

## **Remittances and deforestation in developing countries: Is institutional quality paramount?**

Dr. Komivi AFAWUBO

CEREFIGE EA3942-University of Lorraine-France

54037 Nancy Cedex, France

CRESE EA3190-University of Bourgogne Franche-Comté

F-25000 Besançon, France

komivi.afawubo@univ-lorraine.fr

Dr. Yawo Agbényegan NOGLO

Research Center : Mosaiques-LAVUE, Paris West University Nanterre La Defense, France

P.O.B. 200 Avenue de la République, 92001 Nanterre Cedex, France.

Research Observatory : CAP-Afriques, University of Québec in Montréal (UQAM), Canada

Lecturer at INSEEC MSc & MBA Institute, Paris

Mail : noglohonore@hotmail.fr

## **Remittances and deforestation in developing countries: Is institutional quality paramount?**

### **Abstract**

This study examines the impact of remittance inflows on deforestation in developing countries. We also investigate the role of institutional quality in enhancing remittances' effect in reducing deforestation. Our results suggest that overall remittances reduce deforestation. We show that remittances' reduction effect on deforestation is greater in middle-income countries than in low-income countries. Considering institutional quality, our findings suggest that, for the entire sample, and in low- and middle-income countries, control of corruption, political stability, government effectiveness and rule of law act to reduce deforestation. Moreover, institutional quality enhances the impact of remittances on reducing deforestation in the entire sample and in middle-income countries. In contrast, in low-income countries, institutional quality does not complement remittances to reduce deforestation.

These results imply that, to reduce deforestation rates, the focus should not only be on economic development, but to an even greater extent, on institutional quality.

Keywords: Deforestation; Remittances; Institutional quality; Developing countries

JEL: Q23; F24; P37; O10

## **I- Introduction**

Deforestation is currently one of the key environmental issues in the context of climate change and loss of biodiversity. Hansen et al. (2013) define forest loss as a stand-replacement disturbance or the complete removal of tree cover canopy at the Landsat pixel scale. The same authors define forest gain as the inverse of loss, or the establishment of tree canopy from a no-forest state.

Several recent studies have provided information about the evolution of deforestation. Due to different data sources, these studies lead to different assessments of global forest resources. According to the last Forest Resource Assessment (FRA) by FAO (2015), deforestation has slowed down: the net annual rate of loss slowed from -0.18% in the 1990s to -0.08% between 2010 and 2015. This decreasing trend is at odds with Kim et al. (2015), who show that deforestation increased by 62% in the 2000s compared to the previous decade. Kim et al.'s (2015) findings use data similar to the dataset employed by Hansen et al. (2013) and also are based on land cover imagery processing.

Economists have long studied the determinants of deforestation. Responsible factors include economic development (Culas, 2012; Chiu, 2012), institutional factors (Culas, 2007; Galinato and Galinato, 2013), plantations (Heilmayr, 2014), and agricultural activity (Barbier, 2004).

To the best of our knowledge, studies linking migrants' remittances and deforestation are still rare, but some research has provided interesting lessons. According Lopez-Feldman and Chavez (2017), theoretically, the impact that remittances have on local environment is ambiguous. Indeed, for these authors, as remittances alleviate poverty, they might allow households to use market goods instead of extracting natural resources locally (e.g., gas instead of firewood) but they could also increase the demand for goods that put more pressure on the local environment (e.g., locally raised meat). Thus remittances could decrease or increase the pressure on natural resources. As for Hecht et al. (2006), if remittances could help to preserve or regenerate forest areas, they could also produce the opposite effect depending on the context. According to Duval and Wolff (2009), transfers of funds by migrants significantly influence the process of deforestation in developing countries.

