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Remittances, Human Capital, and Economic Growth: Panel Data Evidence from Asia and Sub-Saharan Africa[1]

Chakra Pani Acharya[1] and Roberto Leon-Gonzalez[2]

[1] *National Planning Commission, Kathmandu, Nepal, E-mail: acpani2003@gmail.com/ cpacharya@npc.gov.np*
[2] *National Graduate Institute for Policy Studies, Tokyo, Japan E-mail: rlg@grips.ac.jp*

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Abstract: We examine the impact of remittances on economic growth using panel data (1975-2014) for 18 countries in Asia and Sub-Saharan Africa (SSA) that are similar in size and development level. We allow for heterogeneous production functions across countries and calculate the average marginal effects of remittances using the panel dynamic ordinary least squares estimator. The estimation results show that remittances increase growth significantly, especially through investments in human capital. In addition we find that: (i) remittances have a modest impact on growth when controlling for physical and human capital channels through which remittances potentially affect output growth; (ii) when we do not control for human capital the effect is larger regardless of the sub-samples considered " the elasticity of output with respect to remittances is 7.3 percent in the full sample, and 18.6 percent among Asian countries; (iii) remittances have a significant positive long-run effect on human capital formation regardless of the sub-samples considered but the effect on physical capital accumulation is significant only among middle income and Asian countries. The findings suggest that channeling the remittances towards investments in physical capital and adoption of new knowledge, skills and technology is crucial for high economic growth in low income countries.

Keywords: Economic growth; human capital; international remittances

JEL Codes: C24, O15

1. Introduction

In recent decades, remittances have emerged as a main and stable source of international financial resources in developing countries (World Bank, 2017). However, whether remittances work as a source of development finance for saving, investment, employment, education, health, poverty reduction, and economic growth in the developing world is highly contested. Since Stark and Bloom's (1985) seminal work, an extensive body of literature evolved on this issue (see Adams (2011) for review of recent household surveys).

Previous studies on the growth effect of remittances show mixed results. On the one hand, several studies show a positive growth effect conditional on ancillary variables such as financial development, human capital, and the institutional quality of a country (Catrinescu, Leon-Ledesma, Piracha, & Quillin, 2009). On the other hand, few studies conclude that remittances have negative effects on growth (Chami, Fullenkamp & Jahjah, 2003) or no effect

(Spatafora, 2005). The mixed findings may possibly be due to the estimation approaches and assumptions; for example, homogeneity of parameters among stark heterogeneous countries.[2] In addition, to our best knowledge, previous studies rarely explore the long-run effect of remittances on physical and human capital accumulation at macro level (Ngoma & Ismail, 2013). Surprisingly, some studies control schooling and investment in the regression models, the channels through which remittances possibly do impact economic growth, and conclude that remittances have an adverse growth effect (e.g., Nwaogu & Ryan, 2015).

In this context, we re-examine the issue by (i) considering a panel of similar countries, (ii) estimating production functions accounting for the effect of remittances possibly through total factor productivity and physical and human capital, (iii) adopting an advanced econometric methodology to relax the assumption of homogeneity among parameters across countries and the exogeneity of remittances, and (iv) estimating the long-run effects of remittances on physical and human capital investment. We include countries from Asia and Sub-Saharan Africa (SSA) that have moderate population size and area with low income (below US$ 1,000 constant 2010) in the early 1970s, or at least dropped to this threshold level during the 1970s, 1980s, or early 1990s. We investigate data availability and include only 18 sample countries for 1975-2014 in our study. Methodologically, we estimate separate production functions for each country with capital, labor, and other factors that affect total factor productivity (TFP). Unlike previous works that either assume the exogeneity of remittances or use instruments to account for endogeneity, we relax the assumption of the exogeneity of remittances while allowing for heterogeneity in the log-run parameters across countries, using the less restrictive panel dynamic ordinary least squares (DOLS) estimator (Stock & Watson, 1993).

We find a positive and significant effect of remittances on per capita GDP, even after controlling for physical and human capital in the model. The results are robust, but vary by sub-group categorized on low and middle income, and Asian and SSA countries. We find larger growth effects for middle income countries compared to low income countries, and for Asian countries compared to those in SSA. The effect becomes large when we allow for the effects of remittances on growth through the human capital channel. We also confirm the positive and significant long-run effect of remittances on human capital investment, regardless of sub-sample. However, the effect on physical capital accumulation is significant only among middle income or Asian countries. Similarly, foreign direct investment (FDI) has a positive and larger effect on growth than remittances and investment and human capital do. Meanwhile, we find no growth effects of foreign aid in the sample countries.

The rest of the paper proceeds as follows. Section 2 reviews the existing literature on remittances and economic growth. Section 3 describes the data and econometric model. Section 4 presents the results, discussion, and robustness checks. Section 5 concludes the paper with policy implications.

