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The World Bank has forecast that the adverse economic impact of the ongoing Covid-19 induced recession in advanced countries and oil-producing countries would lead to a steep decline in worldwide remittances (REM) in 2021 and 2022. It is expected that economic growth in Cambodia, Laos, and Vietnam (CLV), known as transitional economies is expected to be hit hard. This paper explores the nonlinear effect of remittances on economic growth using a panel of three CVL countries for the period 2000-2017. While remittances positively contribute to long-run economic growth, the nonlinear analysis reveals that remittance inflows have an asymmetric effect on per capita GDP. The effect of negative partial sum decomposition is higher than that of the positive partial sum decomposition of remittances. Further, our results show that ICT and remittances are found to be having a mutual growth effect in these transition economies.

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1. Introduction

Compared to the decreasing annual inflows of overseas development assistance (ODA) since the late 1990s and fluctuations in foreign direct investment (FDI) inflows to low and lower-middle-income countries (LMICs), remittances inflow was seen steadily increasing until 2019. Following the increasing trends in globalization and international mobility of labor since the New Millennium, citizens as well as residents working overseas transfer funds to their families left behind in their home countries. The REM inflows to the poor households have been substantial support towards poverty mitigation (Adams and Page, 2005). Further, they have been augmenting the foreign exchange reserves of the recipient countries and contributing towards a reduction in current account deficits. The annual global REM flows recorded the highest in 2019 at US$717 billion. For LMICs, REM inflows were also the highest at US$ 548 billion in 2019.

With the widespread use of information and communication technology (ICT), REM flows across international borders through formal banking channels have not only become secure but also emerged to be smoother, faster, and less expensive than informal channels. In the absence of access to banking facilities in developing countries, which were only available in urban centers, REM recipient families in rural and remote parts of LMICs were spending their funds on inessential consumption (Giuliano and Ruiz-Arranz, 2009; Mohan and Ray, 2017). The advent of ICT and the rising digitization process with the use of mobile phones and online banking have facilitated the financialization of savings from REM, which is now reflected more in the form of bank deposits. The latter adds to bank reserves and boost lending activities (Makun and Jayaraman, 2020). These eventually lead to the creation of jobs, economic growth, and a rise in per capita incomes.

This paper undertakes an empirical study on remittances and economic growth visa-v ICT of three LMICs countries in Southeast Asia, namely Cambodia, Laos, and Vietnam (CLV). Once centrally planned economic regimes, they switched on to market economic systems (Laos in 1986, Vietnam in 1988, and Cambodia in 1993). All the three, having made some notable progress, though still in a gradual manner and hence known as transitional countries, were admitted in the second half of the 1990s to the ten-member intergovernmental Association of Southeast Asian Nations (ASEAN)[1] (Vietnam in 1995, Laos in 1997, and Cambodia in 1999). The CLV countries are now more open than before with greater mobility of labor within and outside the ASEAN region. Consequently, since the 2000s, they have been receiving substantial amounts of REM from their citizens living and working overseas (see appendix Table A1). Further, they have also adopted ICT in economic activities, including banking and finance, which enabled them to figure in the list of top ten REM recipient countries in the East Asia and Pacific (EAP) region in recent years (see appendix Table A2).

However, prosperity reflected in rising per capita incomes in CLV countries was given a heavy jolt in the first quarter of 2020, as the Covid-19 virus engulfed the world. The pandemic-induced recession began with a fall in economic activities and loss of jobs in advanced

[1]In the ten-member ASEAN, Singapore and Brunei are two high-income countries, while Malaysia and Thailand are two upper- middle income countries. The other six, namely CLV countries, Indonesia, Myanmar and , Philippines are LMICS, which are dependent on remittances.

economies as well as in oil-producing countries, which play host to migrants from LMICs. The 2020 third-quarter forecast by World Bank (2020) was that global remittances would decrease from US$717 billion in 2019 to US$666 billion in 2020 and continue to decline further to US$619 billion in 2021. It is also projected that the global economic growth rate would be a negative 4.4 percent in 2020. As for the subsequent years, with continuing uncertainties relating to the delivery, storage and quick and effective coverage of the vaccines, IMF (2020) observes that the recovery to pre-pandemic levels would be "a long and difficult ascent".