This article aims at providing a new study of the impact of international remittances on deforestation in developing countries. This research is interesting for several reasons. First, the issue of the influence of migrants' financial transfers continues to play an important role in economic debates. For developing countries, these transfers represent a source of external financing twice as high as the development aid they receive, and equivalent to almost two-thirds of their foreign direct investment (Ratha, 2005, cited in Duval, 2009). Also, the graphs in appendices 1 and 2 indicate a significant increase in remittances from 1995 to 2014 in low- and middle-income countries. In low-income countries (appendix 1), although net official development assistance (ODA) is higher than remittances, the latter have increased since 1995 (1.29% of GDP) to 4.86% of GDP in 2014. As regards middle-income countries (appendix 2), remittances are higher than net ODA and, after a peak reaching 1.79% of GDP in 2003 and 1.71% of GDP in 2007, sharply decreased to 1.43% of GDP in 2014. Secondly, forests play an essential role in the subsistence of rural poor people in developing countries, as they are also a source of food (meat, vegetables, fruit, etc.). The World Bank estimates that more than one billion people live in and around forests (World Bank, 2006). In addition, the World Bank estimates that more than 2 billion people depend on wood for their energy needs, mainly for cooking and heating (World Bank, 2006).

Moreover, what makes this research unique is that it extends the global study by Duval and Wolff (2009). This is because it uses more recent data from 1996 to 2014, while the Duval and Wolff (2009) study was based on old data (between 1990 and 2005). In addition, for the first time in the economic literature, our study also involves a decomposition of low- and middle-income countries.

The aim of our research is to explore whether remittances could improve people's living conditions and therefore divert them from deforestation activities. Comparing remittance levels between low-income and middle-income countries (see Appendices 1 and 2), we find that the level of remittances in low-income countries is much higher than that of middle-income countries in our study period. Therefore, we hypothesize that low-income countries will benefit more from remittances (Appendix

1 vs. Appendix 2), which could improve people's living conditions and therefore reduce the burden of deforestation. On the other hand, middle-income countries with better living conditions will receive fewer remittances (Appendix 1 vs. Appendix 2) so that ultimately remittances will not be able to hugely and significantly reduce deforestation.

Finally, we introduce an innovation into our approach that no longer exists in any literature, i.e. the influence of institutional quality. This new approach is intended to clarify for the first time whether or not institutional quality mitigates the influence of international remittances on deforestation. As a result of this study, we can understand in a more comprehensive way, both globally and specifically (income levels), how migrants' financial transfers impact deforestation in developing countries in the case of institutional involvement.

The present work seeks to help fill the gap left in the literature by attempting to answer the following questions: Could low-income countries with higher remittance inflows make a greater contribution to reducing deforestation than middle-income countries with lower remittance inflows? What is the role of institutional quality in this relationship?

We carried out a panel analysis on 106 countries for the period 1995-2014, using remittances and the standard explanatory variables used in the literature. We estimate three econometric models namely OLS FE, OLS RE and GMM, on the overall sample and on the decomposition into low- and middle-income countries. Our results suggest that overall remittances reduce deforestation in developing countries and also in low- and middle-income countries taken separately. In contrast with our hypothesis, the effect on reducing deforestation is more acute in middle-income countries than in low-income countries. This could be explained by the fact that remittances, although high in low-income countries, do not significantly reduce the extreme poverty in these regions and consequently only slightly reduce deforestation compared to middle-income countries.

The interaction effects between remittances and institutional quality (control of corruption, political stability, effectiveness and the rule of law) are also addressed. For the entire sample, the results show

that the control of corruption and government effectiveness accentuate remittances' negative impact on deforestation. Considering low-income countries, the cross effects between remittances and the four institutional quality variables are not significant in any of the models. Hence, the institutional environment does not significantly influence remittances' impact on deforestation. As regards middle-income countries, the interaction impact of remittances and the four institutional quality variables reduces deforestation. Thus, the institutional framework of middle-income countries further increases the advantageous effect of remittances to combat deforestation. Thus, if remittances can have an impact on reducing deforestation, institutional quality is paramount in order to permit these financial flows to be effective. Control variables, such as GDP per capita, square GDP per capita, GDP per capita growth, population density, openness, and terms of trade, also provide interesting results that will be analyzed.