2. Literature Review

Theories and models on economic growth depict different channels or sources that affect economic growth (Acemoglu, 2008). We thus assume that international remittances affect economic growth through three different sources. First, remittances may contribute to physical capital accumulation, a proximate causes of growth, by relaxing credit constraints and fostering investment, for instance, on productive assets such as household assets, equipment, housing, and establishment of enterprises.[3] On the one hand, when a significant portion of remittances are used for so-called non-productive goods such as jewelry, land, and so on, it may create short-run aggregate demand and a short-run growth effect, but may slow long-run growth due to the failure to contribute to saving and investment. On the other hand, remittances, as a main source of income for several poor households of LDCs, may help boost basic food consumption in these households, leading to significant poverty reduction (Acharya & Leon-Gonzalez, 2013),but it may not necessarily increase investment.

Second, remittances combined with international migration may contribute to long-run growth through human capital investment. Migration may have a "brain effect" and "drain effect" on growth through human capital (Beine, Docquier & Rapoport, 2001). Remittances may have an 'income effect' on the both the quality and quantity of children's education, such as increased school enrollment, decreased dropouts, and enhanced transfer from public to private schools through financing the direct and opportunity costs of schooling. However, the magnitude may depend on the severity of credit constraints (Acharya & Leon-Gonzalez, 2014; Calero, Bedi & Sparrow, 2009) and the local environment (Alcaraz, Chiquiar & Salcedo, 2012). Meanwhile, international migration may increase the importance and returns on schooling among migrants from information-constrained households, thus leading to higher investment in children's education (Acharya & Leon-Gonzalez, 2014).

Third, remittances may affect growth through TFP, although the direction of the effect is not clear priori. It may enhance the economy's productivity through the acquisition and adoption of new knowledge, skills, and technology from a worldwide Diaspora financed through remittances.[4] In addition, remittances may enhance labor productivity in labor abundant countries that receive sufficiently large remittances, which work as a source that converts labor into capital (e.g., Mamun, Sohag, Samarg & Yasmeen, 2015 for cross-country panel work; and Mamun, Sohag, Uddin, & Shahbaz, 2016 for a case of Bangladesh). In contrast, remittances may adversely affect growth by degrading the economy's competitiveness and the effectiveness of government institutions. Increased demand for consumption may increase inflation, thus leading to an appreciation of the real effective exchange rate and decrease production in the tradable sector—the Dutch Disease syndrome (Lartey, Mandelman, & Acosta, 2008; Sapkota, 2013). Meanwhile, remittances may

create distortions in labor markets such as a decrease in participation particularly among non-migrant members of recipient households (see Bayangos & Jansen, 2011, for the Philippines). In addition, some scholars find that remittances may weaken the quality and effectiveness of government, for instance, by prolonging the duration of the government by funding patronage (Ahmed, 2012).

Empirical researches find a mixed growth effect of remittances. Several studies show positive effects of remittances (see Cooray, 2012; Imai, et al., 2014; Siddique, Selvanathan & Selvanathan, 2012). However, the sign and magnitude of the effects may depend on other ancillary factors such as institutions, financial development, human capital, and so on. For instance, Catrinescu *et al.* (2009) show that remittances have no robust positive growth effect while they do not control the institutions in their model examining 162 countries (1970-2003), but find positive and larger growth effects while interacting with institution in the model. Giuliano and Ruiz-Arranz (2009) show a positive growth effect of remittances among developing countries with substitutability with financial development for growth, in contrast to a complementarities effect in 25 Latin American and Caribbean (LAC) countries (Mundaca, 2009) and South Asia (Cooray, 2012). In contrast, few studies find an adverse or no effect of remittances on growth (e.g., Singh, Haacker, Lee, & Goff, 2011; Le, 2009). Utilizing the labor-leisure framework, Chami *et al.* (2003) show a negative effect of remittances on growth using panel data of 162 countries (1970-1998). The authors argue that the moral hazard problem among non-migrant members decreases their participation in the labor market, leading to an adverse growth effect. Nwaogu and Ryan (2015) find that remittances have no effect on growth among 87 African and LAC countries during 1970-2009. The results may be biases as the authors use investment in physical capital and schooling as control variables, thus blocking the channels through which remittances may potentially affect growth.

Previous studies on the growth effect of remittances generally adopt similar econometric models (Cooray, 2012, among few exceptions). These works mostly use panel data for a region, a few regions, or developing countries and attempted to identify causality between remittances and GDP per capita growth using panel econometric approaches such as fixed effect, random effect, generalized method of moments (GMM), and instrumental variable estimates. Despite similar methods and data sets, these studies yield contrasting results, possibly due to the assumption of homogeneity among countries, lack of an effective identification strategy to deal with endogeneity of remittances, and over-controlling the channels of growth. To fill this gap, we estimate the long-run growth effect of remittances with country-specific production functions among similar countries, considering the possible endogeneity of remittances, and allowing for the growth effect of remittances through the TFP and physical and human capital investment channels.