Although the literature on remittances and growth has been growing (Ratha, 2007; Buch Kuckulenz, 2010; Jayaraman et al., 2012; Kumar, 2012; Brown et al., 2013; Masuduzzaman, 2014; Jawaid and Raza, 2016), REM-growth relationship in CLV countries has not been intensively studied. The present study attempts to fill this gap. In doing so, we contribute to the literature by highlighting the role of ICT as a contingent factor in the REM-growth nexus. Further, we employ the nonlinear autoregressive distributed lagged (NARDL) procedure proposed by Shin et al. (2014) for investigating the existence of an asymmetrical relationship in the REM- growth nexus. The extant literature mostly assumes the symmetric effect of REM on growth. However, with the unfolding crisis related to Covid-19, REM is likely to have a differential impact. The NARDL analysis examines the impact of both positive and negative shocks of REM on economic growth by decomposing them into their partial sums. Our analysis reveals the following relationship between remittances and economic growth: While remittances positively contribute to long-run economic growth there is inherent nonlinearity in the growth effects of remittances. In other words, remittances have an asymmetric effect on economic growth. This is because positive done to economic growth by increasing remittances inflow is not as great as the negative impact of declining remittances. Further, the estimation shows that ICT is a statistically significant factor in the remittances-growth nexus and mutually enhances economic growth.

This paper is organized along the following lines. Section 2 outlines the theoretical framework and data. Section 3 outlines the methodology and estimation technique. Section 4 presents the estimation result and discussion. The last section 5 presents the conclusions with policy implications.

2. Theoretical framework and modeling

2.1. Framework

To explore the remittances- economic growth nexus, we use the neoclassical economic growth model of Solow (1956). In Solow (1956) framework, the output per capita is expressed as:

$$y_t = A_t k_t^{\alpha}, \qquad 0 < \alpha < 1 \tag{1}$$

Where y_t is output per capita, A_t is stock of technology and k_t is stock of capital per capita and α is share of capital. The model takes that the evolution of technology is given by:

$$A_t = A_o e^{gt} \tag{2}$$

Here A_o is the initial stock of technical expertise and g represents the technology growth over time trend t. In this study, we include remittances and ICT in the production function. The addition of remittances as one of the main inputs is consistent with Chiodi (2012) who argues remittances accelerate capital accumulation, and thus economic growth. Studies by Hong (2017) and Neibel (2018) show that ICT also affects economic growth. Therefore we extend the function from Equation (1) as:

$$y_t = (A_o e^{gt} REM_t^{\beta_1}, ICT_t^{\beta_2}, ICTREM_t^{\beta_3}) k_t^{\alpha_1} \quad (3)$$

Where *REM* is remittances percent of GDP and *ICT* is represented by mobile subscriptions per 100 inhabitants. We also include the interaction term (*ICTREM*) of *REM* and *ICT*[2]. Taking logs (*l*) and reorganizing Equation (3) leads to Equation (5), which is further transformed into linear and nonlinear panel ARDL regression equations in section three.

$$ly_t = \alpha_0 + \alpha_1 lk_t + \beta_1 lREM_t + \beta_2 lICT_t + \beta_3 lICTREM_t + \varepsilon_t \quad (4)$$

2.2. Data

The study covers the period 2000 to 2017 and employs the data series on annual real GDP per capita (constant US$), capital stock per capita (in constant US$), REM as a percent of GDP, and mobile subscriptions per 100 inhabitants, which is a proxy for ICT. The datasets are sourced from *World Development Indicators* (World, Bank, 2019) and *Penn World Tables* (2019). All the variables were transformed into their logs to obtain elasticity estimates. We also subject the variables to the panel unit root tests to address any stationarity issues. Table 1 shows that variables are integrated of the same order.

