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Remittances and Growth in Latin America: A Panel Unit Root and Panel Cointegration Analysis

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Abstract

Using recently developed panel unit root and panel cointegration tests and the Fully-Modified OLS (FMOLS) methodology, this paper estimates the impact of remittances on the economic growth of selected upper and lower income Latin American & Caribbean countries. Despite a large flow of remittances to the region, there have been relatively few empirical studies assessing the impact of remittances on growth in Latin American and the Caribbean. Panel unit root tests suggests that several of the macro variables included in the model exhibit unit roots, yet, at the same time, Pedroni's panel cointegration methodology determined that there is a cointegrating relationship among the variables in the estimated model. Moreover, FMOLS estimates suggest that remittances have a positive and significant effect on economic growth in both groups of countries. The interaction of remittances with a financial development variable revealed that these two variables act as substitutes and, moreover, that the impact of remittances is more pronounced in the presence of the financial development variable.

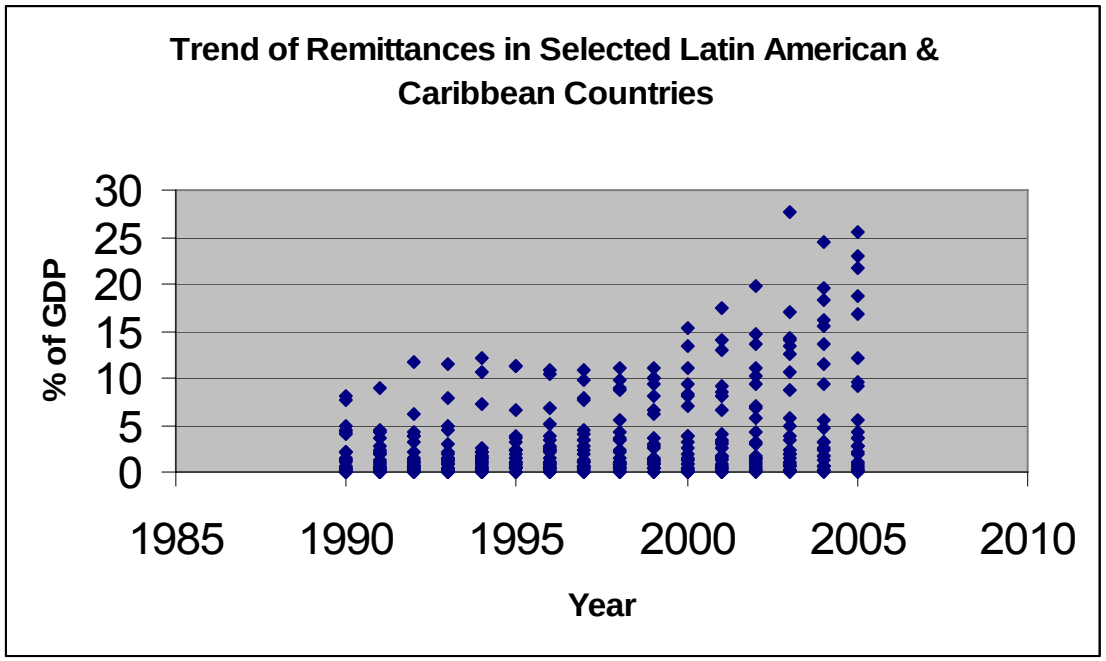
JEL Classifications: C22**,** C23, F40, O10, O50.

Keywords: Economic Growth, Foreign Direct Investment (FDI), Fully Modified Ordinary Least Squares (FMOLS), Latin America & Caribbean, Pedroni's Panel Cointegration Methodology, Panel Unit Root Tests, Pooled Regression, Remittances.

I. Introduction

In recent years, remittances have increased significantly for many countries around the world, even exceeding their foreign direct investment (FDI) and foreign aid flows. World Bank estimates put official remittances to developing countries at US$ 199 billion in 2006, while the total remittance flows in the world were expected to be about US$ 268 billion for the same year. However, the remittance transfer through unofficial channels is high and thus the true amount of remittance flows could be much higher. The World Bank believes that remittance flows to the Latin America and the Caribbean region could well be around US$ 53 billion in 2006-- a 119% increase since the year 2001. This makes this region the largest recipient of world remittances in nominal terms.

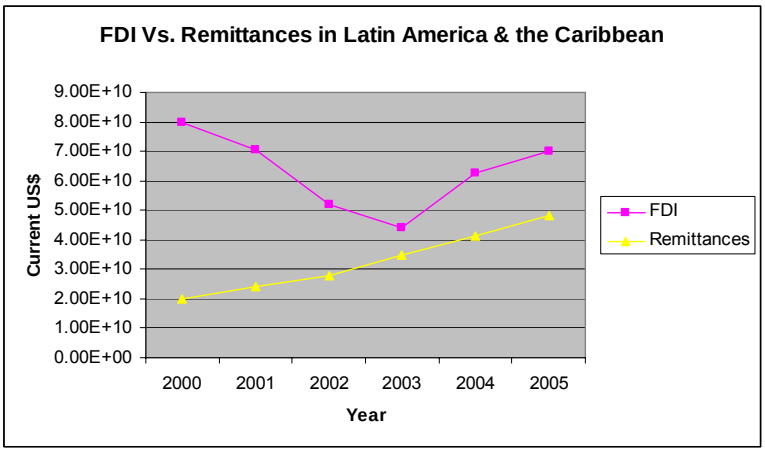
Figure 1: Trend of Remittances in Latin American & Caribbean Countries (Source: WDI, World Bank, 2007)



The figure above shows that remittance flows are exhibiting an increasing trend. Each dot in the graph represents a country, and it can readily be seen that the spread of the data is

higher in the later years with a decreased concentration on the lower end of the graph. This implies that remittances as a percentage of GDP are increasing in many countries, and in some countries remittances are more than 20 percent of GDP. As indicated above, remittances have exceeded foreign direct investment flows and foreign aid in many developing countries. The recent trend in remittance and FDI flows to the region is shown in Figure 2.