3. Data and model specification

Data sources and description

We analyze panel data of similar countries from Asia and SSA. While selecting panel countries, we consider countries of moderate size (measured by population above 10 million and below 200 million) with income below US$ 1000 per capita GDP (at 2010 constant prices) in 1971. We also include countries that had higher than US$ 1000 during the 1970s but fell below during the 1970s or 1980s in the sample. Thus, our sample excludes several small low-income countries such as land-locked or island countries, as well as large countries such as China, India, and Indonesia (which although had low income in 1971, do not meet the population criterion). Meanwhile, most of the sample countries exhibit high ethnic diversity and mostly experienced internal conflict or external invasion since the 1960s. We thus believe that our sample is more homogenous in size and the initial level of development, which provides a ground for validating our estimation and results. However, we did not include some similar countries in the sample due to lack of data on the variables of interest. Hence, we have a panel of 18 countries, split evenly between low and middle income according to the World Bank classification (2017). Due to the availability of remittances data from 1975 (except for few countries), we include data covering 1975-2014 and have an unbalanced panel of 720 observations.

The main source of data is the World Development Indicators (2017) from the World Bank (2017). However, we complement the data using annual data series of human capital from the Penn World Table (Feenstra, Inklaar & Timmer, 2015). Human capital is an index based on the linearly interpolated average years of schooling and returns on primary, secondary, and tertiary level schooling (Barro & Lee, 2013; Caselli, 2005). We use population, GDP, GDP deflator, gross fixed capital formation (GFCF), personal remittances, net FDI, and net official development assistance (ODA) inflows as a measure of foreign aid from WDI. Nominal data are deflated by the GDP deflator and expressed in 2010 US dollars. We compute physical capital stock data series using GFCF. Following Goldsmith (1951), we construct capital stock series using the perpetual inventory method (PIM) as follows:

$$K_{i,t} = I_{i,t} + (1 - \delta)\, K_{i,t-1} \tag{1}$$

where $K_{i,t}$ is the physical capital stock of a country i in year t, δ is the depreciation rate (we assume 5 percent for our sample countries), and $I_{i,t}$ is investment in year t for country i. We measure investment by the flow of the gross investment (GFCF) in the current year. GFCF includes land improvements; plant, machinery, and equipment purchases; and construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Following Abu-Qarn and Abu-Bader (2007), we rearrange equation (1) to get the following equation.

$$\frac{K_t - K_{t-1}}{K_{t-1}} = -\delta + \frac{I_t}{K_{t-1}} \quad \textbf{(2)}$$

We assume that in the long run, the growth rate of capital stock is constant over time and is equal to the real GDP growth rate (g), thus we get

$$K_{t-1} = \frac{I_t}{(g+\delta)} \quad (3)$$

Using equation (3), we calculate the initial capital stock (K_0) for each country.

Remittances include personal transfers in cash or in kind received by resident households from nonresident households and compensation of employees from countries in which they are not resident or of residents employed by nonresident entities. FDI includes direct investment equity, that is, equity capital, reinvestment of earnings, and other capital flows in the economy. Finally, foreign aid is the sum of the disbursement of loans made on concessional terms (net of repayments of principal) and grants from official donors.

Table 1 presents descriptive statistics of the sample countries with average growth rates during 1975—2014. MICs have about a three times higher average real GDP per capita than LICs do and Asian countries have about double per capita GDP than SSA countries do. The ratio of average capital stock to GDP per capita is also higher among MICs than for LICs. Average human capital, per capita remittances, and FDI is also higher in MICs than in LICs and Asian countries than in SSA countries, in contrast to the average per capita foreign aid. The average real growth rate of GDP per capita, capital stock per capita, human capital, per capita remittances, and per capita FDI is higher among MICs and Asian countries than in LICs and SSA countries respectively. In contrast, the population and foreign aid growth rate is higher in LICs than in MICs, and in SSA countries than in Asian ones.

Econometric specification

Following the approach of empirics of the growth literature, we assume that for a set of countries i= 1,2, .., N, over a number of years, t=1,2, ….T, the GDP of each country, Y_{it}, is produced by physical capital, K_{it}, and labor employed, L_{it}, through a standard Cobb-Douglas function as:

$$Y_{i,t} = A_{i,t} K_{i,t}^{\alpha_i} L_{i,t}^{(1-\alpha_i)} \qquad 0 < \alpha_i < 1 \quad (4)$$

where $A_{i,t}$ is the measure of total factor productivity (TFP). We argue that TFP is determined by human capital ($HC_{i,t}$), remittances ($REM_{i,t}$), FDI ($FDI_{i,t}$), and foreign aid($AID_{i,t}$):

$$A_{i,t} = Fi(HC_{i,t}, REM_{i,t}, FDI_{i,t}, AID_{i,t}) \quad (5)$$

Thus, we can express the output per worker, augmented with TFP by substituting $A_{i,t}$ from equation (5) in to equation (4), as:

Table 1: Summary statistics

Country	*Sample mean (1975-2014)*						*Average annual growth (1975-2014)*						
	GDP	*Capital*	*Human capital*	*Remit-tances*	*FDI*	*Foreign aid*	*GDP*	*Popula-tion*	*Capital*	*Human capital*	*Remit-tances*	*FDI*	*Foreign aid*
Bangladesh	502	948	1.6	27.0	2.6	17.6	2.7	2.1	4.1	1.3	12.8	0.5	-0.3
Burkina Faso	408	794	1.1	14.8	2.9	51.3	2.0	2.7	3.2	0.5	0.8	0.7	1.1
Cambodia	582	651	1.5	10.8	37.6	47.5	5.4	1.8	8.2	1.0	13.9	4.1	0.6
Cameroon	1,237	2,341	1.6	4.7	14.5	48.3	0.5	2.8	1.0	1.0	7.7	0.9	-0.3
Ghana	996	1,395	1.9	11.5	30.9	70.5	1.4	2.6	3.1	1.4	16.3	2.3	0.2
Kenya	887	1,447	1.8	14.1	5.3	54.5	0.8	3.1	1.1	1.3	5.3	0.4	0.6
Madagascar	472	615	1.4	4.9	9.7	42.2	-1.3	2.9	1.6	0.8	12.3	0.5	-0.1
Mali	546	846	1.1	21.2	8.4	75.1	1.5	2.5	1.7	0.6	3.7	0.2	-0.1
Mozambique	262	348	1.1	3.5	25.9	55.5	2.8	2.5	7.4	0.2	1.3	3.6	2.7
Nepal	419	711	1.3	69.6	0.7	30.5	2.2	1.9	3.0	1.2	16.9	0.0	1.3
Niger	386	945	1.1	3.7	9.7	50.4	-0.5	3.3	-1.0	0.4	1.8	0.9	-0.6
Pakistan	794	1,101	1.5	39.0	7.6	17.7	2.1	2.6	2.1	0.9	4.3	0.3	-0.8
Rwanda	410	553	1.3	3.5	4.5	70.6	2.1	2.5	5.1	1.1	11.5	0.8	1.1
Senegal	908	1,555	1.3	48.0	11.8	87.5	0.2	2.8	3.2	0.9	6.3	0.6	0.4
Sri Lanka	1,673	3,134	2.6	110.9	18.9	63.6	3.8	1.1	4.9	0.9	13.3	1.3	-0.4
Thailand	3,096	7,508	2.1	35.0	77.7	10.3	4.2	1.2	5.8	1.5	10.8	1.7	-0.1
Uganda	419	552	1.6	22.1	13.7	46.8	2.4	3.3	4.9	1.5	1.6	1.3	1.1
Viet Nam	848	1,931	2.0	68.9	45.3	26.5	4.8	1.6	4.2	1.3	8.5	2.9	2.5
LICs	480	768	1.3	18.2	11.2	56.3	1.5	2.6	3.5	0.8	6.5	1.1	0.7
MICs	1,267	2,536	1.9	37.2	24.8	39.0	2.5	2.1	3.2	1.2	9.9	1.2	0.1
Asia	1,181	2,463	1.8	51.7	26.3	29.5	3.4	1.8	4.4	1.1	11.2	1.3	0.3
SSA	638	1,058	1.4	13.6	12.3	59.6	1.0	2.8	2.8	0.9	6.4	1.1	0.5
All	839	1,571	1.5	26.9	17.5	48.4	1.9	2.4	3.4	1.0	8.1	1.2	0.4

Note: Sample means are in levels and all the variables are in per capita terms (in US$ at constant prices of 2010), except human capital.

$$y_{i,t} = c_i + \alpha_i k_{i,t} + \beta_{1i} h_{i,t} + \beta_{2i} r_{i,t} + \beta_{3i} f_{i,t} + \beta_{4i}\, aid_{i,t} \quad (6)$$

where $y_{i,t}$ is the log real per capita output (GDP), $k_{i,t}$ is the log of per capita physical capital stock, and $h_{i,t}$ is the log of average per capita human capital stock. Similarly, $r_{i,t}$, $f_{i,t}$, and $aid_{i,t}$ are the log of per capita remittances, FDI, and foreign aid, respectively.[5]

Empirically, we use a DOLS specification (equation (7)) to estimate the panel data model with the logarithm of GDP per capita as the dependent variable in a non-stationary setting. The DOLS addresses the issues of endogeneity and residual serial correlation in the regression specification, and gives consistent and unbiased estimates.