Table 1: Panel unit root test

Variables	Test statistics (probability values)				
Panel A: In Level	LLC	IPS	MW(ADF)	MW(PP)	Conclusion
ly	-1.224 (0.110)	1.117 (0.868)	1.680 (0.946)	1.918 (0.927)	-
lk	3.366 (0.996)	1.116 (0.867)	1.757 (0.941)	10.352 (0.111)	-
lREM	4.179 (0.652)	-1.607 (0.271)	9.728 (0.136)	4.246 (0.634)	-
lICT	1.814 (0.935)	0.173 (0.568)	3.606 (0.729)	1.814 (0.935)	-
lICTREM	-1.481 (0.963)	0.045 (0.518)	4.745 (0.576)	5.832 (0.442)	-
Panel B: In First Difference					
Ly	-2.496 (0.006)*	-2.133 (0.016)**	14.775 (0.022)**	26.294 (0.000)*	I (1)
Lk	-2.106 (0.017)**	-1.424(0.077)***	11.109(0.085)***	26.913 (0.000) *	I (1)
lREM	-5.019 (0.000)*	-5.886 (0.000)*	37.874 (0.000)*	64.047 (0.000)*	I(1)
lICT	3.615 (0.021)**	-2.858 (0.002)*	19.313 (0.003)*	50.876 (0.000)*	I (1)
lICTREM	-1.305(0.093)***	2.678 (0.003)*	18.179 (0.005)*	20.700 (0.002)*	I (1)

Note: LLC and IPS indicate Levin et al. (2002) and Im et al. (2003) panel unit root tests. MW (ADF) and MW (PP) represent Maddala and Wu (1999) Fisher-ADF and Fisher-PP panel unit root tests. The LLC, IPS, MW (ADF), and MW (PP) all inspect the null hypothesis of a unit root. The values in brackets are the probabilities of wrongfully rejecting the true null hypothesis.*, **, and *** indicate significance levels at 1%, 5%, and 10% level respectively.

[2]The interaction term is test whether ICT and REM are substitute or complementary in supporting economic growth. A significant and positive coefficient would suggest mutual effect while negative result would suggest ICT and REM are substitute. Insignificant outcome will suggest ICT and REM are independent.

3. Model and methodology

We employ the NARDL model developed by Shin et al. (2014) to explore the asymmetric effects of remittances on the real per capita GDP of CLV countries. The NARDL model is the asymmetric extension of Pesaran et al.'s (2001) linear ARDL model, which is a single long-run cointegration and error correction procedure. The two widely used techniques in the heterogenous panel ARDL estimation procedure are the Pooled Mean Group (PMG) estimator and the Mean Group (MG) estimator (Pesaran et al, 1999). The MG estimator relies on estimating *N* time-series regression and takes the average coefficient (Blackburne and Frank, 2007), whereas the PMG estimator takes the combination of pooling and averaging of coefficients. Nevertheless, to obtain the preferred estimator between the two, the Hausman test is applied. The null hypothesis is that the PGM is an efficient estimator while the alternative hypothesis is that the MG is an efficient estimator. In addition to panel regression analysis, the PMG and MG estimators also estimate the short-run coefficient of individual units.

Given the NARDL model is an asymmetric extension of the linear ARDL model, it is useful to begin by presenting the linear panel ARDL model first. According to Pesaran et al. (2001), the following unrestricted error correction model is written as:

$$\Delta ly_{it} = \alpha_0 + \alpha_1 ly_{it-1} + \alpha_{2i} lk_{t-1} + \alpha_{3i} lREM_{t-1} + \alpha_{4i} lICT_{t-1} + \alpha_{5i} lICTREM_{t-1} + \sum_{i=1}^{n} \beta_{1i} \Delta ly_{it-i}$$
$$+ \sum_{i=0}^{n} \beta_{2i} \Delta lk_{it-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lREM_{it-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lICT_{it-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lICTREM_{it-i} + \mu_i + \varepsilon_{it} \quad (6)$$

Here α_0 is the constant, μ_i is the group-specific effect, ε_t is the error term, $\alpha_{1,2..4}$ represents long-run parameters, and $\beta_{1...4}$ is short-run parameters. n indicates optimal lags of variables in difference form which is selected by SIC. Equation (6) can be further re-specified as error correction model as:

$$\Delta ly_{it} = \delta \tau_{it-1} + \sum_{i=1}^{n} \beta_{1i} \Delta ly_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lREM_{it-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lICT_{it-i}$$
$$+ \sum_{i=0}^{n} \beta_{5i} \Delta lICTREM_{it-i} + \mu_i + \varepsilon_t \quad (7)$$

Where $\delta \tau_{it-1}$ is the error correction term and δ is the adjustment parameter. Δ is the difference operator indicating short-run dynamics.