Figure 2: FDI vs. Remittances in Latin America & the Caribbean Countries (Source: WDI, World Bank, 2007)



As can be discerned from the figure, FDI flows for the countries in question have been volatile over the years, but remittances have been increasing at a steady pace. In Mexico, for example, remittances have grown steadily since 2000, with a slight leveling off during 2001-02 as a result of the U.S. recession, followed by pronounced increase which culminated in a level exceeding that of FDI flows in 2005. In this connection, Chami et al. (2005) found that remittances do not behave like foreign investment flows, but rather act as compensatory transfers. On the other hand, Giuliano et al. (2006) argue that remittances help boost the growth rate of the economy in less financially developed

countries by providing credit which would otherwise not be available. However, Giuliano et al. (2006) found a negative relation between remittance flows and growth in economies with a highly developed financial sector.

In view of the growing economic importance of remittance flows and the contradictory findings in the literature, this paper utilizes recently developed panel unit root and panel cointegration tests to assess empirically the effects of remittance flows on the economic growth of 23 Latin American and Caribbean countries during the 1990-2005 period. The paper also assesses the role of the financial (banking) sector in determining the relative effectiveness of remittance flows to the region. The results suggest that remittances have a positive and significant effect on economic growth in the region, and that the impact is more pronounced when a financial development variable is included in the model. Thus, the findings reported in this study represent a significant contribution to the extant literature, particularly because they have been generated utilizing econometrically reliable estimation techniques.

The paper is organized as follows. Section II reviews the extant literature. Section III presents the estimation methodology and data, while Section IV presents the panel results. Finally, Section V summarizes the main results and suggests avenues for future research.

II. Literature Review

There is now a significant and growing literature that attempts to assess empirically the impact of remittances on economic growth for selected developing countries, including several in Latin America and the Caribbean. Mundaca (2005), for example, in a study

assessing the impact of remittances on growth in selected countries in Central America found a strong correlation between remittances and economic growth. Remittances had a significant impact on the growth of these economies, and the impact was stronger when the financial sector was included in the model. Mundaca carried out several estimations on the impact of remittances on growth using different variables to proxy for financial development. When domestic credit from banks was used as one of the explanatory variables, a 10 percent increase in remittances as a percentage of GDP increased GDP per capita by 3.49%. However, when no variables were included to proxy for financial development, a 10 percent increase in remittances as a percentage of GDP increased GDP per capita at a lower rate of 3.18%.

However, Mundaca's findngs are not readily accepted by many other scholars working on this topic. Chami et al. (2005) found a negative correlation between remittances and growth. Basically remittances were found to be counter-cyclical in nature. They argue that remittances act like compensatory transfers and, hence, do not aid in the process of economic growth. Their idea was that remittances are intended for consumption rather than investment. Hence, the impact of remittances on economic growth is insignificant. In a related study, Poonam Gupta (2005) carried out a study which examined the macroeconomic determinants of remittances in India, one of the largest recipients of remittances in the world, and found that remittances are counter-cyclical in nature. Interestingly, she found that interest rates and exchange rate depreciation had no significant impact on the flow of remittances. Most of the increase in remittance flows was attributable to increased migration and increased earnings of those migrants.

As noted in the introduction, Giuliano et al. (2006) conducted a similar study which examined financial development as one of the explanatory variables. They used several indicators like M2/GDP and private credit provided by the banking sector as proxies for financial development. They found that remittances have a positive and significant impact on growth in less financially developed countries. They hypothesize that remittances act as substitutes for financial sector variables and provide credit to the people who need it for investment purposes. However, they too found a negative impact of remittances in financially developed economies. In financially developed economies, credit is easily available and people need not wait for remittances for investment purposes. In a more recent and related, Ziesemer (2006) reports estimates which suggest that remittances have a higher impact in countries with low per capita income (below $1200). Remittances were found to have accounted for about 2% of the steady-state level of per capita GDP and the ratio of steady-state growth with remittances compared to the growth rate without remittances was 1.39.

In light of the fact that remittances have different effects on growth based on the level of financial development, it is important to determine the role of financial development on growth. Rioja and Valev (2003) argue that the level of financial development has different effects on growth depending upon the stage of financial development of the country. They basically divide countries into three categories based on their financial development. In countries with very low levels of financial development, additional financial development has little impact on growth. In countries with an intermediate level of financial development, a further increase in financial development has a significant effect on growth. They found that a 0.10 point increase in private credit flows as a

percent of GDP in countries at an intermediate stage of financial development generates an increase in the growth rate of 0.61 percentage points. Finally, in countries at a high level of financial development, there was no discernible effect on growth from increased private credit flows. The authors suggest that this is largely due to diminishing returns to additional financial development. When the authors estimated the impact of private credit flows without any consideration for the level of financial development, the impact was statistically significant but at a much lower level. A 0.10 point increase in private credit as a percentage of GDP generated an increase in the growth rate of 0.37 percentage points.

In a similar vein, Honohan (2004) argues that there is a close relationship between financial development and GDP growth. As the ratio of liquid liabilities to GDP increases, ceteris paribus, the average per capita GDP growth rate also increases. However, Honohan is quick to point out a potential reverse causality between growth and financial development, viz., a growing country demands a greater level of financial depth and, in turn, deeper financial development stimulates growth. These results should be reviewed with a dose of skepticism because of the fact that financial development, as measured by banking depth, is often misleading.

Genevieve Boyreau Debray (2003), on the other hand, performed a study on the structure of the banking sector and growth at the provincial level in China and found a negative relation between credit provided by the banking sector at the provincial level and growth.

Hence, studies on financial development and growth do not necessarily support the hypothesis that increased financial development will increase growth. Now, let us revert

back to an examination of recent studies that have been undertaken to assess the impact of remittances on growth.

Lopez and Seligson (1991) performed a study on the impact of remittances on small business development in El Salvador. El Salvador was going through a civil war in the 1980s and many people migrated in search of jobs to sustain their families. The authors report that a significant number of these migrants sent remittances back home to sustain and finance small businesses. However, there are various channels through which remittances may affect economic growth and it is imperative to ascertain as many of them as possible in order to assess properly the impact of remittances on growth. Moreover, the effect of remittances might be different in different time periods depending upon several other factors affecting the economy.

In a related paper, Glytsos (2001) reports estimates which suggest that remittances have had a positive impact on the economic growth rate in Egypt during the 1970s but a negative one in the 1980s. He argues that the use of remittances depends on the expectations of recipients. If they have positive expectations about the future and if the risks are perceived as low, then they are likely to invest the remittances. However, it is also possible that recipients are overly dependent on remittances for consumption purposes. So, the higher income will induce them to buy modern amenities at the cost of future returns that could have been generated from the investment of remittances. Glytsos refers to the example of Morocco to illustrate this tendency.