The paper is organized as follows. After presenting a literature review of different determinants of deforestation, we describe the empirical strategy and the data. Then, we provide the results of the impact of international remittances on deforestation and the influence of institutional quality. The paper ends with some concluding remarks.

## **II- Literature review**

Although there is an impressive literature on the determinants of deforestation, few studies have been devoted to the link between remittances and deforestation. This literature review first presents these works and then sheds light on other factors that affect forest cover in order to highlight the importance of the issue of deforestation.

The few studies that address the issue of remittances and deforestation include Hecht et al. (2006), Duval and Wolff (2009), and López-Feldman and Chávez (2017). Hecht et al. (2006) in their study of globalization and forest resurgence in El Salvador, prove that remittances contribute to forest recovery. Remittances in this country average roughly US\$121/month, which is about the equivalent

of the minimum wage, and are received by about one-fifth of all rural households. As remittances supplement the incomes of the poor, many rural households prefer to rely on remittances and wages rather than sell farm produce, and have consequently ceased to grow annual crops. This behavior has reduced agricultural land pressure and so deforestation. However, Hecht et al. (2006) also observe that elsewhere in Latin America, capital is employed to extend agriculture and pasture, and increasing capital is often more correlated with deforestation. Duval and Wolff (2009) conducted a cross-country analysis for 102 developing countries from 1990 to 2005. They demonstrate econometrically that remittances permit forest resurgence. For these authors, from a macroeconomic point of view, financial flows from international emigration allow developing countries to import more agricultural goods from other countries. This reduces the conversion of forests to arable land, which is recognized as an important factor of deforestation. López-Feldman and Chávez (2017) used the village survey from the Mexico Rural Household Survey to study econometrically the link between remittances and natural resources in Mexico. Their findings show that the international remittances sent back by migrants to their communities of origin significantly decrease households' participation in natural resource extraction, and also reduce their involvement in agriculture with a move into wage and service activities.

Other determinants of deforestation exist taking different approaches. In the 1950s, Kuznets introduced the stylized Kuznets Curve, which is an inverse U-shaped link between income and inequalities. This non-linear relationship was then extended to environmental issues and is known as the Environmental Kuznets Curve (EKC). Environmental deterioration increases in the early stages of development, and reduces as the economy develops beyond a certain point. The application of EKC to deforestation issues explains the U-shaped evolution from high forest cover to decreasing forest cover that has taken place in many developed countries.

In line with the EKC concept, Buitenzorgy and Mol (2011) conducted an empirical study of 177 countries between 1990 and 2000, to observe the link between democracy and deforestation.

According to these authors, the EKC relationship between deforestation and democracy suggests that deforestation rates increase from the beginning of democracy until a democracy threshold is reached, after which more democracy leads to a lower rate of deforestation. In other words, there would be less deforestation in an autocracy or a mature democracy, and more deforestation in a semi-democracy or in transitional countries, i.e. the democratic transition peak (Buitenzorgy and Mol, 2011). Another aspect of EKC is stated by Angelsen and Kaimowitz (1999). Indeed, they observe in the short run a positive correlation between a country's overall income and its general demand for agricultural products, leading to agricultural land expansion that ultimately promotes deforestation. However, once a certain level of income and capital stock is reached, the country is able to switch from an agricultural-based economy to an industrial-based economy, because farmers leave their lands for better-paid urban jobs (Wolfersberger et al., 2015). Agricultural production then becomes more intensive, and some previously abandoned lands revert to forest. Choumert et al. (2013) express reserves about the absolute validity of such stylized facts and several empirical studies on deforestation have tested this relationship to find contradictory results.