To analyze for the nonlinear panel ARDL, which allows for the asymmetric effect of remittances to real per capita GDP, we consider Equation (6) following Shin et al. (2014). Under this scenario, positive and negative shocks of remittances are examined and their impacts on GDP are not expected to be the same. The asymmetric version of Equation (6) is present below:

$$\Delta ly_t = \alpha_{0i} + \alpha_{1i} ly_{t-1} + \alpha_{2i} lk_{t-1} + \alpha_{3i} lICT_{t-1} + \alpha_{4i} lICTREM_{t-1} + \alpha_{4i}^{+} lREM_t^{+} + \alpha_{4i}^{-} lREM_t^{-} + \sum_{i=1}^{n} \beta_{1i} \Delta ly_{t-i}$$
$$+ \sum_{i=0}^{n} \beta_{2i} \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lICT_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lICTREM_{t-i} + \sum_{i=0}^{n} \beta_{4i}{}^{+} \Delta lREM_{t-i}^{+} + \sum_{i=0}^{n} \beta_{4i}{}^{-} \Delta lREM_{t-i}^{-} + \mu_i + \varepsilon_t \quad (8)$$

Where $lREM_t^{+}$ and $lREM_t^{-}$ are the positive and negative partial sum decomposition computed as $lREM_t^{+} = \sum_{t=1}^{n} \Delta lREM_t^{+} = \sum_{t=1}^{n} \max(\Delta lREM_{t,} 0)$ and $lREM_t^{-} = \sum_{t=1}^{n} \Delta lREM_t^{-} = \sum_{t=1}^{n} \min(\Delta lREM_{t,} 0)$. Where $lREM_t = lREM_0 + lREM_t^{+} + lREM_t^{-}$. The elasticity coefficient of $lREM_t^{+}$ and $lREM_t^{-}$ is computed as: $\eta^{+} = -\frac{\alpha_{4i}^{+}}{\alpha_{1i}}$ and $\eta^{-} = -\frac{\alpha_{4i}^{-}}{\alpha_{1i}}$.

The error correction representation of Equation (8) yields the following:

$$\Delta ly_t = \rho \varsigma_{it-1} + \sum_{i=1}^{n} \beta_{1i} \Delta ly_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lICT_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lICTREM_{t-i} + \sum_{i=0}^{n} \beta_{4i}{}^{+} \Delta lREM_{t-i}^{+}$$
$$+ \sum_{i=0}^{n} \beta_{4i}{}^{-} \Delta lREM_{t-i}^{-} + \mu_i + \varepsilon_t \quad (9)$$

The error correction term ($\rho \varsigma_{it-1}$) estimates the equilibrium asymmetric relationship in the specified model and the associated parameter (ρ) captures the adjustment speed after shock. The short-run positive and negative changes in remittances are captured by β_{4i}^{+} and β_{4i}^{-} respectively. To test for the long run and short run symmetry, the standard Wald test is applied. The null hypothesis ($H_{null} : \eta^{+} = \eta^{-}$) for long-run symmetry is tested against the alternative hypothesis ($H_{alt} : \eta^{+} \neq \eta^{-}$). Similarly, the short-run symmetry of remittances is tested by evaluating the null hypothesis ($\sum_{i=0}^{n} \beta_{4i}{}^{+} = \sum_{i=0}^{n} \beta_{4i}{}^{-}$).