Most of these studies seem to be missing other channels through which remittances can generate economic growth.. For instance, remittances can increase the pool of savings which might ultimately boost investment and growth. On the other hand, remittances

increase the aggregate demand for goods and services; and the increased demand for domestic goods and services will stimulate the domestic industries to increase production and generate employment provided that there is sufficient excess capacity utilization which is generally the case.

For example, Taylor (1996) presents evidence which suggests that remittance flows increase domestic aggregate demand and thus have a positive effect on economic growth. However, he believes that this positive effect of emigration can be realized only if it does not lead to an export of scarce labor resources. If there is scarcity of labor in the home country, emigration will further worsen the problem. Wages will rise prohibitively and businesses may be forced to shut down because of the unavailability and/or cost of labor resources.

In another study, Adams (2002) suggests that international remittances had a positive effect on the savings rate in Pakistan during the 1980s and early 1990s. The marginal propensity to save out of international remittances was found to be 0.71 compared to the marginal propensity to save out of rental income of just 0.085. He believes that the increased remittance flows were viewed as uncertain in nature, and hence people wanted to save more for the future. If these savings were to be channeled through the banking sector for investment purposes, remittances could potentially have a positive effect on economic growth.

There are several authors who have found positive effects of remittances on growth. Aitymbetov (2006) found that approximately 10 percent of remittances were used as some form of investment in Kyrzastan, and thus had a positive impact on the economy. In a less researched but important topic, investigators have found that remittances are used

to finance investment in micro-enterprises in Mexico. For example, Woodruff (2006) found that there is, in general, a positive relation between investment spending and the growth of micro-enterprises. Woodruff determined that about 5 percent of remittance flows are invested in micro-enterprises and that this could have a significant impact on the long-term growth of these labor-intensive enterprises.

One highly important and recent area of investigation relates to the effect of remittance flows on the poverty rate of recipient countries. Most scholars agree that increased remittance flows help reduce poverty in the recipient countries. Acosta et al. (2006) found a positive effect of remittances on poverty reduction in Latin America. Based on their estimates, a one point increase in remittances as a percentage of GDP generated a reduction in poverty of about 0.3 to 0.4 percent. At the same time, increased remittance flows are also associated with higher economic growth in Latin America. In a related topic, Acosta et al. (2007) estimated the impact of remittances on poverty and inequality in Latin America. They found that remittances have a statistically significant effect on poverty reduction, but the impact on reducing inequality was small. On average, a 1 percentage point increase in the remittances to GDP ratio generates about a 0.37 percent reduction in poverty even though the effects vary across countries. Remittances tend to play a greater role in poverty reduction in households with low income. In Mexico and El Salvador, where most of the migrants are from lower-income level households, increased remittance flows reduced extreme poverty about 35 percent while moderate poverty was reduced by 15 percent.

Another important aspect of the literature on remittances relates to the underlying causes of remittance flows, and this is closely related to the research on the impact of

remittances on the source country. If increased remittance flows are based primarily on pecuniary motives, then remittances act as an investment vehicle and should enhance economic growth. However, if remittance flows are mainly counter-cyclical in nature, and respond to the business cycle back home, then, as reported by Chami et al.(2005), they should have a negative correlation with economic growth.

Finally, there are a several economic, institutional and social factors which have a potential effect on the size of remittance flows. The size of the migrant population, the length of stay away from their home country, the migrants' income and that of family members back home, volatility of exchange rates, the economic freedom of the source country, the transfer costs, and the migrants' motivation to go back. For example, Canas et al. (2007) raise the issue of falling money-transfer costs and the new measurement techniques adopted by the Banco de Mexico as the most important factors in determining the increased remittance flows to this country. They have determined that the size of the Mexican migrant population, income, and their attachment to the home country as being less important in determining the size of the flow. So, remittances have the potential to increase irrespective of the home-country situation if the costs of money transfer decrease. In the future, the cost of transferring funds will continue to fall, and thus remittance flows are likely to increase.

III. Data and Estimation Methodology

In order to assess the impact of remittances on growth, this paper estimates different models, some of which take into account the financial development of the country. For example, some of the models use variables such as domestic credit provided by the

banking sector as a percentage of GDP and the money supply (M2/GDP) as proxies for financial development (see Giuliano et al. 2006)

Most of the data for the Latin American and the Caribbean countries are obtained from the World Bank's World Development Indicators (WDI). Thus, all of the data limitations mentioned in the WDI will also affect the reliability of our estimates. For example, a significant portion of remittances is transferred through unofficial channels, more so in the 1990s than in the 21st century due to the lack of accessible official channels during that period. Many people used to take the money home themselves or send it via someone they knew. Unofficial remittances are not included in our study, and thus will impact the validity of our study. It is extremely difficult to account for the amount of unofficial remittances as there are several channels of transmission. Arbitrary input of unofficial remittances will not be reliable either. So, one way or the other, we are going be affected by the poor data set.

Basically, remittances are comprised of the money sent by the workers and the compensation of employees received by a country. The estimated model utilizes data for 23 countries in the Latin America and Caribbean region during the 1990-2005 period. It excludes countries such as The Bahamas, Cayman Islands, Cuba, Puerto Rico etc. due to lack of remittance flow data. Even for the 23 included countries, not all of them have a continuous data set starting in 1990. Table 1 below presents a list of the countries included in our sample along with data on reported remittance flows as a percentage of GDP in 2005.

