, despite the loss of independent monetary policy and the revenues generated through seignorage¹, the advantages of lower inflation rates, sound fiscal management, and lower interest rates lead to an economic environment more conducive to economic growth.

Indeed, when we look at the numbers in Panama, dollarized for over 100 years, we can see that it has experienced low inflation rates, steady growth rates, and low interest rates compared to the norm in Latin America. For example, from 1950 to 2001 Panama experienced only 4 years of negative growth (Brea, Davalos and Santos, 2001, p. 69). Average inflation rates during the three decades since the 1970s have been 3.1%, which is significantly below the average for the rest of Latin America of 15.3% (Edwards, 2003, p. 10). As a result, Panama is one of the few countries in Latin America, if not the only one, to offer 30-year fixed rate mortgages (Hausmann, 1999, p. 10). These are indications that there are positive effects on economic growth from adopting another country's currency through dollarization - an unofficial or informal monetary union.

Before moving on to an analysis of some empirical studies, it is important to recognize that despite the fact that Mundell has preferences for fixed exchange rates and/or common currencies (Dean, 2001, p. 54), his 1961 analysis does not necessarily advocate that the world should revert to a fully fixed exchange rate regime. Instead, he suggests that we move to regional currencies, which would be free to float against each other. To quote Mundell (1961), "Today, if the case for flexible exchange rates is a strong one, it is, in logic, a case for flexible exchange rates based on *regional* currencies, not on national currencies. The optimum currency area is the region" (p. 660). Mundell suggests that today three regions form OCAs; the Yen, the Euro and the U.S. dollar (Mundell, 2003, p. 21-2).

¹ The difference between the face value of money and its cost to produce (Binhammer, 1993, p. 567)

With this background, it is now appropriate to examine more closely the empirical foundations of the link between monetary unions and economic performance. To this end, the following section will present the methodology and the findings of the empirical research that has motivated this paper; namely, studies conducted by Frankel and Rose (2002), and Edwards and Magendzo (2001, 2006).

II.2. Economic Growth and Monetary Unions: The Empirical Debate.

II.2.1 “An Estimate of the Effect of Common Currencies on Trade and Income” by Jeffrey Frankel and Andrew Rose. (2002)

The authors of this work conclude that the effect of monetary unions on income is substantial. They also conclude that the traditional claims of why monetary unions improve incomes - such as fiscal discipline and the reduction of transaction costs - are not the principal driving forces. They postulate that the principal factor of this effect is a significant increase in the amount of trade between countries using the same currencies.

The authors arrive at their conclusions through the use of a two-stage approach. In the first stage they determine the effect that being a member of a monetary union has on trade. In the second stage, they use the results obtained in the first stage to estimate the effect of trade on income. The first estimation is conducted utilizing the gravity model of trade. Since the gravity model will not be used in the estimation conducted in the second half of this paper, an in-depth description and analysis of the model is not provided. We highlight only the main assertions of the model in order to better understand the results obtained by Frankel and Rose (2002).

The gravity model of trade asserts that trade between two countries is a function of the product of both countries' gross national product, divided by the distance between these same

two countries multiplied by some constant (Carrillo and Li, 2002, p. 8-9). Frankel and Rose (2002) and Glick and Rose (2001) have augmented the model by including variables such as common borders, common language, common colonizers, and more relevant to our discussion, common currencies. Their empirical model is similar to the following form (Glick and Rose, 2001, p. 3):

$$\begin{aligned} \log(X_{ijt}) = & \beta_0 + \beta_1 \log(Y_i Y_j)_t + \beta_2 \log\left(\frac{Y_i Y_j}{Pop_i Pop_j}\right)_t + \beta_3 \log D_{ij} + \beta_4 Lang_{ij} + \beta_5 Cont_{ij} + \beta_6 FTA_{ijt} \\ & + \beta_7 Landl_{ij} + \beta_8 Island_{ij} + \beta_9 \log(Area_i Area_j) + \beta_{10} ComCol_{ij} + \beta_{11} CurCol_{ijt} \\ & + \beta_{12} Colony_{ij} + \beta_{13} ComNat_{ij} + \delta CU_{ijt} + \varepsilon_{ijt} \end{aligned}$$

where i and j denote countries, t denotes time, and the variables are defined as follows:

- X_{ijt} denotes the average value of bilateral trade between i and j at time t ;
- Y is real GDP;
- Pop is population;
- D is the distance between countries;
- $Lang$ is dummy variable for common language;
- $Cont$ is for common land border;
- FTA indicates a free trade agreement between countries at time t ;
- $Landl$ is for landlocked countries;
- $Island$ is for number of island nations (0,1,2);
- $Area$ is the land area of the country;
- $ComCol$ is for common colonizer;
- $CurCol$ indicates whether country was a colony at time t ;
- $Colony$ indicates if country i colonized j ;
- $ComNat$ indicates whether the pair of countries form part of the same nation; and
- CU indicates whether the two countries utilized the same currency at time t .

To estimate this augmented gravity model, they utilize simple OLS with period fixed effects (p. 440). The data set used to estimate the gravity model contains 41,678 bilateral trade observations for 186 countries (p. 462). The data were compiled from various sources, such as the World Trade Database, Penn World Tables 5.6 (PWT), World Development Indicators, and other information taken from the CIA world fact book (p 462-63). For the gravity model estimation they utilize a panel data approach.

The coefficient of interest in the formulation above is δ , which corresponds to the common currency dummy variable. Their results indicate that being part of a monetary union increases trade by a factor of 3.9, more than tripling the amount of trade between nations (p. 442). Frankel and Rose (2002) themselves acknowledge that “a three-fold effect strikes those who are new to this literature as very large, and indeed it is” (p. 442), yet they argue that it is the most likely explanation for the ‘home country bias’ findings of authors such as McCallum (1995) and Helliwell (1998) (p. 443).

Having obtained these results, the authors move to the second stage in their estimation of the effect of currency unions on income. In reality, however, they perform a three-step procedure. After estimating the gravity equation, the authors use the fitted values of trade across trading partners to create an estimate of openness (p. 445). They then include this measure of openness, accounting for the effect of monetary unions, as an instrument in the income equation (p. 445). The empirical model formulation is the following (p. 446):

$$\log\left(\frac{Y}{Pop}\right)_{90,i} = \alpha\left(\frac{X+M}{Y}\right)_{90,i} + \beta_0 + \beta_1 \ln(Pop)_i + \phi Z_i + \gamma \ln\left(\frac{Y}{Pop}\right)_{70,i} + \delta_i \left(\frac{I}{Y}\right)_i + \delta_2 n_i + \delta_3 School1_i + \delta_4 School2_i + u_i$$

for $i = 1, \dots, N$; and i denotes the country

where Y stands for income; and:

- Pop for population;
- X for exports;
- M for imports;
- I for investment;
- Z for the control variables;
- n for population growth; and
- $School1$ and $School2$ are measures of human capital investment.

This formulation is motivated by the convergence growth model as per the work of Mankiw, Romer and Weil (1992), a methodology similar to that which will be used in the empirical analysis conducted in this paper. The hypotheses of convergence will be discussed in more detail in the following section; we concern ourselves here with the empirical methodology and the results obtained.