4. Results and discussion

We first carry out the cointegration test to check for the long-run equilibrium relationship between the variables. We use Pedroni's panel cointegration test, which is based on the null hypothesis of no cointegration. Pedroni's test has four statistics: panel (group) ADF, panel (group) PP, panel (group) -rho, and panel –v statistics. Panel test within dimension and group statistics is between dimensions. Table 2 reports the cointegration test result. The result shows evidence of an equilibrium long-run cointegration among the series. Excerpt for Panel-v and group-PP, all the test statistics discard the null proposition, implying variables are cointegrated.

In the next step, we estimate the relationship. First, we estimate the linear ARDL model (6). Both, the PMG and MG estimators are used and afterward the results from the estimates are subjected to the Hausman test. The result of the Hausman test is reported in Table 3. Our results indicate the null hypothesis cannot be rejected and that the PMG estimator is the efficient estimator for modeling remittances-growth nexus in our case. Hence, the results of the only ideal estimator are reported and discussed in this paper.

Table 2: Cointegration Test

	Cointegration test	Statistics (p-value)
Pedroni	Panel-v	0.332 (0.369)
	Panel-rho	3.671 (0.025)**
	Panel-PP	2.072 (0.063)***
	Panel-ADF	8.748 (0.000)*
	Group-rho	14.599 (0.000)*
	Group-PP	1.073 (0.858)
	Group-ADF	-1.389 (0.082)***

Note: Schwarz information criterion is used in lag selection. The estimation includes intercept and trend.

The linear model using the linear measure of remittances is estimated as a benchmark, and long-run and short-run dynamics are examined. In the long run, the share of the capital stock (*lk*) is 0.56, implying that a unit increase in capital stock per capita, ceteris paribus, leads to a 0.56 percent increase in real per capita GDP. The effect of remittances (*lREM)* which is of particular interest to this paper is found to be positive. The elasticity estimates are statistically significant both in the long run and short run. The result indicates that a one percent increase in remittances causes about a 0.014 percent increase in real GDP per capita on average in the long run while the effect is about half in the short run. This result is consistent with the findings of Jongwanich (2007) and Kumar et al. (2014).

Table 3: Linear panel ARDL estimation

Variables	Coefficient	Standard error	P-value
lk	0.565	0.016	0.000*
lREM	0.014	0.006	0.053**
lICT	0.023	0.016	0.001*
ICTREM	0.015	0.003	0.000*
Δlk	0.124	0.024	0.000*
$\Delta lREM$	0.006	0.002	0.001*
$\Delta lICT$	0.039	0.047	0.412
$\Delta ICTREM$	0.031	0.015	0.049**
Constant	1.034	0.007	0.005*
$\hat{\tau}_{t-1}$	-0.738	0.022	0.000*
Hausman test	0.157 (0.226)		
Log-likelihood	251.183		
No. of Obsv	52		
Error correction terms for each country			
Cambodia	-0.395	0.0069	0.000*
Laos	-0.141	0.0004	0.000*
Vietnam	-0.321	0.0063	0.000*

Note: *, ** and *** indicate statistical significance at 1%, 5% and 10% respectively. The probability value for the Hausman test is in the brackets.

Further, the ICT indicator is found to be positively associated with real GDP per capita in the long run. The elasticity coefficient of ICT is 0.02 percent, consistent with Hong (2017) and Neibel (2018). The usage of ICT including mobile technology has substantially increased in CLV economies and with positive spillovers to it reduces cost and boosts productivity contributing to economic growth and development. The interaction term is positive and statistically significant suggesting a complementary effect of ICT and REM on economic growth in CLV countries.

We now turn to the results of the NARDL model to examine the asymmetrical relationship between REM and growth in per capita income. The use of the nonlinear ARDL model is based on the notion of both positive and negative changes in REM and these changes may differ. First, we test the long-run and short-run asymmetries. Table 4 shows the results of the Wald test for long and short-run symmetry. The asymmetric Wald test rejects the null hypothesis of long and short-run symmetry because estimated probability values of F-statistics are significant at a one percent level for the panel of CLV countries. Based on the Wald test statistics for long and short-run symmetry, the results of the estimated nonlinear model are reported in Table 5.