Table 1: Remittances as a Percentage of GDP in 2005 for Selected Countries from Latin America and the Caribbean. (Rounded off to 1 decimal point) Source: WDI, World Bank 2007

Country	Remittances
Argentina	0.2
Belize	4.2
Bolivia	3.6
Brazil	0.4
Colombia	2.7
Costa Rica	2.1
Dominican Republic	**9.2**
Ecuador	**5.6**
El Salvador	**16.7**
Guatemala	**9.6**
Guyana	**25.5**
Haiti	**23.1**
Honduras	**21.7**
Jamaica	**18.6**
Mexico	2.8
Nicaragua	**12.2**
Panama	0.8
Paraguay	3.7
Peru	1.8
St. Lucia	0.2
St. Vincent and the Grenadines	1.2
Trinidad and Tobago	0.6
Venezuela, RB	0.1

As can be seen from Table 1, some of these countries received remittances which were as high as 25 percent of GDP. Many countries, including Haiti, El Salvador, Jamaica and Honduras, recorded extremely high levels of remittance flows relative to their GDP. Mundaca (2005) carried out a study similar to the one reported in this paper for selected countries from Central America, Mexico and Dominican Republic. This panel study expands the data set significantly to include 23 countries from the region over a longer time period. More importantly, this study applies the recently developed and methodologically superior panel unit roots and cointegration techniques to estimate the standard models.

Estimation Methodology

Following the lead of Giuliano et al. (2006), we first estimate the model without the interaction of financial development variables. However, in the second model, remittances are allowed to interact with one of the financial development variables. This enables us to determine the impact of remittances on growth through the various financial development variables.

Initially, a basic (panel) OLS model is estimated for 23 countries over the 1990-2005 period for a total of 368 observations, including time-specific and unobserved country-specific fixed variables.

$$Growth_{it} = \alpha_0 + \alpha_1 * Growth_{i,t-1} + \alpha_2 * \mathrm{Re}\,mit\,\tan ces_{it} + \alpha_3 * X_{it} + \mu_t + \eta_i + \upsilon_{it} \qquad (1)$$

Where *Growth* is the change in the log of real per capita GDP in constant dollars, *Remittances* refers to the log of remittances as a percentage of GDP, *X* refers to the control variables, μ is the time-specific effect, η refers to the country-specific fixed effects and finally υ refers to the error term. The control variables are fixed capital

formation, openness [(X + M)/GDP], the money supply (M2/ GDP) or credit provided by the banking sector, and labor force. Initially, the model is estimated without any variables that proxy for the financial development of a country.

Next, financial development variables are included to determine if there is any relation between financial development and the impact of remittances on growth. The sign of the coefficient of the interaction term is important, given that a negative sign would imply that remittances and financial development act as substitutes.

$$Growth_{it} = \alpha_0 + \alpha_1 * Growth_{i,t-1} + \alpha_2 * \mathrm{Re}mit\tan ces_{it} + \alpha_3 * Financialdev_{it} + \alpha_4 * (\mathrm{Re}mit\tan ces_{it}.Financialdev_{it}) + \alpha_5 * X_{it} + \mu_t + \eta_i + \upsilon_{it} \quad (2)$$

The OLS estimates (available upon request) are not reliable because they suffer from several problems not addressed in the extant literature. For example, most of the macroeconomic variables employed in these studies are likely to exhibit either stochastic and/or deterministic time trends and are therefore non-stationary; thus, the reported estimates are likely be spurious in nature (see Engle and Granger, 1987). It is therefore highly important to test for the presence of unit roots (non-stationarity) the variables in the model.

This study uses several panel unit root testing methodologies to determine the order of integration of these variables. If the order of integration is zero, the series is considered to be stationary and thus free from a unit root. Traditionally, DF (Dickey-Fuller) or ADF (Augmented Dickey Fuller) tests have been used to test for the presence of unit roots in univariate time series data. However, these tests suffer from low power in rejecting the null of a non-stationary series as well as limiting distributions which are complicated and not well-defined. In order to avoid these problems, this study uses the more reliable and well-behaved panel unit root tests such as those developed by Levin, Lin and Chu (LLC,

2002), Im, Pesaran and Shin (IPS, 2003) and Hadri (HD, 2000). The aforementioned investigators have shown that panel unit root tests are more powerful (less likely to commit a Type II error) than unit root tests applied to individual series because the information in the time series is enhanced by that contained in the cross-section data. Moreover, in contrast to individual unit root tests which have complicated limiting distributions, panel unit root tests lead to statistics with a normal distribution in the limit (see Baltagi, 2000). The LLC and IPS are based on ADF principles, while HD is based on KPSS. The former two tests are based on the null of a unit root, while the Hadri test assumes the null of stationarity against the alternative of non-stationarity of the series.

The IPS (2003) test allows for heterogeneity across different panel members. Thus, there are different sets of ADF regressions for each panel member which can be specified as follows:

$$\Delta y_{i,t} = \alpha_i + \beta_i\, y_{i,t-1} + \sum^{p^i}_{j=1} \rho_{i,j}\, \Delta y_{i,t-j} + \varepsilon_{i,t}, \qquad (3)$$

where i=1,…,N and t=1,…,T

The error terms are assumed to be independently and normally distributed with zero means and potentially finite heterogenous variances for all countries and years, while the lag order (ρ) as well as β_i' s are allowed to vary across countries. A simple average of the individual countries is taken to calculate the t-statistics. The null hypothesis in this case is:

H0: $\beta_i = 0$ for all i's against the alternatives:

H1: $\beta_i = 0$ for some i's OR $\beta_i < 0$ for at least one i.

Hence, the IPS-test enables investigators to have two different alternative hypotheses allowing β_i to vary across groups, and thus allowing some series (not all) to exhibit unit

roots. Under the null hypothesis, all the series are assumed to be non-stationary processes. IPS differs from LLC because all the series in the alternative hypothesis are stationary processes in LLC, while in IPS some series can still be non-stationary in the alternative hypothesis.

If the presence of a unit root is detected in the variables, then it is necessary to check for the presence of a cointegrating relationship among the variables. If two variables are integrated of the same order, and if there is a long-run relationship between the variables, an estimation of such a relationship will give us errors which are stationary. To determine if such a long-run relationship exists, panel cointegration techniques generated by Pedroni (1999) are utilized. Pedroni develops seven different statistics to test for panel cointegration and they are based on either a within-dimension or between-dimension statistics. Within-dimension based statistics are referred to as panel cointegration statistics, while between-dimension based statistics are termed as group mean cointegration statistics. Pedroni extends the two-step residual-based strategy of Engle and Granger (1987) to develop these panel cointegration tests. These tests are based on the null of no cointegration and work with the assumption of heterogenous panels. All of the seven tests are based on the following panel regression:

$$y_{i,t}=\alpha_i + \beta_1 X_{1,i,t} + \beta_2 X_{2,i,t} + \ldots.. + \beta_n X_{n,i,t} + \mu_{i,t} \quad , \qquad (4)$$

where Xi,t are the regressors for n cross sections. Time effects and fixed effects can be included as needed in the estimated regressions. Next, a regression of the following form is performed on the residuals from equation (4):

$$\mu_{i,t} = \rho_i \, \mu_{i,t-1} + \nu_{i,t} \qquad (5)$$

where μi,t refers to the actual residuals from the previous regression.