To estimate this model, Frankel and Rose (2002) utilize a second data set that contains up to 7,803 observations compiled from similar sources as the previous one, such as the PWT 5.6. As per the formulation above, GDP per capita in 1990 is regressed on population, land area, the openness measure (T/Y), and what Frankel and Rose (2002) call the ‘control’ variables from neoclassical growth theory (p. 463). The variables, other than GDP per capita and openness, are taken as averages for the period of 1960-1996 (p. 446). As opposed to the first stage, this is a cross-sectional data set. This is the reason why there is no time dimension in the formulation of the model. Using this data set, they estimate the model using simple OLS as well as instrumental variable (IV) estimation.

Frankel and Rose (2002) utilize IV estimation to account for the problem of ‘endogeneity.’ This problem arises because exports are included as an explanatory variable. Therefore, they argue that interpreting causality from trade to growth is problematic (p. 444). Their list of instruments includes variables such as distance, populations, common borders and language. These, they suggest, are “plausibly exogenous” and “highly correlated with trade” (p. 445).

In their OLS regression, Frankel and Rose (2002) find that the coefficient of openness is significant and positive (p. 447). They estimate that the long-run effect on equilibrium income is 1/3% for every 1% increase in openness (p. 448). With IV estimation they find an even more

striking result. The coefficient on the openness variable is higher and remains statistically and economically significant (p. 450). The steady state impact of openness on income is now 1.6 (p. 450). From these results they estimate that monetary unions have, on average, a 4% positive impact on income (p. 456). Frankel and Rose (2002) also estimate the long-run effects of adopting the dollar or euro. For example, they estimate that Albania could receive a 23% “boost” to income in the long run from adopting the euro (p. 457). If Canada were to adopt the U.S. dollar, this “boost” to income would be 36% (p. 457).

Frankel and Rose (2002) determine that the growth effect of monetary unions is through trade and not through central bank credibility or a stable macroeconomy (p. 438). To test this hypothesis, the authors include the monetary union dummy variable directly into the income equation. Again they conduct simple OLS and IV estimation. This methodology is similar to what will be used in the empirical analysis conducted in this paper and, therefore, it is of major relevance.

In their experiment, the authors find that the openness coefficient remains significant. However, the coefficient on the dummy variable for monetary unions now becomes non-significant and has a negative sign. (p. 454). The monetary union dummy only becomes positive and significant when taking into account the number of countries in a currency area (p. 454). This leads the authors to conclude that the evidence “supports the notion that the currency union effect on income comes instead through the trade route” (p. 455). Furthermore they emphasize that “there is little support here for the theory that belonging to a currency union *per se* is good for growth regardless of the partner. Rather...it matters whether the currency union includes important trade partners” (p. 455). This result is contradicted by the empirical analysis conducted

in this paper, which indicates that there is evidence to support the central bank credibility and transaction costs channel. This issue will be elaborated upon in the second part of the paper.

The authors, however, caution against their results. They suggest possible endogeneity of the decision to adopt a currency. They also point to the dependency of their data set on small nations and territories (p. 459). Thus, one must take these results cautiously and simply note that there is evidence of a significant effect of monetary union participation on income.

II.2.2 “Strict Dollarization and Economic Performance: An Empirical Investigation” by Sebastian Edwards and I. Igal Magendzo (2006)

This work, as well as “Dollarization, Inflation and Growth” (2001) by the same authors, will be examined in this section. The emphasis in these papers is on countries that are officially dollarized. However, dollarized countries are treated as informal monetary unions, which make these results a significant part of the empirical evidence of OCA theory and growth. More importantly, Frankel and Rose (2002) include dollarized nations, such as Panama, as monetary unions. This is also done in this paper.

Edwards and Magendzo’s (2001, 2006) conclusions are far different from those of Frankel and Rose (2002). Their empirical results indicate that dollarized nations experienced lower inflation than their counterparts. However, they conclude that dollarized nations experienced slower growth and greater income volatility - volatility that is consistent with Friedman’s ‘insulation hypothesis.’

The empirical methodology differs significantly between the two investigations conducted by these authors. More focus will be placed on the most recent paper, the reason being that the methodology resembles closely that of the second-stage of Frankel and Rose (2002), the

methodology utilized by Barro and Sala-I-Martin (2004) and Coulombe (2007). This is also the methodology applied in this paper.

One of the major criticisms that Edwards and Magendzo (2006) have of other empirical studies is that they have not included enough observations on countries that are ‘strictly’ dollarized (p. 270). Neither has the difficulty in establishing an appropriate ‘control group’ of countries been adequately addressed. Their methodology relies on estimating the ‘probability of a country being dollarized’ as a ‘treatment’ variable in a regression of the convergence growth model. Their empirical model is presented below (Edwards and Magendzo, 2006, p. 272):

$$\begin{aligned}y_j &= X_j\beta + \gamma\delta_j + \mu_j \\ \delta_j &= \begin{cases} 1, & \text{if } \delta^*_j > 0 \\ 0, & \text{otherwise} \end{cases} \\ \delta^*_j &= W_j\alpha + \varepsilon_j\end{aligned}$$

for $j = 1, \dots, N$; and j denotes the country; and

where X and W are vectors, and y_j is GDP per capita growth.

The vector X contains what they term the ‘traditional determinants of economic performance’ (p. 272), such as the initial level of GDP and openness. The dollarization dummy, δ_j , depends on δ^*_j which is an “unobserved latent variable” that accounts for the probability of a nation being dollarized (p. 272-73). Some of the variables in W are the same as those variables in X (p. 273).

To estimate this system of equations they utilize Maximum Likelihood estimation as well as IV estimation. Edwards and Magendzo (2006) do not list the IV used. They simply state that they have used the procedure suggested by Wooldridge (2002) (p. 274). Because they utilize a

system of equations one would assume that they are utilizing the system IV (SIV) described by Wooldridge (2002, p. 189). The authors make use of a data set with observations for 148 countries over the 1970-1998 period. These include 16 fully dollarized nations or territories (p. 271). As in Frankel and Rose (2002), the data set in Edwards and Magendzo (2006) comprises a cross-section with the values for the variables calculated as averages for the period in question (p. 274).

The results, as in Frankel and Rose (2002), are striking. However, they paint a significantly different picture. Their estimation results show that the dummy for dollarization is negative in most regressions and is non-significant in all regressions. While Frankel and Rose (2002) suggest that a common currency can increase incomes by an average of 4%, the results of Edwards and Magendzo (2006) indicate that the average effect on yearly growth of dollarization was -0.5% to -1% (p. 278). The point estimates, however, are not statistically significant. They also conclude that “dollarization has resulted in higher volatility in countries that are less open (p. 278). This gives strength to the argument for Friedman’s ‘insulation hypothesis.’

Similar results are obtained in Edwards and Magendzo (2001) utilizing a much different methodology. In their study they utilize a ‘matching estimator approach’ to create a control group. They employ this methodology to compensate for what they see as a possible drawback of the traditional regression. The problem as they see it is that the dollarization decision is not necessarily random, making the estimator for the dummy variable biased. This bias can result from omitted variables due to non-linearity (p. 6).

What they are essentially trying to do with the method of matching estimators is to compare the performance of dollarized nations with their performance had they not dollarized. This evidence is obviously not observable. The methodology behind the matching estimators

approach is beyond the scope of this paper. But put simply, it uses available data to create this missing, or unobservable, information (p. 7). They introduce into the estimation an artificial control group to which the dollarized nations can be compared.

In using this methodology, they find that those countries that have been dollarized have had significantly lower inflation, and lower rates of growth of GDP per capita that differ approximately 1% on average (p. 13). They also conclude that there is no significant difference in volatility with non-dollarized nations (p. 13).