Table 4: Asymmetric effect Wald test

Null hypothesis	Long run	Short-run
Remittances have symmetric effect on real per capita GDP	$X^2(1) = 3.474$ (0.000)*	$X^2(1) = 4.241$ (0.001)*

Note: * represent statistical significance at 1% level.

The long-run asymmetric parameters ($lREM_t^+$ and $lREM_t^-$) capture the asymmetric effect of remittances inflow on economic growth. The coefficients 0.11 and 0.24 are associated with positive ($lREM_t^+$) and negative ($lREM_t^-$) partial sum decomposition, respectively. The positive coefficient of remittances explains that a 1 percent increase in remittances inflow leads to an increase in real per capita GDP by 0.11 percent whereas the negative decomposition implies that a 1 percent decrease in remittances inflow results in a decrease in per capita real GDP to decrease by 0.24 percent. This differential effect implies the asymmetric effect of remittances on economic growth. The result shows the impact of negative ($lREM_t^-$) partial sum decomposition is much greater in magnitude than that of positive ($lREM_t^+$) partial sum decomposition for these transitioning economies. In other words, a decline in remittances inflow is relatively more harmful than a similar size increase in remittances inflow. The effect of other conditioning variables, such as capital stock ICT, and interaction term have expected positive signs and are also statistically significant in the long run.

Similarly, in the short run, we find a statistically significant effect of positive ($lREM_t^+$) and negative change ($lREM_t^-$) in remittances-inflow, with negative change having a large adverse effect on growth. Based on these findings, it is clear that the per capita GD, which is our indicator for economic growth of the CLV countries is statistically dependent on remittance inflows.

Table 5: Non-linear panel ARDL estimation

Variables	Coefficient	Standard error	P-value
lk	0.489	0.253	0.067***
$lREM_t^+$	0.113	0.059	0.068***
$lREM_t^-$	0.241	0.081	0.007*
$lICT$	0.049	0.003	0.000*
$ICTREM$	0.016	0.004	0.001*
Δlk	0.439	0.304	0.167
$\Delta lREM_t^+$	0.024	0.006	0.001*
$\Delta lREM_t^-$	0.078	0.009	0.000*
$\Delta lICT$	0.022	0.041	0.591
$\Delta ICTREM$	0.049	0.028	0.092***
Constant	0.962	0.0059	0.000*
$\hat{\varsigma}_{t-1}$	-0.248	0.126	0.063***
Hausman test	0.959 (0.302)		
Log-likelihood	251.183		
No. of Obsv	52		
Error correction term for each country			
Cambodia	-0.485	0.005	0.000*
Laos	-0.156	0.001	0.000*
Vietnam	-0.201	0.004	0.000*

Note: *, ** and *** indicate statistical significance at 1%, 5% and 10% respectively. "+" and "-" denote positive and negative partial sums respectively. The probability value for the Hausman test is in the brackets.

The error correction term (ECT) coefficients for the two panels are negative and statistically significant ($\hat{\tau}_{t-1}$ =-0.73 for the linear panel and $\hat{\varsigma}_{t-1}$=-0.24 for the non-linear panel). The error-correcting speed for these transitioning countries is higher in the linear setting. For instance, any shock to the linear model will be adjusted by about 73 percent, and the system converging to the long run in about 1.3 years, while for the nonlinear model the adjustment is about 24 percent and long-run convergence to equilibrium will take about 4 years. Besides this PMG estimator also gives the individual country groups error model. In Tables 1 and 3, the error correction coefficient of each country in each panel is shown. From these ordered error correction estimates, all the countries have a negative and statistically significant coefficient, implying that there is a long-run cointegration relationship. The overall speed of adjustment is fastest in Cambodia followed by Vietnam and Laos.

To account for differences in the three transition countries and to see whether there is a country difference in growth effects of remittances, we use heterogeneous regressions for each country by applying the times series process (see appendix Table A3). Overall, the estimates of times series provide evidence the remittances contribute to long-run economic growth. The impact is about 0.47, 0.109, and 0.05 percent for a percent increase in REM in the long run for

Cambodia, Laos, and Vietnam, respectively. The effect of interaction terms of ICT and REM remains positive and significant. The nonlinear analysis also provides support for the asymmetric effect of remittances on economic growth in country-wise analysis. Excerpt for Laos, all the transition countries have larger negative partial sum effect of remittances.