Based on this estimation, seven different statistics are calculated. Panel-v, panel-rho, panel non-parametric-t and panel parametric-t are based on the within dimension, while group-rho, group non-parametric-t and group parametric-t are based on the between dimension of the panel. In the within-dimension framework, the null of no cointegration is given as

H0: $\rho i = 1$ for all i,

against the alternative of H1: $\rho i = \rho < 1$ for all i. On the other hand, in the between-dimension framework, the null of no cointegration is measured against the alternative hypothesis of H1: $\rho i < 1$ for at least one i. Thus, the between-dimension test is less restrictive and allows for heterogeneity across members. In the case of the within-dimension test, a common value for all cross sections is imposed, i.e., $\rho i = \rho$.

Once cointegration has been established among (between) the relevant variables, the model is estimated utilizing the fully modified ordinary least squares (FMOLS) technique first proposed by Pedroni (1996, 2000). According to Pedroni (2000), standard OLS estimation of a panel will lead to an asymptotically biased estimator because the estimates will be dependent on the nuisance parameters that are associated with the dynamics of the underlying system. He argues that only in the case of exogeneity of the regressors and homogenous dynamics across the individual members of the panel, is it possible for the OLS estimator to be unbiased.

The superior FMOLS estimator is able to account for both serial correlation and potential endogeneity problems, and hence is preferable to simple OLS estimation. One of the advantages of using FMOLS techniques is that it allows for the country-specific fixed effects to be heterogenous while estimating the long-run relationships (Pedroni,

2000). Pedroni (2000) also contends that t-statistics for group mean panel FMOLS offers more flexible alternative hypothesis than pooled panel FMOLS because the former are based on the between-dimension as opposed to within-dimension of the panel; thus it estimates the cointegrating vectors for a common value under the null hypothesis, while under the alternate hypothesis the values for the cointegrating vectors are allowed to vary across groups. This is of special importance in the context of Pesaran and Smith's (1995) finding that under heterogenous cointegrating vectors across different countries, group mean estimators give consistent estimates of the sample mean of cointegrating vectors while pooled within dimension estimators fail to do so.

Hence, we will look at the FMOLS estimator which is based on the estimation of the following cointegrated panel:

$$y_{i,t} = \alpha_i + \beta x_{i,t} + \mu_{i,t} \text{ and,} \qquad (6)$$

$$x_{i,t} = x_{i,t-1} + \nu_{i,t}$$

where, α_i allows for the country specific fixed effects, β is a cointegrating vector if yi,t is integrated of order 1. At the same time, the vector error process $\varepsilon_{i,t} = (\mu_{i,t}, \nu_{i,t})$ is a stationary process. Pedroni (2000) shows that the group-mean FMOLS estimator is consistent and that the test statistic performs reasonably well even in small samples as long as the time period under consideration is not smaller than the number of cross sections, and this is clearly the case in this study.

IV. Estimation Results

The analysis begins with an examination of the integration properties of the variables included in the model. As indicated earlier, two different sets of data are analyzed based on the income level of the countries in our sample. One set of estimations

deals with the presence of unit roots and cointegration in the upper level income data set, while the other assesses the existence of unit roots and cointegration in the lower income level data set. Subsequently, two long-run models are estimated to determine the impact of remittances on growth in selected Latin American and Caribbean countries. Table 1 below reports panel unit roots test estimates for upper income level countries.

Table 1: Panel Unit Roots Test Results for Upper Income Level Countries (Levels)

	LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square	Hadri
Growth	-6.94*	-6.46*	76.1*	57.3*	1.81**
Remittances	-5.75*	-3.98*	54.04*	76.12*	7.23*
Capital	-4.50*	-3.36*	43.84*	39.66*	1.33***
Labor	0.23	2.53	18.99	27.49	7.94*
Openness	-1.06	0.55	13.18	13.21	7.30*
Money Supply	-3.59*	-0.62	33.93**	46.04*	7.23*
Credit	-1.50***	0.31	23.23	13.44	7.35*
Remittances*Credit	-5.58*	-3.46*	51.56*	70.53*	7.32*

Note: All the variables are specified in natural logs. The level models have been specified with individual effects. *, ** and *** mean the rejection of null hypothesis of non-stationarity at 1% , 5%, and 10% level respectively except for Hadri test in which *, ** and *** represent the rejection of stationarity at 1%, 5%, and 10% level respectively.

As can be readily seen from the table, most of the variables do not exhibit unit roots in level form except for labor, openness and credit. Growth, remittances, capital, and the money supply are clearly stationary. In the above table, the tests for panel unit roots were specified with individual effects only. However, if the tests are performed

with individual effects and individual linear trends, then the results are different for some of the variables. These results are not reported in the table above but are discussed below.

For example, the Breitung t-stat suggests that remittances as a percentage of GDP in level form exhibit a unit root even though most of the other tests seem to reject the null of non-stationarity. The Breitung t-stat has a test statistic of -0.36 with a probability of 0.36 for the null of a unit root. Similarly, in the case of capital, the IPS and ADF-Fisher Chi-square fail to reject the null of unit roots at 5% and 10% levels, respectively, while the PP-Fisher Chi-square fails to reject the null of a unit root at the 1% level when the model is estimated with both individual effects and linear trends.

All of the above tests show that the money supply (M2/GDP) exhibits a unit root when using individual effects and individual linear trends in the model. The Breitung t-stat also favors unit roots in levels at the 10% level. The results based on the Hadri test indicate that all of the variables are non-stationary. This might be due to the fact that, in the presence of autocorrelation, this test generates over-rejection of the null hypothesis of stationarity. Even though panel unit root tests are much more powerful compared to unit root tests for individual time series, it is still important to interpret these results with caution. Often, these tests reject the null when it should not be rejected or fail to reject the null when in fact it should be rejected.

Table 2 below performs these tests on the relevant variables in first differences.