III. Economic Growth Theory

The empirical methodology applied by the studies described in the previous section is based on the theoretical background provided by the Solow growth model, the convergence hypotheses, and related growth model. The Solow model, as Romer (2001) describes it, is “the starting point for almost all analyses of growth” (p. 7). Therefore, before proceeding to describing the convergence model and the empirical model, it is essential to describe the foundation provided by the Solow model.

III.1 The Solow Model and Convergence

We now describe what Mankiw, Romer and Weil (1992) title the ‘Textbook Solow Model’, borrowing heavily from Romer (2001). From this foundation many of the new growth models and endogenous growth models have been developed, augmenting the basic Solow model through the incorporation of human capital, or, introducing a maximizing decision, as in the Ramsey model (Blanchard and Fischer, 1996, p. 21). As is customary in the literature and in

most textbooks and courses, we start first by describing the basic assumptions of the production function.

There are essentially two assumptions: first, that of constant returns to scale (CRS), and secondly, that the only highly important inputs are capital, labour and knowledge (Romer, 2001, p. 10). Therefore we have a production function of the form $F(K,AL)$; where K is capital, A is knowledge, L labour and AL represents “effective labour.” Since the production function shows CRS, dividing it by AL the “intensive form” of the production function becomes:

$$y = f(k), \quad (1)$$

where y is output per unit of “effective labour”, and k is capital per unit of “effective labour.”

The initial values of the variables specified within this equation are taken as given (Romer, 2001, p. 12). However, L and A grow at constant rates defined as n and g by the following two equations (Romer, 2001, p. 12):

$$\frac{dL(t)}{dt} = nL(t) \quad (2)$$

$$\frac{dA(t)}{dt} = gA(t). \quad (3)$$

The evolution of capital (K) is defined by:

$$\frac{dK(t)}{dt} = sY(t) - \delta K(t), \quad (4)$$

where s is the investment ratio, and δ the depreciation rate (Romer, 2001, p. 13).

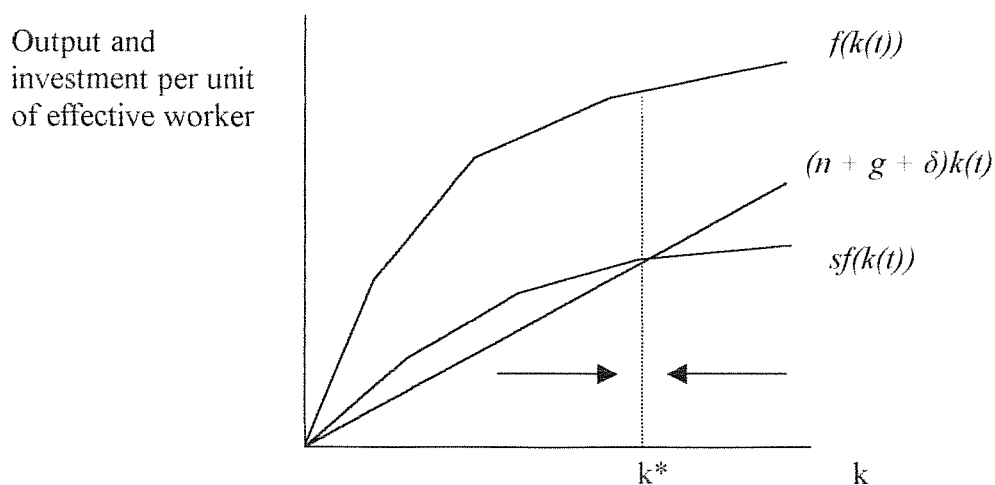
To examine the dynamics of the model Mankiw, Romer and Weil (1992), as well as Romer (2001), indicate that it is essential to look at the capital stock per effective unit of labour -

k . To do so, $k=K/AL$ is differentiated, and after manipulation and substitution from equations (2), (3), and (4), the “key equation of the Solow model” is arrived at (Romer, 2001, p. 15):

$$\frac{dk(t)}{dt} = sf(k(t)) - (n + g + \delta)k(t); \quad (5)$$

From this equation the main conclusions and implications of the Solow model are easily observable. The model predicts clearly that the investment ratio, s , will have a positive effect on output per effective worker (equation 1) through the effect on capital per “effective worker” in equation 5. Similarly, n , the growth rate of labour, has a negative impact on output per “effective worker.” As will be clear in the empirical formulation for the exercise conducted, these are two of the ‘control’ variables included in the model. In addition, it brings out the important and controversial implication of ‘convergence.’

Figure 1: The Solow Growth Model (Romer, 2001, p. 21)



Equation 5 implies that if a country's actual investment is below that needed to 'break-even' ($(n + g + \delta)k(t)$), capital per "effective labour" will be rising. The converse will be true if actual investment is larger than 'break-even' investment (Romer, 2001, p. 15). In both cases, capital per effective worker converges to a 'steady-state' level of " k^* ". This is the "balanced growth path" where k , capital per "effective labour", is constant (Romer, 2001, p. 15). On this "balanced growth path", capital per worker and output per worker are growing at a constant rate g - the growth rate of 'knowledge' or 'technological progress' (Romer, 2001, p. 16-17). This can be seen in figure 1, and demonstrates the implication that if countries have the same steady state, poorer countries should 'catch up' to rich countries (Perkins *et al*, 2001, p. 58).

There has been much empirical work conducted to test this implication, but the evidence has been mixed. For example, results presented by Williamson (2004) using data from the PWT 6.1 indicate that there has been no convergence during the period of 1960-1995 (p. 270-271). In looking at a subset of countries, Williamson (2004) finds that there has been convergence within the richest countries, but no convergence within poor countries (p. 271). Baumol (1986) (as cited in Romer, 2001, p. 31) presents evidence for the period of 1870 to 1979 that indicates a high degree of convergence, practically perfect convergence, among the most industrialized countries (Romer, 2001, p. 31). Barro and Sala-I-Martin (1992) find evidence that countries that are below their steady-state values tend to grow faster (p. 245). They also find that in a large sample of countries from 1960-1995, as in Williamson (2004), there exists evidence for convergence. This convergence, however, is 'conditional' (p. 246).

These findings highlight the distinction between 'absolute' and 'conditional' convergence. 'Absolute convergence' is a term that Barro and Sala-I-Martin (2004) define as "the hypothesis that poor economies tend to grow faster per capita than rich ones - without

conditioning on any other characteristics of economies” (p. 45). This implies that the parameters in the model, such as n , g , δ and $f(k)$ are exactly the same for all countries, only differing in initial capital per worker (p. 44). Therefore, the Solow model only predicts ‘absolute convergence’ when these variables are the same for all countries.

It is for ‘absolute convergence’ that the empirical results show very little support. For this reason, Barro and Sala-I-Martin (2004) argue that the theory must be adapted by allowing the parameters in the model to differ across countries, allowing for ‘conditional convergence’ (p. 46), “the main idea being that an economy grows faster the further it is from its *own* steady-state value” [italics added for emphasis] (p. 47). As Romer (2001) points out, this is what the Solow model predicts – “countries converge to their balanced growth paths” (p. 30). This means that the Solow model predicts ‘conditional convergence.’