$$\begin{aligned} y_{i,t} = c_i + \Sigma_{j=-d_1}^{d_2} \omega_{ij+j} \Delta k_{ij+j} + \Sigma_{j=-d_1}^{d_2} \gamma_{1ij+j} \Delta h_{ij+j} + \Sigma_{j=-d_1}^{d_2} \gamma_{2ij+j} \Delta r_{ij+j} + \Sigma_{j=-d_1}^{d_2} \gamma_{3ij+j} \Delta f_{ij+j} + \\ \Sigma_{j=-d_1}^{d_2} \gamma_{4ij+j} \Delta aid_{ij+j} + \alpha_i k_{i,t} + \beta_{1i} h_{i,t} + \beta_{2i} r_{i,t} + \beta_{3i} f_{i,t} + \beta_{4i}\, aid_{i,t} + \varepsilon_{i,t}, \varepsilon_{i,t}\ i.i.d.N(0, \sigma^2) \end{aligned} \quad (7)$$

where d_1 and d_2 are non-negative scalars denoting the orders of lags and leads, respectively, and $\varepsilon_{i,t}$ is the error term. At the estimation stage, we identify the orders of lags and leads statistically by the AIC criterion. We allow for heterogeneity for both the short- and long-run parameters across countries and estimate the model. However, the reporting presents the average of these parameters (with t-statistics and p-values) only.

4. Empirical results

We carried out the IPS (Im, Pesaran & Shin, 2003) test and augmented Dickey–Fuller (ADF) test based on Fisher type test for panel unit roots. Table 2 presents the test results for the variables (in levels) in the model for all 18 countries. The IPS and ADF test statistics show that we fail to reject the null hypothesis that variables have unit roots for all variables in the model, except for foreign aid. Thus, the results confirm that the data series are generally characterized as I(1) process; that is, they follow the unit root non-stationary process.[6]

Table 2: Panel unit root tests

Variable	*IPS test*	*Fisher-type test based on ADF*			
	Statistics (w-t-bar)	*Inverse chi-squared (36)*	*Inverse normal*	*Inverse logit t(94)*	*Modified inv. chi-squared*
		P	Z	L*	Pm
GDP	5.37	17.18	5.027	5.59	-2.22
Remittances	1.47	25.27	2.0	1.982	-1.27
FDI	-0.54	22.27	2.99	3.34	-1.62
Foreign aid	-4.31***	64.85***	-3.3***	-63.34***	3.4***
Physical capital	0.64	36.73	0.31	0.36	0.09
Human capital	5.42	34.05	4.69	5.6	-0.23

Note: ***, ** and * denote rejection of the null hypothesis that all countries have unit roots at 1%, 5% and 10% respectively. Trends are not included and tests are computed with three lags except for human capital (calculated with one lag) due to insufficient number of time periods to compute W-t-bar.

Table 3: Panel cointegration tests

Test statistics	*All*		*LICs*		*MICs*		*Asian*		*SSA*	
	Statistics	*p-value*	*Statistics*	*p-value*	*Statistics*	*p-value*	*Statistics*	*p-value*	*Statistics*	*p-value*
A. Pedroni residual cointegration test[§]										
Panel statistics (weighted)										
Panel v-Statistics	-3.902	1.000	-2.823	0.998	-2.684	0.996	-2.262	0.988	-3.15	0.999
Panel rho-Statistics	-1.973	0.024	-2.065	0.020	-0.588	0.278	1.596	0.945	-2.648	0.004
Panel PP-Statistics	-5.189	0.000	-4.306	0.000	-2.863	0.002	0.546	0.708	-5.439	0.000
Panel ADF-Statistics	-5.343	0.000	-4.966	0.000	-2.881	0.002	0.814	0.792	-6.176	0.000
Group statistics										
Group rho-Statistic	1.472	0.930	1.172	0.879	0.910	0.819	1.599	0.945	0.607	0.728
Group PP-Statistic	-2.821	0.002	-1.544	0.061	-2.446	0.007	-0.947	0.172	-2.854	0.002
Group ADF-Statistic	-2.539	0.000	-2.763	0.003	-2.543	0.006	-0.704	0.241	-4.237	0.000
B. Kao residual cointegration test[£]										
ADF	-2.417	0.018	-1.886	0.030	-2.267	0.012	-1.826	0.034	-1.808	0.035
Residual variance	0.002		0.003	0.000	0.001	0.001	0.000	0.000	0.003	0.000
HAC variance	0.003		0.003	0.000	0.002	0.002	0.000	0.000	0.004	0.000

Note: [§]No deterministic intercept or trend is included in the estimation of residual. Dickey-Fuller residual variances with correction for the degree of freedom are reported and lag length selection was based on AIC with lags from 1 to 9. [£]No deterministic trends are included in the estimation. The lag length selection was based on AIC with maximum of 9 lags.