Table 2: Panel Unit Roots Test Results for Upper Income Level Countries (First Differences)

	LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square	Hadri
Growth	-9.71*	-8.30*	97.59*	141.14*	3.71*
Remittances	-18.12*	-10.40*	90.42*	95.53*	1.59***
Capital	-8.71*	-7.21*	84.80*	114.50*	2.58*
Labor	-6.57*	-5.08*	60.32*	61.38*	4.34*
Openness	-7.22*	-6.27*	73.04*	74.11*	-0.19
Money Supply	-6.80*	-4.48*	54.60*	65.35*	1.88**
Credit	-7.52*	-7.14*	82.44*	101.41*	-0.13
Remittances*Credit	-16.84*	-10.06*	94.82*	100.54*	2.39*

Note: The models have been specified with individual effects. *, ** and *** mean the rejection of null hypothesis of non-stationarity at 1% , 5%, and 10% level respectively except for Hadri test in which *, ** and *** represent the rejection of stationarity at 1%, 5%, and 10% level respectively.

All the tests show that the variables are stationary in first differences except for the Hadri test which still rejects the null of stationarity in most cases. However, based on most of the other tests, it is reasonable to assume that these variables are integrated of order zero in first differences. It is interesting to note that all the tests, except for the Hadri test, reject the null of non-stationarity at the 1% level of significance. Again, in the presence of high serial correlation, there is a size distortion in the Hadri test and this may be the reason for over-rejection of the null of stationarity.

Table 3 below presents the integration properties of the variables in the lower income data set.

Table 3: Panel Unit Roots Test Results for Lower Income Level Countries (Levels)

	LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square	Hadri
Growth	-6.88*	-4.67*	67.69*	65.57*	2.58*
Remittances	-1.52**	1.03	26.30	34.13	8.87*
Capital	-3.57*	-2.75*	47.31*	30.40	4.72*
Labor	4.35	4.67	20.45	24.89	9.26*
Openness	-0.16	-0.43	34.12	27.81	4.15*
Money Supply	-4.54*	-1.96**	53.77*	33.15	7.36*
Credit	-7.19*	-4.02*	61.02*	52.43*	4.93*
Remittances*Credit	-4.82*	0.13	37.47***	36.14***	8.64*

Note: The models have been specified with individual effects. *, ** and *** mean the rejection of null hypothesis of non-stationarity at 1% , 5%, and 10% level respectively except for Hadri test in which *, ** and *** represent the rejection of stationarity at 1%, 5%, and 10% level respectively.

Again, the estimates from the different tests are mixed. Remittances as a percentage of GDP, labor, and openness seem to exhibit unit roots. The Hadri test rejects the null of stationarity for all the variables in level form. These results are based on the models specified with individual effects only. The models were also estimated with both individual effects and individual linear trends and, in view of space limitations, the results are not reported in the table but are discussed below.

The Breitung t-stat ,IPS, and ADF-Fisher Chi-square tests all indicate that the M2/GDP variable in level form exhibits a unit roots when both individual effects and

individual linear trends are included. Similarly, the aforementioned tests show that the domestic credit/GDP variable exhibits a unit root when estimated with both individual effects and individual linear trends. However, the LLC test rejects the null of a unit root in these circumstances as well.

Table 4 below presents the unit root tests for the relevant variables in first differences.

Table 4: Panel Unit Roots Test Results for Lower Income Level Countries (First Differences)

	LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square	Hadri
Growth	-17.65*	-13.86*	171.75*	222.70*	0.32
Remittances	-9.48*	-7.76*	102.77*	116.35*	2.29**
Capital	-9.33*	-7.73*	102.84*	105.63*	-0.78
Labor	-6.24*	-5.75*	85.31*	85.17*	1.35***
Openness	-10.60*	-10.17*	130.50*	144.48*	0.39
Money Supply	-4.82*	-5.10*	72.51*	105.78*	2.82*
Credit	-10.79*	-7.67*	105.34*	108.16*	2.64*
Remittances*Credit	-9.33*	-7.82*	102.64*	124.65*	3.09*

Note: The models have been specified with individual effects. *, ** and *** mean the rejection of null hypothesis of non-stationarity at 1% , 5%, and 10% level respectively except for Hadri test in which *, ** and *** represent the rejection of stationarity at 1%, 5%, and 10% level respectively.

All the tests, except again for the Hadri test, show that the relevant variables are stationary in first differences, mostly at the 1% level of significance. The Hadri test rejects the null of stationarity for some of the variables despite the fact that most of the

other tests show the opposite. As we discussed earlier, this might again be due to severe size distortion associated with autocorrelation.

Panel Cointegration Analysis

Even though it is well-known in the literature that it is not possible for two series integrated of different orders to form a cointegrated series, it is less well-recognized that it is possible for *more* than two series integrated of different orders to combine to form a cointegrated series of lower order of integration. More precisely, if $x_t \sim I(1)$ and $y_t \sim I(0)$, then x_t and y_t cannot be cointegrated. However, if $x_t \sim I(2)$, $z_t \sim I(2)$ and $y_t \sim I(1)$, then x_t and z_t can cointegrate to form an I(1) series which can then cointegrate with y_t to give a I(0) series (see Pagan and Wickens, 1989). Harris (1995) indicates that there can be up to n-1 linearly independent cointegrating vectors, where n is the number of variables. Hence, even if some of our tests for the order of integration are inconclusive, it is still possible to find multiple cointegrating vectors which can then form a linear combination (cointegrate) to generate an I(0) series. In the estimations below we use both GDP per capita in levels as well as in first differences to estimate possible cointegrating relationships.

Furthermore, given that the inclusion of a lagged dependent variable increases the bias towards finding a cointegrating relationship, it is not included when testing for a cointegrating relationship among the variables in our growth equation. This study uses either the M2/GDP variable or domestic credit provided by the private sector (as a percent of GDP) to proxy for financial development. Hence, there are two different set of statistics based on whether M2 or domestic credit provided by the private sector is used

to proxy for the financial development of a country. We begin with Pedroni's cointegration test for the upper income data set.

As indicated above, it is possible for variables of different orders of integration to combine to form a cointegrating relationship as long as there are multiple cointegrating vectors. Table 5 below presents Pedroni's test for potential cointegrating relationships among the following variables: change in the log of per capita GDP, remittances as a percentage of GDP, and other control variables. Again, the lagged dependent variable is not included in the test in order to avoid the bias towards finding a cointegrating relationship.