III.2 Conditional convergence growth model

The conditional-convergence growth model forms the basis for the empirical work of Barro and Sala-I-Martin (1992, 2004), and Mankiw, Romer and Weil (1992). This is also the foundation for those studies more relevant to the discussion of monetary unions and growth, such as Edwards and Magendzo (2006), and Frankel and Rose (2002). The convergence model takes the following form (Barro and Sala-I-Martin, 2004, p. 50):

$$\log\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = a - b \log(y_{i,t-1}) + u_{i,t}; \quad (6)$$

for $i = 1, \dots, N$; $t = 1, \dots, T$; and y stands for per capita income.

This formulation is similar to that used by Baumol (1986) to test the hypothesis of convergence during the period of 1870 to 1979, among the major industrialized nations in the world (as cited in Romer, 2001, p. 31). In this formulation, however, the model describes ‘absolute convergence.’ This is because parameters such as n , g , δ , and any other determinant of the steady state are not included. Thus they are assumed to be the same across countries.

To account for the possibility of conditional convergence it is essential to add what Barro and Sala-I-Martin (2004) call “control and environmental” variables (p. 516). The conditional convergence growth model, then, should take the following form:

$$\log\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = a - b \log(y_{i,t-1}) + cX_{i,t} + u_{i,t}; \quad (7)$$

for $i = 1, \dots, N$ and $t = 1, \dots, T$

In this form, X is a vector of “control and environmental” variables, such as the growth rate of the work force n , the depreciation rate δ , as well as any other variables that might influence the steady state level of income. Barro and Sala-I-Martin (2004) introduce a great number of variables in X such as life expectancy, fertility rates, government consumption ratios, openness ratios, investment ratio, and inflation rate (Table 12.3, p. 522). They find that introducing these variables makes the relationship between initial level of income per capita and the growth rate of income per capita highly significant and negative, thus, demonstrating that there is significant evidence to support the hypothesis of ‘conditional’ convergence (p. 50).

It is this model of ‘conditional’ convergence that will be used in the empirical analysis conducted for this paper. The empirical model, the data, methodology and results are presented in the following section.

IV. Monetary Unions and Economic Performance: the empirical exercise

IV.1 The Empirical Model

As previously stated, in their studies on the effects of monetary unions and economic performance, Edwards and Magendzo (2006), as well as Frankel and Rose (2002) (in their second stage estimation), utilize the conditional convergence growth model – or a variant of it. It is also the model that is used here, and it takes the following form:

$$\frac{\left[\log \left(\frac{GDPPW_{i,t}}{GDPPW_{i,t-1}} \right) \right]}{5} = \alpha - \beta \log GDPPW_{i,t-1} + \delta D_{i,t} + \gamma \log N_{i,t} + \phi \log I_{i,t} + \varphi \log O_{i,t} + \mu_i + \lambda_t + u_{i,t} \quad (8)$$

for $i = 1, \dots, N$ and $t = 1, \dots, T$

where $GDPPW_{i,t}$ is real gross domestic product per worker of country i at time t , and:

- $D_{i,t}$ is the dummy variable for monetary union;
- N is the population growth rate of country i at time t ;
- $I_{i,t}$ is the average investment share of real GDP of country i for period t ;
- $O_{i,t}$ is the average openness ratio of country i for period t .
- μ, λ represent country and period fixed effects.

Division by five of the dependant variable is done to account for the fact that we are using 5-year periods. The variables D, N, I and O all act as the ‘control and environmental variables’ that are included in X in equation 7. The estimations are done adding one of these variables at a time. Equation 8 is the most complete formulation that will be used in the estimations. Although we include the ‘control and environmental’ variables to account for differences across countries, there is still the implication that the growth rates of technological progress and depreciation rates are the same for all countries (Coulombe and Tremblay, 2004, p. 10).

Any changes to these ‘control and environmental’ variables “can affect only the relative level of the long-run equilibrium as long as β is a positive fraction” (Coulombe, 2007, p. 6).

Since at the steady state there will be no change in GDP per worker, the long-run solution for the specification in equation (8) is represented by (Coulombe, 2007, p. 6):

$$\log GDPPW_{i,t}^* = \frac{\alpha + \delta D_{i,t} + \gamma \log N_{i,t}^* + \phi \log I_{i,t}^* + \varphi \log O_{i,t}^* + \mu_i + \lambda_i}{\beta} \quad (9)$$

During the transition to this steady state, the growth rate of GDP per worker can be represented as follows (Coulombe, 2007, p. 7):

$$\Delta(GDPPW_{i,t}) = \beta(GDPPW_{i,t}^* - GDPPW_{i,t-1}) \quad (10)$$

Here the β coefficient represents the “annual speed of convergence toward the steady state” (Coulombe, 2007, p. 7). As Coulombe (2007) notes, “economies will converge to their steady states as long as β is positive and <1 ” (p. 7). This corresponds to b in equations (6) and (7) of the convergence growth models presented in the previous section.

IV.2 The Data set

The data for GDP per worker, population growth, investment share and openness were collected from the Penn World Tables 6.2 (PWT6.2). This is the latest update to the database compiled by Atena, Heston and Summers (2006). Earlier versions of the PWT have been used to collect data for almost all the major studies on growth cited in this paper such as Mankiw, Romer and Weil (1992), Barro and Sala-I-Martin (2004), Coulombe and Tremblay (2004), and Williamson (2004). More relevant is that both Frankel and Rose (2002), and Edwards and Megendzo (2006), also utilize the PWT as a source of data for the same variables used in this empirical exercise. This makes the results of this paper comparable to those studies, even though more recent data are used. The PWT6.2 contain information on macroeconomic indicators for

188 countries starting from the year 1950. In this study, the data collected are for the period of 1960-2000, which results in a total number of 98 countries that have available data. This sample size of countries is comparable to that of Mankiw, Romer and Weil (1992).

Similar to Coulombe and Tremblay (2004), the data are divided into 5-year periods resulting in a total of 9 periods from 1960-2000. Since we have 98 countries (cross-section), and 9 time periods (time-series), this gives a total of 882 observations per variable. The values for real GDP per worker are taken as given by the PWT6.2. The growth rate of the population N is also taken from the PWT6.2. However, since the PWT6.2 only give numbers for the total population, the growth rate of the population is calculated from these absolute numbers. The investment share of GDP and the openness ratio are averaged over the 5-year periods. For example, the investment share of GDP for the period of 1966-1970, inclusive, is the average investment share over these five years.

As noted by Coulombe and Tremblay (2004) the values reported in the PWT are in purchasing power parity, “which allows real quantity comparisons to be made across countries” (p. 7). This allows us to utilize the results to make adequate comparisons between monetary union and non-monetary union countries. The dummy variable for the “monetary union” effect is, however, compiled from other sources.

IV.2.1 The Monetary Union Dummy

The dummy variable for monetary unions, $D_{i,t}$, takes the following values:

$$D_{i,t} = \begin{cases} 1, & \text{if country } i \text{ was part of a monetary union at time } t \\ 0, & \text{otherwise} \end{cases}$$

For the purpose of this exercise, a 'monetary union' is defined, in a broad sense, to include countries that form part of formal and informal monetary unions. Formal monetary unions include the EMU, the Western African States Monetary Union, Central African States Monetary Union, and the Common Monetary Area of the South African Rand. These formal unions involve countries that have agreed, through formal and multi-lateral agreements, to adopt the same currency in their respective countries, and to cooperate with each other on issues of monetary policy. Informal monetary unions include countries that have unilaterally adopted another country's currency as legal tender (i.e. dollarization), allowed their currencies to be interchangeable with another nations currency, or, as is the case of Mozambique, have not had independent monetary policy due to colonial relationships (i.e. Portugal as issuer of currency) (Banco de Mozambique, 2005). This also means that the monetary union dummy variable, $D_{i,t}$, for Panama will be 1 for all the periods in question, given that it has been dollarized since independence (Edwards and Magendzo, 2001, p. 2).