Given that the panel data series follow unit root processes, we employ panel co-integration tests to test if our variables are cointegrated in model (7). We use Kao (1999) and Pedroni (1999, 2004) residual co-integration tests. Table 3 reports the results. The Kao test rejects the null hypothesis of no cointegration at the 5 percent significance level, and thus shows the existence of co-integration among the variables in the model. The panel and groups statistics for the Pedroni test (6 out 8 tests) are significant at 5 percent or better, and reject the null hypothesis. Thus, the tests confirm that the variables are cointegrated.

We use the DOLS estimator, as we explained in Section 3, to estimate the parameters of the cointegration relationship. First, Table 4 (model 1) reports the estimates of per capita GDP including all variables in equation (7) for the full sample and the sub-samples categorized based on LICs and MICs, and Asian and SSA countries. Among the full sample countries with all variables in the regression except foreign aid have a positive and significant long-run effect on GDP per capita. The coefficient of remittances is 0.048 (t-statistic 3.37), implying that a 10 percent growth in per capita remittances increases per capita GDP by 0.48 percent when controlling physical and human capital, key channels through which remittances potentially affect growth. The results are similar to those of several studies (Siddique, Selvanathan, & Selvanathan, 2012) and contradict others (e.g., Singh, Haacker, Lee, & Goff, 2011).

The modest growth effects suggest that the effects from the favorable outcomes of remittances, such as knowledge and technology transfer and increased labor productivity in the recipient countries, are stronger than the potential adverse outcomes of remittances, such as deteriorating competitiveness and governance, as discussed in Section 2. However, there might be a concern about whether the magnitude of these outcomes is heterogeneous among countries. We therefore estimate the model among sub-samples categorized based on development level and region (panels B-E). The coefficients of remittances are positive among all sub-samples, but significant among MICs and SSA countries only. Among MICs, a 10 percent growth in per capita remittances increases per capita GDP by 0.85 percent through the TFP channel, which is about twice the average effect among all sample countries.

Surprisingly, the impact of FDI on growth through the TFP channel is about four times higher than that of remittances: it would lead to a 1.6 percent growth in per capita GDP for a 10 percent growth in FDI. The remarkable effect may be due to strong diffusion of technology with FDI. The results are consistent with previous studies, such as Keller (2004) who shows that the productivity effect of FDI is mainly through technology transfer or diffusion. Other studies suggest that the magnitude of the effect may depend on the local factors such as financial development (Alfaro et al., 2004), human capital (Borensztein, De Gregorio & Lee, 1998; Li & Liu, 2005), open trade regimes (Balasubramanyan, Salisu, & Sapsford, 2006), the technology gap (Li & Liu, 2005), and so on. Meanwhile, FDI has significant positive coefficients among MICs and Asian

Table 4: Dynamic OLS Estimates of Log of per capita GDP

Variables	*(1)*			*(2)*			*(3)*		
	Coeff.	*t-stat*	*p-value*	*Coeff.*	*t-stat*	*p-value*	*Coeff.*	*t-stat*	*p-value*
Panel A. All sample countries									
Remittances	0.048	3.198	0.002	0.073	3.148	0.002	0.056	1.552	0.121
FDI	0.164	2.097	0.037	0.712	5.232	0.000	1.105	8.178	0.000
Foreign aid	-0.035	-1.205	0.229	-0.157	-3.113	0.002	-0.055	-0.502	0.616
Physical capital	0.045	1.176	0.240	0.252	3.854	0.000			
Human capital	1.348	7.423	0.000						
Panel	18			18			18		
No of observations	555			552			574		
Panel B. Low income countries									
Remittances	0.012	0.637	0.525	0.057	2.170	0.031	-0.037	-0.617	0.538
FDI	0.130	1.092	0.276	0.892	4.257	0.000	1.257	5.896	0.000
Foreign aid	-0.083	-1.649	0.101	-0.274	-3.967	0.000	-0.119	-1.105	0.270
Physical capital	-0.023	-0.580	0.563	0.196	2.864	0.005			
Human capital	2.136	6.426	0.000						
Panel	9			9			9		
No of observations	275			272			290		
Panel C. Middle income countries									
Remittances	0.085	3.655	0.000	0.089	2.312	0.022	0.149	4.215	0.000
FDI	0.197	2.075	0.039	0.53284	2.975	0.003	0.952	5.619	0.000
Foreign aid	0.012	0.377	0.707	-0.04	-0.544	0.587	0.009	0.048	0.962
Physical capital	0.114	1.743	0.083	0.309	2.802	0.006			
Human capital	0.561	3.146	0.002						
Panel	9			9			9		
No of observations	280			280			284		