Table 5: Pedroni's Cointegration Test Results for Upper Income Level Countries (with Growth in Per Capita GDP as dependent variable)

	Panel Statistics			Group Statistics		
Models including	No financial Dev. Variable	Credit	Money Supply	No financial Dev. Variable	Credit	Money Supply
Variance ratio	-2.70**	-2.25**	-3.35*			
Rho statistic	3.23*	4.95*	4.45*	4.29*	5.63*	5.41*
PP statistic	-9.52*	-12.23*	-9.88*	-10.12*	-15.36*	-14.57*
ADF statistic	-3.17*	-0.54	-3.27*	-4.14*	-0.50	-2.12**

Note: The models have been specified with deterministic intercept and trend. *, ** and *** mean the rejection of null hypothesis of no cointegration at 1% , 5%, and 10% level respectively.

From the above estimates, it is evident that there is a strong cointegrating relationship among the variables when the dependent variable is growth. The cointegrating relationship was also estimated with per capita GDP in level form, but the results show

that the cointegrating relationship is more pronounced when growth is used as a dependent variable. The estimates reported in Table 5 show that, despite the presence of different orders of integration in the included variables, it is nevertheless possible to find a stable long-term cointegrating relationship among them.

We also performed Kao's Residual Cointegration test and found a strong cointegrating relationship among the variables irrespective of whether a financial development variable was used or not. In both cases, Kao's test rejected the null of no cointegration at the 1% level of significance.

Table 6 below reports the panel cointegration estimates for the lower income dataset.

Table 6: Pedroni's Cointegration Test Results for Lower Income Level Countries (with Growth as the dependent variable)

	Panel Statistics			Group Statistics		
Models including	No Financial Dev. Variable	Credit	Money Supply	No Financial Dev. Variable	Credit	Money Supply
Variance ratio	-3.40*	-4.10*	-4.83*			
Rho statistic	3.00*	4.44*	4.40*	4.23*	5.70*	5.93*
PP statistic	-8.12*	-22.85*	-18.84*	-9.47*	-25.70*	-24.93*
ADF statistic	-2.29**	-5.27*	-4.60*	-1.80***	-3.08*	-4.50*

Note: The models have been specified with deterministic intercept and trend. *, ** and *** mean the rejection of null hypothesis of no cointegration at 1% , 5%, and 10% level respectively.

All of the reported statistics suggest the presence of a strong cointegrating relationship among the variables in the model. As can be readily seen, most of the statistics are significant at the 1% level. Moreover, Kao's test also suggests that there is a strong cointegrating relationship among these variables. In both cases, Kao's test statistic is significant at the 1% level. Cointegration tests were also performed using per capita GDP in level form, but there was a stronger cointegrating relationship among the variables when growth in per capita GDP was used as the dependent variable.

FMOLS Estimation.

Having established that there is a linear combination that keeps the pooled variables in proportion to one another in the long run, the paper proceeds to estimate a long-run growth equation in order to assess the impact of remittances. Initially, the model was estimated via OLS but the results were not reliable as they suffer from several problems, including positive serial correlation and endogeneity. Tables 7 and 8 below report the estimates generated using the Fully Modified OLS (FMOLS) estimator for the lower and upper income countries, respectively. The FMOLS estimator, as opposed to the OLS estimator, corrects for both serial correlation and potential endogeneity.

Two models are estimated for the lower income region. One of the estimations includes domestic credit provided by the banking sector to proxy for financial depth and an interaction term between remittances and the financial development variable. The other model was estimated with the M2/GDP variable as a proxy for financial depth, but the estimates were contrary to those reported in the literature. The M2/GDP variable may not be a good proxy for financial depth because M2 can increase significantly during periods of high inflation without any relation to economic growth. Thus, it is more likely

that increases in M2 as a percentage of GDP represent greater financial depth if there is a relatively stable macroeconomic environment. Unfortunately, this was not the case for many countries in the Latin American region which were suffering from high rates of inflation during the period under review. In view of this, we report results from the models in which domestic credit provided by the banking sector as a percentage of GDP is used as a proxy for financial depth.

Table 7: Dependent Variable: Growth in GDP per capita Income (Lower Income Group)

Variable	Without Financial Dev. Variable		With Financial Dev. Variable	
	Coefficient	t-stat	Coefficient	t-stat
Growth(-1)	-0.69	-11.01	-0.56	-16.93
Remittances(-1)	0.01	1.80	0.05	6.31
Capital	0.07	6.65	0.02	8.76
Openness	-0.11	-5.13	0.07	-1.20
Labor	0.53	4.56	0.17	8.32
Credit			0.04	-4.74
Remittances*Credit			-0.01	-3.94

Note: All the variables are as specified in the variables section and are expressed in natural logs. The models include common time dummies.

Table 7 shows that remittance flows have a positive and significant impact on economic growth in both models. However, the impact is more pronounced when the financial development variable is included. The sign of the coefficient of the interaction term (remittances*domestic credit) is negative implying that remittances can act as a

substitute for the financial sector variable. This result is consistent with the previous results found by Giuliano et al. in 2006.

In addition, the signs of the coefficients for capital and labor are as expected and the variables are statistically significant. The openness coefficient is not significant when the financial development variable is included, but it is significantly negative when domestic credit provided by the banking sector is excluded from the model. It is not surprising to find a negative coefficient for openness in less developed Latin American countries because they might be importing a lot of consumer goods and/or exporting primary goods which are notoriously volatile in their behavior over time. The lagged dependent variable has a negative and statistically significant coefficient. There might be several factors in play here, including expectations. Expectations can be positive or negative depending upon several other macroeconomic variables. If there is pessimism about the future state of the economy, then the future growth rates are likely to decrease. If, on the other hand, economic agents are optimistic about the future of the economy, then future growth rates are likely to increase. If the economy is not performing well, people might expect the economy to get better. If the economy is growing at a high rate of growth, they might expect the economy to slow down in the future.