5. Conclusion and policy implications

This study investigates the impact of REM inflows on economic growth in three transitional economies in the ASEAN region. Besides modeling the linear panel ARDL model, we account for the asymmetric nature of the relationship, by formulating a nonlinear panel ARDL model following the time series panel data framework of Shin et al. (2014), which is similar to the non-stationary heterogenous panel model without asymmetries. The linear model results reveal that REM inflows have a statistically significant and positive effect on real per capita GDP. ICT and remittances are found to be having a mutual growth effect in these transition economies. Our result based on a nonlinear model reveals that the economic growth of the three countries responds asymmetrically to changes in REM inflows. Although, an increase in inward REM has a positive impact on economic growth and a decrease in REM harms economic growth, the magnitude of negative partial sum decomposition of REM is much larger than the magnitude of the positive partial sum effect of REM.

From the policy perspective, our results highlight that the CLV countries are vulnerable to fluctuations in REM, particularly the negative shock in REM flows. In the context of the current economic crisis unleashed by Covid-19, the CLV countries would face challenges in regards to maintaining REM inflows and/or reducing dependency on REM inflows. It is vital that productive use of REM such as investment in human capital and small-medium enterprise development is encouraged and appropriate social safety net policies are pursued. It is also crucial to invest in ICT including access, education, and training, which will not only facilitate formal channels of remitting foreign resources and reduce cost but link recipients to mainstream formal economy activity.

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APPENDIX

Table A1: Country key indicators

Cambodia	2000	2005	2015	2016	2017	2018
Area (sq.km)	176520	176520	176520	176520	176520	176520
Population (million)	12.5	13.3	15.1	15.2	15.4	15.6
Real GDP growth (%)	10.7	13.2	7.0	7.0	7.0	7.4
Per capita real GDP (US$)	431.2	613.1	1024.6	1079.6	1137.8	1205.0
Structure (% of GDP)						
Agriculture	37.8	32.4	28.2	26.3	24.9	23.5
Industry	23	26.4	29.4	31.3	32.8	34.4
Services (% of GDP)	39.1	41.2	42.3	42.4	42.3	42.1
Exports (% of GDP)	38.1	46.2	51.7	51.3	50.6	52.8
Imports (% of GDP)	52.8	62.3	73.6	70.5	69.9	76.5
Current A/C balance (% of GDP)	-3.7	-4.8	-8.6	-8.5	-8.1	-12.1
Tourism earnings (% of GDP)	9.3	14.7	18.9	17.4	18.1	19.6
FDI (% of GDP)	3.2	6	10.1	12.3	12.6	13.1
Remittances (% of GDP)	2.8	2.6	6.6	6	5.8	5.8
Laos	2000	2005	2015	2016	2017	2018
Area (sq.km)	230800	230800	230800	230800	230800	230800
Population (million)	5.09	5.62	6.49	6.59	6.68	6.78
Real GDP growth (%)	5.7	7.1	7.2	7.0	6.8	6.2
Per capita real GDP (US$)	672.8	842.9	1538.8	1621.7	1706.7	1785.5
Structure (% of GDP)						

Agriculture	48.5	36.7	19.7	19.5	18.3	17.7
Industry	19.1	23.5	32.5	32.5	34.9	35.3
Services	32.4	39.8	48	48	46.8	46.8
Exports % of GDP	20.2	20.4	25.4	26.9	28.9	29.2
Imports % of GDP	32.7	32.5	39.4	34	33.6	34
Current A/C balance (% of GDP)	-0.4	-6.3	-15.7	-8.7	-7.4	-7.9
Tourism earnings (% of GDP)	6.5	5.2	5.0	4.5	3.8	4.2
FDI (% of GDP)	2.0	1.0	7.4	5.9	1.0	7.4
Remittances (% of GDP)	0.04	0.03	1.3	1.2	1.4	1.3