Countries that became part of a monetary union - such as the EMU countries - within a 5-year period have a value of '1' for the monetary union dummy in that period. If a country exited a monetary union within a period, however, the monetary union dummy takes the value of '0'. It is reasonable to apply this because of expectations. As individuals and governments expect a country to become part (or exit) a monetary union the benefits (or drawbacks) of monetary union membership can be felt before the change officially takes place.

Part of the contribution of this paper is the compilation of this dummy variable. To do this we use a mix of sources to determine the value country i would take at period t . These sources include academic papers such as Engel and Rose (2002), Hanke and Schuler (1999), and Hadjimichael and Galy (1997). Also, sources such as the central banks of these nations, the

European Central Bank (ECB), and the Central Bank of West African States (BCEAO in French acronym), provide the main source of data.

The benefit of most of the central bank electronic sources is that they provide a history of the currency of their respective nations, making them invaluable sources of information. For example, Malawi in 1960 did not have monetary independence. Malawi's central bank was founded in 1964 to replace the Federal Bank of Rhodesia and Nyasaland, which conducted operations for what today are Zimbabwe, Zambia and Malawi (Central Bank of Malawi, 2003). Therefore, in 1960 the monetary union dummy variable for Malawi takes the value of 1. This means that Zambia and Zimbabwe will also take the value of 1 for this period. Argentina, like Panama, is another example of an informal monetary union. During the time of Argentina's convertibility law that was introduced on March 20, 1991, Argentina pegged its new currency, the peso, to the U.S. Dollar on a one-to-one basis (Hanke and Schuler, 1999, p.3). This made this system of convertibility essentially a dollarization of the Argentine economy (Hanke and Schuler, 1999, p. 2).

Finally, 'Table A1' in Engel and Rose (2002), provides comparison and confirmation between the two data sets. For example, Engel and Rose (2002) do not include Argentina or the EMU countries. The latter are not included because their data set, as in Frankel and Rose (2002), does not include the years after the EMU was officially active. Argentina, on the other hand, is included in this exercise because of the practical dollarization that its convertibility law created, as expressed above. Frankel and Rose (2002) also include Argentina. However, Edwards and Magendzo (2001, 2006) do not.

Frankel and Rose (2002) also provide a list of 59 countries that formed part of monetary unions (p.464). The data set in this paper includes a total of 47 countries that at some point in the

period of 1960-2000 were part of a monetary union (see Appendix B). Only 26 of these countries presently, or as of the year 2000, were part of a monetary union within this 98-country sample. In total, there are 205 incidents where the monetary union dummy variable takes the value of “1” out of the 882 possible incidents over 9 periods.

IV.2.2 A Caution on the data

Before proceeding to the methodology used in the estimations, two cautionary issues should be noted about the data - sample selection bias and measurement error. Romer (2004) notes that DeLong (1988), identified that in Baumol (1986), the data series would be biased because countries that would have available data would likely be the most industrialized nations. This would create a bias that would lead to evidence of absolute convergence (Romer, 2001, p. 31). Measurement error would be present because the data for 1870 real income per capita was imprecise, creating more bias towards finding convergence (Romer, 2001, p. 31).

In the data set collected for this paper, it is possible to think that selection bias is present, since we are using a sample of countries that have data available - excluding all others. It is possible that these countries form a set of the most industrialized. However, simply by looking at the list of countries included in the sample, one can see that there is a wide range of countries having varying degrees of industrialization. For example, the sample includes nations such as Canada, the U.S, the U.K, Switzerland and others such as Malawi, the Dominican Republic, Zimbabwe, Gabon, Bolivia, Niger and Nicaragua. Certainly this last set of countries does not comprise a list of the most industrialized nations. In addition, the minimum value of GDP per worker in the sample is approximately \$700, and the maximum approximately \$85,000.

What the data for such a mix of countries can introduce, however, is the second issue of measurement error. Because some of these nations are less developed, the measurement techniques or methodology might not be as accurate as those reported for industrialized nations that might have access to better methodology. Credibility might also be a factor - credibility in the sense that more industrialized nations might not manipulate their data as much as less developed nations. Even though measurement error might be present, the data are collected from the PWT, which is the same source for the other studies cited. This allows us to ignore this effect since we are concerned with a comparative analysis.

Differences in the data sets

Frankel and Rose (2002) use a data set that includes information up to the year 1995. By 1995 the EMU had not yet taken full effect, and therefore, no observations for the EMU members are included in the sample. Similarly Edwards and Magendzo (2001, 2006) use data sets that reach only up to 1998. The data set used in the estimations conducted for this paper take information from the PWT6.2 which now includes data up to the year 2004. Because the periods are divided into five-year intervals, only data up to the year 2000 are utilized². The EMU was introduced in three stages, finalizing in 1999. In stage two, the ERMII exchange rate mechanism was introduced and adopted on June 1997 (European Central Bank, 2007). For this reason we include observations in the monetary union dummy for EMU countries.

In addition, Edwards and Magendzo (2001, 2006) focused on 'strictly dollarized' nations. This group of countries includes some of the smallest nations in the world and some territories that are not fully independent. In adding observations for the EMU countries, our data set might

² 4-year intervals may not be sufficient to capture the effects of the variables and not all countries have information for 2004 in the PWT6.2.

be better balanced - balanced in the sense that there are now large, industrialized nations included in the sample of countries that are part of monetary unions.

The inclusion of these countries might affect the results. Perhaps adding the EMU countries creates an opposite bias to that in Edwards and Magendzo (2001, 2006) and Frankel and Rose (2002), a bias created from including small nations. Yet the results achieved in this paper indicate that there is evidence that forming part of a monetary union has a positive and significant effect on long-run income.

IV.2.3 The Methodology

The first step was to transform the variables. GDP per worker, investment, and openness were transformed into logarithmic deviations from their period specific cross sectional means. Population growth and the monetary union dummy were transformed by subtracting the period cross sectional mean. The reason for applying this transformation is to “detrend” the variables (Gujarati, 2003, p. 803). This “detrending” is done, as per Coulombe and Tremblay (2004), to obtain unbiased results by eliminating common trends that might be present in the variables (p. 9). This methodology is also equivalent to introducing period specific fixed effects (Coulombe and Tremblay, 2004, p. 9). Once the data were transformed, LS and 2SLS were used for the estimations.

Pooling TSCS data has several advantages. These include taking into account the heterogeneity of individual variables if fixed effects are included (i.e. within countries), improved efficiency, reduced collinearity, and better suitability for the “dynamics of change” (such as the convergence model) (Gujarati, 2003, p. 637-8). For example, in both the LS and 2SLS, country fixed effects are utilized to take into account possible heterogeneity across

countries. This methodology is also used in Coulombe (2007), Coulombe and Tremblay (2004), as well as in Barro and Sala-I-Martin (2004).

The estimation of the model using LS is consistent with Islam (1995). Because Mankiw, Romer and Weil (1992) used a cross-section of data, they conducted their regressions using Ordinary Least Squares (OLS). In doing this, they “assume that the rates of saving and population growth are independent of country-specific factors shifting the production function. That is, [they] assume that s and n are independent of ε ” (p. 411). However, Islam (1995) suggested that using TSCS data is a better framework to control for the error term, ε (p. 1134-35).