Turning now to the estimates for the upper income countries of Latin America displayed in Table 8 below:

Table 8: Dependent Variable: Growth in GDP per Capita Income (Upper Income Group)

Variable	Without Financial Dev. Variable		With Financial Dev. Variable	
	Coefficient	t-stat	Coefficient	t-stat
Growth(-1)	-0.48	-10.80	-0.62	-17.58
Remittances(-1)	0.09	11.94	0.14	20.16
Capital	0.11	5.97	0.08	2.70
Openness	0.31	11.57	0.34	16.97
Labor	0.05	0.56	0.55	23.77
Credit			-0.29	-18.20
Remittances*Credit			-0.03	-23.69

Note: All the variables are as specified in the variables section and are expressed in natural logs.

In this case, it can be readily observed that there is an even greater impact of remittances on the growth rate of GDP per capita. Both models have statistically significant coefficients, but the impact of remittances is higher when domestic credit was used to proxy for the financial development of the country. The coefficient of the interaction term (Remittances*Credit) is negative implying that remittances and domestic credit provided by the banking sector act like substitutes. However, the coefficient of the financial development variable is negative and significant. This is an unexpected result but can be explained by the financial turmoil some of these Latin American countries went through during part of the period under consideration in this study. For instance, Argentina went into deep recession in the late 20th century which lasted until 2002-03, but the domestic credit provided by the banking sector as a percent of GDP was continuously going up. Moreover, financial depth as measured by the domestic credit provided by the banking sector in the upper income countries was higher compared to the lower income countries.

So, there might have been more imprudent lending in the upper income countries for the period under review. If the financial sector is inefficient, then higher lending does not necessarily help promote the growth process. Moreover, it is important to note that the results for individual countries might be different given that the reported estimates represent the overall effect of domestic credit on growth in the upper income group.

In sharp contrast to the lower income group, openness has a positive and significant impact on the growth rate of per capita GDP in the upper income group. This is reasonable because these countries are more developed and are in a better position to exploit the opportunities associated with international trade. The signs of the coefficient for capital and the lagged dependent variable are as expected and are statistically significant in both models. The coefficient for labor is positive and significant when the financial development variable is included in the model. Overall, our reported estimates are consistent with those in the existing literature, but are more reliable in view of both the enhanced data set and the superior estimation methodology employed.

V. *Conclusion*

Using recently developed panel unit root and panel cointegration tests and the FMOLS methodology, this paper estimates the impact of remittance flows on the economic growth of selected Latin American & Caribbean countries. The estimation methodology controls for potential endogeneity and serial correlation. Since most of the time series data are integrated of order one and are likely to exhibit unit roots, this paper examined the integration properties of the variables as well as potential cointegrating relationships. The estimates suggest that some of the variables are integrated of order one while others are not. Even though some of the variables are already stationary in level

form, Pedroni's test suggests that there exists a cointegrating relationship among the variables in our model.

The estimated models for upper income and lower income groups suggest that remittances have positive and significant impact on per capita GDP growth in selected Latin American & Caribbean countries. The reported estimates corroborate those obtained by Giuliano et al. (IMF, 2006) which suggest that remittances can act as substitutes for financial markets. In the case of the lower income group, both domestic credit provided by the banking sector and remittances have a positive and significant effect on per capita GDP growth. In the upper income group, domestic credit provided by the banking sector has a negative impact on growth while remittances have a positive and significant impact on growth. Remittances and domestic credit provided by the banking sector act like substitutes, but remittances might be more efficient and hence have a positive effect. All of these results suggest that remittances are able to alleviate credit constraints faced by economic agents in these countries.

Another interesting result reported in this study is that the economic impact of remittances is higher in the upper income group than in the lower income group. However, these results have to be reviewed carefully. For example, Giuliano et al. (2006) found a negative impact of remittances at high levels of financial development, while Chami et al. (2005) found a negative effect of remittances on economic growth without considering the degree of financial development. Our sample suggests that the higher income group has greater financial depth in general. Even though our results are somewhat surprising, they are not totally unexpected. The countries under consideration in our study are all developing countries, whether they belong to the upper income group

or the lower income group. The differential impact of remittances might be due to the fact that most of the remittances are spent on consumption in lower income countries, while the households in the upper income countries have more opportunities to invest them profitably.

This study explored only one conduit through which remittances can affect economic growth. There are several other channels, including the level of education and the degree of economic freedom, through which increased remittance flows can positively affect economic growth. For instance, remittances can boost economic growth if they are used to defray expenses associated with increased levels of primary and secondary education. Increased remittance flows are also more likely to be invested, and thus promote economic growth, if the countries in question promote the protection of private property and the freedom of exchange. As more reliable data becomes available, we suggest that future studies control for these economic and institutional variables.

Overall, the reported estimates suggest that remittance flows have a positive and significant impact on economic growth in the selected Latin American and Caribbean countries during the 1990-2005 period, and that the effect of remittances is more pronounced once the interaction of remittances with the financial development of the countries in question is taken into account.

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Appendix

Table 1: Pedroni's Cointegration Test Results for the Upper Income Level Countries (with Per Capita GDP as dependent variable)

	Panel Statistics			Group Statistics		
Models including	No financial Dev. Variable	Credit	Money Supply	No financial Dev. Variable	Credit	Money Supply
Variance ratio	2.11**	-0.36	0.34			
Rho statistic	3.81*	5.11*	5.59*	5.02*	6.30*	6.27*
PP statistic	1.14	-0.57	0.80	-4.89*	-4.36*	-4.74*
ADF statistic	2.41**	4.50*	1.89***	1.11	2.16**	1.63

Note: The models have been specified with deterministic intercept and trend. *, ** and *** mean the rejection of null hypothesis of no cointegration at 1% , 5%, and 10% level respectively.

Table 2: Pedroni's Cointegration Test Results for the Lower Income Level Countries (with Per Capita GDP as dependent variable)

	Panel Statistics			Group Statistics		
Models including	No financial Dev. Variable	Credit	Money Supply	No financial Dev. Variable	Credit	Money Supply
Variance ratio	-0.20	-2.10**	-1.08			
Rho statistic	3.08*	4.48*	4.49*	4.73*	6.01*	6.13*
PP statistic	-1.83***	-3.18*	-3.09*	-2.68**	-11.16*	-11.73*
ADF statistic	2.10**	3.08*	3.32*	0.86	1.28	1.47

Note: The models have been specified with deterministic intercept and trend. *, ** and *** mean the rejection of null hypothesis of no cointegration at 1% , 5%, and 10% level respectively.