Vietnam	2000	2005	2015	2016	2017	2018
Area (sq.km)	325490	325490	325490	325490	325490	325490
Population (million)	77.1	81.9	91.7	92.6	93.6	94.7
Real GDP growth (%)	6.7	7.5	6.6	6.2	6.8	7.0
Per capita real GDP (US$)	765.1	1018.1	1667.1	1752.5	1852.9	1964.4
Structure (% of GDP)						
Agriculture	24.5	19.3	18.9	18.1	17	16.3
Industry	36.7	38.1	37	36.4	37.1	38
Services	38.7	42.6	44.2	45.5	458	45.7
Exports (% of GDP)	46.3	56.3	83.8	86	96.1	88.4
Imports (% of GDP)	45.1	60.5	80	80.6	91.3	92.6
Current A/C balance (% of GDP	3.5	-0.9	-1.0	0.3	-0.7	2.4
Tourism earnings (% of GDP)	NA	3.9	3.8	4.1	3.9	4.1
FDI % of GDP	4.2	3.4	6.1	6.1	6.3	6.3
Remittances % of GDP	4.3	5.5	6.7	6.8	6.7	6.5

Source: ADB (2019) and World Bank (2019).

Table A2: Remittance and Mobile usage for Cambodia, Laos, and Vietnam

	2000-09	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Cambodia									
Remittance (% of GDP)	2.45	4.96	4.76	6.08	6.59	6.60	6.57	5.99	5.84
Mobile Phones subscriptions per 100	13.10	56.96	94.63	129.29	134.89	133.93	134.37	126.35	116.04
Laos									
Remittance (% of GDP)	0.15	0.59	1.26	1.99	1.43	1.42	1.31	1.20	1.50
Mobile Phones subscriptions per 100	14.69	64.09	86.54	67.03	71.02	70.23	55.93	58.57	54.12
Vietnam									
Remittance (% of GDP)	5.48	7.12	6.35	6.42	6.42	6.44	6.83	5.79	6.16

Mobile Phones subscriptions per 100	29.86	126.11	142.36	145.57	135.23	147.12	128.59	127.53	125.62

Note: The value for the year 2000-09 represents the average value of resources transfers from the year 2000 to 2009. Source: World Bank (2019).

Table A3: Country wise linear and nonlinear estimates

	Panel A: Linear estimate of REM			
Cambodia		Coef	Std error	P-value
	lk	0.414	0.06	0.000*
	lrem	0.479	0.175	0.008**
	lmob	0.035	0.008	0.000*
	lICTREM	0.198	0.092	0.035**
Laos		Coef	Std error	P-value
	lk	0.308	0.048	0.000*
	lrem	0.109	0.018	0.000*
	lmob	0.009	0.001	0.000*
	lICTREM	0.047	0.008	0.000*
Vietnam		Coef	Std error	P-value
	lk	0.316	0.023	0.000*
	lrem	0.05	0.012	0.000*
	lmob	0.007	0.004	0.038**
	lICTREM	0.006	0.002	0.012**
	Panel A: Nonlinear estimate of REM			
Cambodia		Coef	Std error	P-value
	lk	0.351	0.104	0.000*
	$lrem^{+}$	0.925	0.492	0.064***
	$Lrem^{-}$	1.17	0.671	0.086***
	lmob	0.025	0.007	0.001**
	lICTREM	0.428	0.242	0.082***
Laos		Coef	Std error	P-value
	lk	0.233	0.063	0.000*
	$lrem^{+}$	0.113	0.017	0.000*
	$Lrem^{-}$	0.09	0.024	0.000*
	lmob	0.007	0.012	0.57
	lICTREM	0.046	0.008	0.000*
Vietnam		Coef	Std error	P-value
	lk	0.336	0.023	0.000*
	$lrem^{+}$	0.04	0.013	0.005**
	$Lrem^{-}$	0.097	0.019	0.000*
	lmob	0.045	0.006	0.000*
	lICTREM	0.005	0.001	0.004**

Note: * is significance at 1%, ** is significance at 5% and *** is significance at 10%.