contd. table 4

Variables	*(1)*			*(2)*			*(3)*		
	Coeff.	*t-stat*	*p-value*	*Coeff.*	*t-stat*	*p-value*	*Coeff.*	*t-stat*	*p-value*
Panel D. Asian countries									
Remittances	0.047	1.627	0.107	0.100	2.583	0.011	0.186	4.405	0.000
FDI	0.269	1.915	0.058	0.997	4.484	0.000	1.618	8.151	0.000
Foreign aid	0.013	0.283	0.778	-0.007	-0.083	0.934	0.032	0.129	0.897
Physical capital	0.180	2.169	0.032	0.458	5.684	0.000			
Human capital	1.440	6.936	0.000						
Panel	7			7			7		
No of observations	195			193			196		
Panel E. SSA countries									
Remittances	0.049	3.390	0.001	0.056	1.936	0.054	-0.027	-0.516	0.606
FDI	0.097	1.144	0.254	0.531	3.083	0.002	0.778	4.275	0.000
Foreign aid	-0.066	-1.990	0.048	-0.252	-3.963	0.000	-0.110	-1.257	0.210
Physical capital	-0.040	-1.357	0.176	0.121	1.300	0.195			
Human capital	1.290	5.498	0.000						
Panel	11			11			11		
No of observations	360			359			378		

Note: Grouped estimation method is used; country specific effects are included but trend not included in the models. Automatic leads and lags specification (based on AIC criterion, max=*) are included in the model. Long-run variances are chosen using AIC criteria; and Bartlett kernel, Newey-West automatic bandwidth, NW automatic lag length used to compute individual coefficient covariances.

countries. In contrast, foreign aid has no effect on growth. This result is similar to a few studies (e.g., Rajan & Subramanian, 2008) but differs from several other studies (e.g., Arndt, Jones, & Tarp, 2015). This implies that the effect of aid on improving productivity is undetermined.

Second, we estimate the growth effect of remittances without controlling physical capital and human capital in the model, and thus allow remittances to have an impact through these channels. For this purpose, we drop human capital and physical capital stock variables one by one from the model. In the human capital investment channel (by dropping the human capital regressor), the growth effect of remittances becomes larger and statistically stronger in the full sample and all sub-samples (Table 4, model 2). In the full sample, a 10 percent growth in per capita remittances increases per capita GDP by 0.73 percent; the effect is lowest among SSA countries (0.56%) and LICs (0.56%) and highest among Asian countries (1.0%). Thus, the size of the growth effect may be remarkable for Asian countries receiving a large amount of remittances, such as Nepal, Bangladesh, and Vietnam.

Third, we also allow for the effect of remittances through both the physical and human capital investment channel by dropping both the physical capital and human capital variables from the model (Table 4, model 3). The coefficients and significance are small in the full sample compared to the case in which we drop only human capital (model 2), suggesting that remittances have no role in growth through the physical capital investment channel, on average. However, the coefficients become larger and stronger among MICs or Asian countries in contrast to the undetermined ones among LICs or SSA countries. For instance, a 10 percent increase in per capita remittances increases output growth by 1.49 percent and 1.86 percent in among MICs and Asian countries, respectively. These results suggest that remittances have not only a robust growth effect through human capital investment, but also through physical capital investment in MICs or Asian countries. However, the impact of remittances on growth in LICs or SSA countries seems to occur only through the human investment channel.

Finally, we explore the long-run effects of remittances on physical and human capital formation using the DOLS estimator with remittances, FDI, and foreign aid as explanatory variables (Table 5). The coefficients of remittances in the models have mostly positive signs, as expected. However, the effect of remittances on physical capital is significant in the full sample and the sub-samples of MICs or Asian countries, but not among LICs and SSA countries, which is consistent with our previous findings. Meanwhile, remittances have significant effects on the human capital model in the full sample and all sub-samples, which is also consistent with our findings on the channels through which remittances affect economic growth.

Households from least developed countries, such as LICs and SSA, may have severe borrowing constraints and they may even fail to get a minimum

Table 5: Dynamic OLS estimates of physical and human capital formation

Variables	*Physical capital*			*Human capital*		
	(1)			*(2)*		
	Coeff.	*t-stat*	*p-value*	*Coeff.*	*t-stat*	*p-value*
Panel A. All sample countries						
Remittances	0.085	1.650	0.100	0.073	5.107	0.000
FDI	0.446	1.471	0.142	0.241	2.503	0.013
Foreign aid	0.225	1.451	0.147	-0.033	-0.612	0.541
Obvs.	652			573		
Panel B. Low income countries						
Remittances	-0.016	-0.167	0.867	0.046	3.033	0.0027
FDI	0.670	1.191	0.235	0.328	2.446	0.0152
Foreign aid	0.361	1.568	0.118	-0.023	-0.548	0.5845
Obvs.	281			288		
Panel C. Middle income countries						
Remittances	0.185	4.674	0.000	0.099	4.126	0.000
FDI	0.223	0.975	0.331	0.155	1.116	0.266
Foreign aid	0.088	0.427	0.670	-0.043	-0.431	0.667
Obvs.	371			285		
Panel D. Asian countries						
Remittances	0.213	4.547	0.000	0.078	2.908	0.004
FDI	1.071	4.501	0.000	0.519	4.477	0.000
Foreign aid	-0.059	-0.223	0.824	-0.067	-0.559	0.577
Obvs.	195			197		
Panel E. SSA countries						
Remittances	0.003	0.037	0.970	0.069	4.387	0.000
FDI	0.049	0.104	0.917	0.065	0.463	0.644
Foreign aid	0.405	2.150	0.032	-0.012	-0.257	0.797
Obvs.	367			376		