Instrumental variables (IV) are used to address the problem of endogenous variables (Coulombe and Tremblay, 2004, p. 12). This, for example, can arise where exports are a component of GDP, yet it is included as part of the explanatory variables as in Frankel and Rose (2002).

Another reason for utilizing IVs is to correct for the Nickell bias (Coulombe and Tremblay, 2004, p.12). According to Nickell (1981) the bias arises in TSCS data when there are “a rather large number of individuals and a rather small number of time periods...” (p.1418). This is certainly a concern in the data utilized in this paper. The data set has 98 ‘individuals’ (i.e. countries) and only 9 periods, some of which are eliminated by the use of lagged variables. Like the measurement error bias, the Nickel bias will also cause overestimation of the convergence speed (Coulombe and Tremblay, 2004, p.12).

The IV’s include the two-period lag of initial GDP per worker, and single period lags of the monetary union dummy variable, population growth, investment and openness. In particular, Barro and Sala-I-Martin (2004) suggest that including the two-period lag of GDP per worker as

an IV “lessens the tendency to overestimate the convergence rate because of temporary measurement error in GDP” (p. 521). Including the two-period lag of GDP per worker also decreases the Nickell bias (Coulombe and Tremblay, 2004, p. 12).

IV.3 Least Squares Results

Convergence Speed

PLS is conducted for six specifications of the model, the results for which are summarized in Table 1. The first specification is similar to that of equation 6, the ‘absolute convergence’ growth model. It is similar in the sense that no ‘control and environmental’ variables are added. The point estimate for the initial level of GDP per worker is significant at the 1% level. This point estimate tells us that the speed of convergence is approximately 4.1%, a result lower than those obtained in Coulombe (2007). It is close, however, to those obtained in Barro and Sala-I-Martin (2004) and the 5% obtained in Coulombe (2000) where 5-year periods are also utilized. In all specifications, the speed of convergence is in the range of 3.7% to 4.2% and significant at the 1% level.

Monetary Union Effects

The most important results of this paper are those of the coefficient on the monetary union dummy variable. With PLS, the coefficients of the monetary union dummy variable, in all specifications, are positive and significant. In three out of five specifications, they are significant at the 5% level. They are significant at the 10% level in the others. Adding the monetary union dummy variable does not affect significantly the point estimate of the convergence speed, which remains highly significant at 4.1%.

The point estimates for the monetary union dummy variable indicate that there is a positive impact on yearly growth of GDP per worker of up to 1%. This result is the opposite of that found in Edward and Magendzo (2006). However, it is of more interest to examine the impact of monetary unions on the long run level of GDP per worker. In Table 1 we also report the long-run elasticities of the monetary union dummy. Following Coulombe (2007), these are computed from equation (9). The elasticities are between 0.146 and 0.243. This tells us that monetary union countries will have a long run level of GDP per worker that is higher by up to 24.3%.

The monetary union dummy variable remains significant when including population growth, investment and openness in the regression. We can see that the point estimate is sensitive to investment and openness. When adding the investment variable in the regression, the point estimate increases in value and becomes significant at the 5% level. When introducing the openness ratio, however, the point estimate is reduced but maintains significance at the 5% level. More importantly, the openness ratio is not significant. This result must be highlighted because it implies that the monetary union effect remains important even when accounting for trade.

A 14.6% to 24.3% impact on the long-run steady-state level of GDP per worker is very large even though consistent with those obtained in Frankel and Rose (2002). As noted previously, these authors estimated that Albania would have a 23% “boost” to income if it adopted the euro (p. 457). Their estimates of the long-run effect of monetary unions vary significantly by country. They range from a low of 1% to a high of 38% (Frankel and Rose, 2002, p. 457). These results, however, contradict those of Edwards and Magendzo (2006) whose estimates indicate that the economies of dollarized nations do not perform better.

Variable	1	2	3	4	5	6
Constant	-0.025** (0.003)	-0.025** (0.003)	-0.025** (0.003)	-0.016** (0.002)	-0.016** (0.003)	-0.021** (0.003)
Initial GDP per worker	-0.041** (0.006)	-0.041** (0.006)	-0.041** (0.006)	-0.037** (0.005)	-0.037** (0.006)	-0.042** (0.006)
Monetary union dummy		0.006* [0.146] (0.003)	0.006* [0.146] (0.003)	0.009** [0.243] (0.003)	0.007** [0.189] (0.003)	0.007** [0.167] (0.003)
Population Growth			0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.000* (0.000)
Investment share of GDP				0.028** (0.002)	0.026** (0.003)	0.014** (0.004)
Openness					0.004 (0.003)	0.006 (0.003)
R-squared	0.397	0.397	0.397	0.492	0.489	0.436
Adjusted R-squared	0.310	0.310	0.308	0.417	0.413	0.352

Notes:

*Significant at 10% level

**Significant at 5% level

Standard errors are reported in brackets (). Country fixed effects are utilized in all regressions (not reported).

A total of 783 pooled observations are included

Long-run elasticities reported in square brackets []

R-squared values for columns 1-3: 1) 0.39664 2) 0.397449 3) 0.396676

A significant implication of these results is that there is evidence that central bank credibility and a stable macroeconomy are the channels through which monetary unions affect income. Frankel and Rose (2002) concluded that the channel through which monetary unions improves income is improved trade (p. 438). They suggested that by including the monetary union dummy directly in the income model, one could determine the main channel through which monetary unions improve income. In their estimation, they found that the monetary union dummy was negative and non-significant (p. 455). In the regressions conducted in this paper the monetary union dummy is included directly in the growth model. Therefore, the positive and

significant coefficients provide evidence for the ‘traditional channels’. This effect is evident even when accounting for trade. Including the openness ratio reduces the impact on GDP per worker of monetary unions but it does not affect the significance or the direction of the effect.

A note on the control and environmental variables

Columns 2-5 of Table 1 show results for the model with the ‘control and environmental variables’ included. An interesting result is that of the coefficient of population growth. The coefficient is non-significant in all but one specification. It also has the opposite sign to that which was expected from the theory. The empirical evidence, however, is mixed on the effect that population growth has on economic growth. For example, variables such as fertility rates and initial levels of population are included among what Barro and Sala-I-Martin (2004) consider variables that are “not robustly related to growth.” (p. 555).

The coefficient for investment is positive and significant at 5%. This positive effect is consistent with most studies on economic growth discussed, and with neoclassical theory. The openness ratio, however, is found to be non-significant. While the coefficient is positive, this is not consistent with the results of Barro and Sala-I-Martin (2004) and Frankel and Rose (2002), where the openness ratio is found to be significant and positive.

The final specification of the model includes the population growth rate, the investment share of GDP, and the openness ratio lagged by one period. This is done to take into account possible lags in responses to changes to the ‘control and environmental variables’. These results are presented in column 6.

IV.4 Two-Stage Least Squares Results

The results obtained with LS indicate a substantial long run effect of monetary unions on GDP per worker. The magnitude of the long run elasticities could be a result of overestimation caused by problems of endogeneity, measurement error and the Nickell bias. To account for this, we re-estimate the model using 2SLS.

Convergence Speed

As with LS, we observe strong evidence for the convergence hypothesis. In the first column of Table 2 the results for the ‘absolute convergence’ growth model are presented. The coefficient for the initial level of GDP per worker is highly significant at the 1% level and has the expected negative sign. With this methodology, however, the estimated speed of convergence is now higher. The speed of convergence ranges from 4.6% to a high of 5.6%. These values are again consistent with those in Coulombe (2000).

Monetary Union Effects

We now discuss the 2SLS results for our main interest – the monetary union dummy variable. In all specifications of the model, the coefficient is positive. It is significant at the 5% level in two of the five specifications and significant at 10% in two others. However, in the last specification in column 6, we see that the coefficient is non-significant³.

The striking difference using this method of estimation is the magnitude of the impact on the steady state level of GDP per worker, which is now more than doubled. As can be seen in Table 2, the long-run elasticities for the monetary union dummy are between 0.286 and 0.630. This is a significant impact on the level of long-run GDP per worker. The lower values remain in

³ P-value is 0.101

the range of those found in Frankel and Rose (2002). Those obtained in the regressions shown in columns 4 and 5 are, however, significantly larger. In particular, a 63% impact on income in the long run is too large to be credible.

The monetary union dummy is now more sensitive to the introduction of other variables. The introduction of the investment variable almost doubles the point estimate. As can be seen from the r-squared values, the introduction of this variable also makes the fit of the regression imprecise. This is one reason to question the validity of a 63% long-run impact on income.

Introducing the openness ratio improves the explanatory power of the regression and lowers the point estimate of the monetary union dummy. However, the coefficient for openness remains non-significant. Contrary to the results in Frankel and Rose (2002), this again gives support to the 'traditional channels' by which monetary unions improve incomes. The sensitivity of the monetary union dummy is evident in the final specification. When utilizing the lag of population growth, investment and openness, the monetary union dummy appears non-significant by a small amount. However, it remains significant in the other specifications.

The magnitudes of the long-run elasticities of the monetary union are very large. The same caution that Frankel and Rose (2002) make is in order. A long-run impact of 63% on income is too large to be possible (p. 459). The monetary union dummy variable could be accounting for other 'control and environmental' variables that are omitted from the model. Some of these omitted variables may include variables such as common borders, common language, and human capital measures that are included in Frankel and Rose and Edwards and Magendzo (2006). In addition, Frankel and Rose (2000) suggest that nonlinearities and the size of a country could account for this overestimation (p. 460).

With 2SLS we obtain higher point estimates than those obtained with LS. In particular, the point estimates of convergence speed and the monetary union dummy are higher. This result is somewhat surprising. The reason for using IV estimation, through 2SLS, was to account for overestimation caused by endogeneity, measurement error and the Nickel bias. The higher values obtained with IVs are opposite of that expected. This is a result that also occurs in the IV estimation conducted in Frankel and Rose (2002). This could be due to the IVs used.

The use of lagged values of the explanatory variables as IVs might not be an optimal solution. Frankel and Rose (2002) utilize a set of IVs that they believed to be highly exogenous. In doing so, they also obtain higher point estimates. They suggest that the decision to adopt another currency might be endogenous (p. 459). Similar to Frankel and Rose (2002), it is possible that other factors, other than monetary union membership, are causing this impact on income. This issue is related to the omitted variables discussed above. In addition, Frankel and Rose (2002) note that, “plausible instrumental variables for currency union membership do not appear to exist in practice” (p. 459).

This point is very relevant to the methodology used in this paper. The IV used for the monetary union dummy is its lag. The use of the lag as IVs might be appropriate for GDP per worker, investment and openness. It might not be adequate, however, for the monetary union dummy. A country that is part of a monetary union in one period is not necessarily part of a monetary union in the previous period. This could make this IV inadequate. However, the monetary union dummy variable is calculated as deviation from the mean, which might lessen some of this effect. In fact, by transforming the monetary union dummy in this form, it is no longer a dummy variable and hence using the lag as an IV might be appropriate.

Despite these downfalls, the long run effects of monetary unions are very high and significant. Perhaps these are too high to be credible. Nevertheless, in both LS and 2SLS the coefficient for the monetary union dummy variable is positive in all specifications. It is also significant at the 5% and 10% levels in 9 out of 10 regressions. While one can question the magnitude of the effect on the long run level of GDP per worker, these results provide evidence to support the argument that monetary unions “boost” income.

Variable	1	2	3	4	5	6
Constant	-0.032** (0.005)	-0.033** (0.005)	-0.032** (0.007)	-0.022** (0.006)	-0.022** (0.005)	-0.025** (0.004)
Initial GDP per worker	-0.055** (0.009)	-0.056** (0.009)	-0.055** (0.014)	-0.046** (0.010)	-0.049** (0.011)	-0.052** (0.008)
Monetary union dummy		0.016* [0.286] (0.009)	0.017* [0.309] (0.010)	0.029** [0.630] (0.013)	0.023** [0.469] (0.010)	0.018 [0.346] (0.011)
Population Growth			-0.008 (0.029)	-0.015 (0.031)	-0.012 (0.022)	-0.002 (0.005)
Investment share of GDP				0.024** (0.011)	0.021** (0.009)	0.014* (0.007)
Openness					0.016 (0.020)	0.009 (0.008)
R-squared	0.418	0.398	0.207	-0.011	0.203	0.415
Adjusted R-squared	0.321	0.296	0.071	-0.186	0.063	0.312

Notes:

*Significant at 10% level

**Significant at 5% level

Standard errors are reported in brackets (). Country fixed effects are utilized in all regressions (not reported).

A total of 685 pooled observations are included

IV List: Two-period lag of GDP per worker, one period lag for dummy, population growth, investment and openness

Long-run elasticities reported in square brackets []

A note on the control and environmental variables

With 2SLS we now obtain, in all specifications of the model, the expected signs for population growth and the openness ratio. However, they remain non-significant. The openness ratio is found to be highly significant in Frankel and Rose (2002) in both specifications of their model. But Barro and Sala-I-Martin (2004) conclude that: “there is only weak statistical evidence that greater international openness stimulates economic growth” (p. 530). Since the empirical evidence is mixed, this result is not surprising. Similarly, we are not concerned with the lack of significance of the population growth rate coefficients, as stated in the previous section. The investment share of GDP remains significant and more importantly is shown to have roughly the same, or slightly less effect, on economic growth as estimated through PLS. For column 6 two-period lags are utilized as IVs.

IV. Conclusion

The debate over currency regimes pitted two Nobel Laureates against each other, with Robert Mundell promoting the theory of OCAs, and Milton Friedman promoting his ‘Insulation Hypothesis.’ The collapse of the Bretton Woods agreement and subsequently the financial and currency crises that swept the Asian region led to a world where Friedman’s ideas on exchange rate regimes were the norm. Yet, since the beginning of the EMU the trend has certainly started to change. Mundell (2003) estimates that in the second decade of the new millennium the Euro area could comprise 50 countries or more. This is due to the addition of new members to the European Union, the CFA franc zone countries now tied to the Euro, and some North African and Middle Eastern countries adopting or fixing their currencies to the Euro (p. 22). Mundell

(2003) also maintains that the Dollar area will likewise expand (p. 22). This has become evident with the recent dollarization of Ecuador, El Salvador and Guatemala.

The analysis of previous empirical studies presented gives mixed evidence as to the benefits of monetary unions. Frankel and Rose (2002) determine that through increased trade, monetary unions can significantly improve incomes, a result that gives credence to Mundell's theory of OCAs. Edwards and Magendzo (2001, 2006), on the other hand, determine that dollarized nations have had poor growth. Their estimates indicate that countries that have been dollarized experienced slower growth and higher volatility - as per Friedman's 'insulation hypothesis.'