Note: The dependent and explanatory variables are expressed in logarithm. See Table 4 note.

standard of consumption, thus largely falling below the poverty line. Remittance income may help them increase their current consumption and bring them out of the poverty trap, but may not necessarily help them invest in physical capital. This is consistent with several household surveys that find positive effects of remittances on consumption and poverty reduction in LICs and SSA countries (e.g., Acharya & Leon-Gonzalez, 2013 for Nepal; Anyanwu & Erhijakpor, 2010 for SSA). Meanwhile, others find a positive effect of remittances on physical capital accumulation among MICs such as Kenya (Kagochi & Kiambigi, 2012). It is therefore not surprising that remittances have no significant effect on capital accumulation in LICs and SSA countries. However, remittance recipient households tend to have higher expenditure on children's education, irrespective of country (see, Acharya & Leon-Gonzalez, 2014 for Nepal; De & Ratha, 2012 for Sri Lanka), providing support for our

findings for the long-run positive effect of remittances on human capital investment at the macro level. In summary, our results, consistent with household surveys (Adams, 2011), suggest that the development level of a country generally shapes the growth effect of remittances. The long-run growth effect is generally through the human capital channel, for all countries, and to some extent through productivity and physical capital investment.

5. Conclusion

In this paper, we estimated the long-run impacts of remittances on economic growth using a panel of similar countries from Asia and SSA. Using a production function approach, we estimated the long-run relationship between remittances and per capita GDP, while allowing for endogeneity in the regressors and heterogeneous production functions among countries.

We conclude that the growth effect of remittances depends on the local context and development level. Remittances have a significant positive effect on output per capita, which occurs mainly through the human capital investment channel, but also to some extent through the physical capital investment and productivity channels. The long-run growth effect is generally through the human capital channel, irrespective of the country and to some extent through the productivity and physical capital investment. Our findings are consistent with previous studies, such as Siddique et al. (2012), and contradict with other studies, such as Chami et al. (2012). Remittances have a positive and significant effect on human capital, regardless of the sub-sample. In addition, we document the positive and strong effect of FDI and human and physical capital investment on growth.

The results suggest that lower income countries may further benefit from remittances if, in addition to investments in human capital, they divert remittances towards investments in physical capital, and the adoption of new knowledge, skills and technology. The case will be important for labor abundant countries in particular because this will enable them to enhance their growth further from increased labor productivity and the short-term migration of surplus labor. The main limitation of this paper is that we did not include some similar countries from Asia and SSA in the sample due to lack of data availability.

Notes

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2. For example: Lee, Pesaran, and Smith (1997) show that the assumption of homogeneous parameters across countries leads to substantial biases in the estimates.

3. For example: Yang (2008) on investment in capital-intensive enterprises in the Philippines, Adams and Cuecuecha (2013) and Kagochi and Kiambigi (2012) on housing in Ghana and Kenya, respectively, and Woodruff and Zenteno (2007) on the establishment of enterprises in Mexico.
4. See, for example, Le (2008) on the effect of international labor migration on technology transfer in OECD countries, and Le (2010) on the transfer of R&D from OECD countries through students to DCs.
5. Due to a lack of data on employment, we use population as the labor force.
6. Although it is acceptable to include a stationary variable in a cointegration regression, we also estimate the model without foreign aid and obtain similar results.

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Table A1: Sample of Countries

Panel A.	**Panel B.**
Countries by Development Level	Countries by Region
A1. Low Income Countries	**B1. Asia**
Burkina Faso	Bangladesh
Madagascar	Cambodia
Mali	Nepal
Mozambique	Pakistan
Nepal	Sri Lanka
Níger	Thailand
Rwanda	Viet Nam
Senegal	
Uganda	
A2. Middle Income Countries	**B2. Sub-Saharan Africa**
Bangladesh	Burkina Faso
Cambodia	Cameroon
Cameroon	Ghana
Ghana	Kenya
Kenya	Madagascar
Pakistan	Mali
Sri Lanka	Mozambique
Thailand	Niger
Viet Nam	Rwanda
	Senegal
	Uganda