In this paper, using both Least Squares (LS) and Two Stage Least Squares (2SLS) we find strong evidence of a positive and substantial effect of monetary unions on income. It is found that monetary unions can have a long run impact on the level of GDP per worker of up to 24%. Furthermore, when conducting the estimation using 2SLS, we found that the effect is substantially larger – ranging from 28.6% to a high of 63%.

As in the studies by Frankel and Rose (2002) and Edwards and Magendzo (2001, 2006), these results must be taken with caution. The data set collected here includes only those nations for which data were available, thereby possibly amplifying sample selection bias. Including EMU countries might lead to capturing the effects of sound fundamentals of more industrialized nations in the monetary union dummy variable and may bias the results. In addition, overestimation of the long run impact of monetary unions on income can be due to endogeneity, measurement error or the Nickell bias. The difficulty of finding an appropriate instrumental variable for the monetary union dummy variable is also a concern.

However, one thing is clear in the estimations conducted: the coefficient of the dummy variable for monetary unions in all specifications is significant at least at the 10% level. In total, 10 specifications including the monetary union dummy variable were estimated using LS and 2SLS. In 5 out of 10 specifications the coefficient for the monetary union dummy is significant at the 5% level. It is significant at the 10% level in four.

Another major result obtained is that of the channel through which monetary unions influence economic performance. Frankel and Rose (2002) suggest that the 'traditional channels', such as reduction in transaction costs, fiscal discipline, and credibility, are not the main channel of the income-effect of monetary unions. Rather, they suggest that monetary unions increases trade between nations and that this leads to higher incomes. Yet the estimations conducted in this paper in both LS and 2SLS include the dummy variable for monetary unions directly into the specification of the convergence growth model. Frankel and Rose (2002) suggest that this methodology tests for the validity of the 'traditional channels'. Therefore, the positive and significant coefficients for the monetary union dummy variable indicate that there is evidence that these 'traditional channels' are valid. Furthermore, accounting for trade by introducing the openness ratio does not significantly impact the results.

Because of the disparity between the results of the empirical research presented and discussed in this paper, it is obvious that further and continued research must be conducted. An obvious next step would be to utilize the next update of the PWT to include a further period that will take into account 5 more years of the EMU, and 5 years of newly dollarized nations such as El Salvador, Guatemala and Ecuador (Edwards and Magendzo, 2001, p. 13). In addition, as more countries join the European Union, they will subsequently become part of the EMU, enlarging the sample of countries. To take into account other factors that influence the steady state of

nations, the empirical model conducted here should also be extended to include further ‘control and environmental’ variables as done in Frankel and Rose (2002), Edwards and Magendzo (2001, 2006) and in Barro and Sala-I-Martin (2004). These variables would also serve as good IVs as suggested by Frankel and Rose (2002).

Despite these limitations, one can conclude that there is strong evidence to support the position that monetary unions have a positive impact on a country’s economic performance. This is not to say that all countries should rush to adopt the euro, dollar or yen in order to accelerate their economic growth. There are many factors that should be taken into consideration, including simple political economy arguments such as the loss of sovereignty through the loss of a national symbol in the currency, and the loss of independent monetary policy (Berg and Borensztein, 2003, p. 87). Furthermore, Frankel and Rose (2002) have noted that it matters which country one joins with in a monetary union (p. 461-62). This suggests that countries should examine carefully the OCA criteria to determine which currency is a better alternative.

In addition, it is possible that for some nations becoming part of a monetary union might not be an adequate policy alternative. In particular, nations that rely heavily on commodities or even more so on a single commodity, should possibly maintain a flexible exchange rate regime in order to absorb shocks to the price of these commodities in international markets (Dehejia, 2004, p. 8).

Only time will tell if the experiment of the EMU will lead to sustained and improved economic performance for current or future members; or if economic shocks and external pressures will cause nations within the EMU to break with the monetary union and allow their currency to fluctuate once again. The same can be said for the newly dollarized nations in Latin America where political uncertainty and turmoil are ever present. Yet the evidence in the

empirical work of Frankel and Rose (2002), and that conducted in this paper, suggests that the international monetary system would benefit from a consolidation of currencies and move towards a more efficient system based on Mundell's view of optimal currency areas.

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Appendix A: List of Countries in Data Set.

Algeria	Honduras	Norway
Argentina	Hong Kong	Pakistan
Australia	Iceland	Panama
Austria	India	Paraguay
Barbados	Indonesia	Peru
Belgium	Iran	Philippines
Benin	Ireland	Portugal
Bolivia	Israel	Romania
Brazil	Italy	Rwanda
Burkina Faso	Jamaica	Senegal
Burundi	Japan	Singapore
Cameroon	Jordan	South Africa
Canada	Kenya	Spain
Cape Verde	Korea, Republic of	Sri Lanka
Chad	Lesotho	Sweden
Chile	Luxembourg	Switzerland
China	Madagascar	Syria
Colombia	Malawi	Taiwan
Comoros	Malaysia	Tanzania
Congo, Republic of	Mali	Thailand
Costa Rica	Mauritius	Togo
Cote d'Ivoire	Mexico	Trinidad & Tobago
Denmark	Morocco	Turkey
Dominican Republic	Mozambique	Uganda
Ecuador	Nepal	United Kingdom
Egypt	Netherlands	United States
El Salvador	New Zealand	Uruguay
Equatorial Guinea	Nicaragua	Venezuela
Ethiopia	Niger	Zambia
Finland	Nigeria	Zimbabwe
France		
Gabon		
Gambia, The		
Ghana		
Greece		
Guatemala		
Guinea		
Guinea-Bissau		

Appendix B: Monetary Union Countries

(Period where country was part of monetary union)

European Monetary Union

Austria (00)
Belgium (00)
Finland (00)
France (00)
Ireland (00)
Italy (00)
Luxemburg (60-00)
Netherlands (00)
Portugal (00)
Spain (00)

Pound Sterling

Ghana (60)
Mauritius (60-65)

Easter Caribbean Currency Authority

Barbados (60-70)

Danish Crowns

Iceland (60)

Federal Bank of Rhodesia and Nyasaland

Malawi (60)
Zambia (60)
Zimbabwe (60)

Singapore-Brunei-Malaysia interchangeability

Malaysia (60-70)
Singapore (60-65)

Portugal

Mozambique (60-75)

Rwanda-Burundi

Rwanda (60)

British Caribbean Currency Board

Trinidad & Tobago (60)

West African Monetary Union

Benin (60-00)
Burkina Faso (60-00)
Cote D'Ivoire (60-00)
Guinea-Bissau (00)
Mali (60,85-00)
Niger (60-00)
Togo (60-00)

Central African States Monetary Union

Cameroon (70-00)
Congo (70-00)
Chad (70-00)
Gabon (70-00)
Equatorial Guinea (85-00)

U.S. Dollar

Panama (60-00)
Argentina (95-00)

Common Monetary Area

South Africa (60-00)
Lesotho (65-00)

Eastern African Currency Board

Kenya (60)
Tanzania (60-65)
Uganda (60-65)

Currencies tied to French Franc

Algeria (60)
Comoros (60-00)
Morocco (60-70)
Burundi (60)
The Gambia (60-65)
Madagascar (60-70)