Faria and Almeida (2016) study the link between trade and deforestation in the Brazilian Amazon between 2000 and 2010, using data from a balanced panel of 782 municipalities. Combining standard econometrics with spatial econometrics, they show that deforestation in the Amazon is positively related to openness to trade. Barbier et al. (2005) find that an improvement in trade terms (i.e. price increase of exports higher than that of imports) in a country with forests increases producers' prices. This deterioration in price competitiveness promotes deforestation. Arcand et al. (2008) have shown that a depreciation in the real exchange rate can increase exports of commodities in countries from the south, and thus increase deforestation.

Gaveau et al. (2016), on the basis of satellite imagery and examining the impact of an industrial plantation in Borneo between 1973 and 2015, find that this plantation has been the primary cause of



deforestation of old-growth forest in the Malaysian part of the island, and to a lesser extent in the Indonesian part.

Liscow (2013), by investigating the relationship between property rights and deforestation in Nicaragua, highlights that land title ownership significantly reduces forest cover given that land titling increases investment and agricultural productivity. By contrast, through an econometric estimation of panel data on Brazilian Amazonian states from 1988 to 2000, Araujo et al. (2009) prove that insecure land property rights drive deforestation. The reason put forward by these authors is twofold. First, squatters may obtain official recognition and formal property titles after invading land plots and clearing the forest. Second, for corruption reasons, landowners may clear the forest to assert the productive use of land and deter the risk of expropriation. Thus, institutional quality is instrumental in the deforestation process (Bohn and Deacon, 2000; Barbier and Burgess, 2001; Bhattari and Hamming, 2001; Culas, 2007; Nguyen-Van and Azomahu, 2007). More broadly, weak governance in developing countries with forests (Barbier et al., 2005), higher corruption, and lower institutional quality (Nguyen-Van and Azomahou, 2007) often lead to higher rates of deforestation.

Kuusela and Amacher (2015) employ panel data between 1961 and 2008 to investigate the influence of political regime changes on tropical deforestation. According to these authors' results, unlike in Asia, new democratic regimes in Latin America and Africa have accelerated the expansion of agricultural and thus tropical deforestation. The same study reveals that new autocratic regimes have had a positive effect on the rate of deforestation, but this impact has been relatively smaller in Africa. Finally, Kuusela and Amacher (2015) find that established democracies have had no statistically significant effect on tropical deforestation.

Barbier (2004) demonstrates through a panel of 178 developing and advanced countries that greater expansion of agricultural land increases forest clearing. Damette and Delacote (2011) in their panel-data analysis show that timber harvesting is strongly and positively correlated with deforestation. For these authors, this strong link implies that demand for timber products is notably fulfilled by

unsustainable timber harvesting. Not only do these results hold for the whole set of countries, but they are stronger when focusing on low-income countries and considering outliers.

Population density is often mentioned as one of key factors that puts pressure on natural resources, including forests. In developing countries endowed with forest resources, rural populations migrate when access to land is improved; they convert forests into croplands and harvest trees for fuelwood, timber, and other forest products (Leblois et al., 2017). In fact, since Cropper and Griffiths (1994) carried out a seminal work on the issue, many econometric studies have shown that population positively influences deforestation in developing countries. Koop and Tole (2001) worked on inequality and deforestation on the basis of FAO data concerning forest cover loss for 48 tropical developing countries between 1961 and 1992. In countries where levels of inequality are high, development is likely to worsen deforestation rates. On the flip side, in countries where distributional profiles are more egalitarian, the negative effects of growth and development on forest cover are ameliorated. Thus, the more egalitarian a country is, the less deforestation takes place.

### **III- Data, variables and methodology**

#### *Data*

This study uses a data sample comprising 106 countries over the period 1996-2014. Appendix 3 presents the list of countries by income level. The data concerning the forest area (measured in thousands of hectares) are extracted from the World Bank data base. The dependent variable, the deforestation rate, is defined as:

$$Deforestation_{it} = -\frac{(F_{it} - F_{it-1})}{F_{it-1}}$$

Where  $F_{it}$  is the forest area of country  $i$  in year  $t$ . More specifically, the forest area is measured as the sum of the wooded natural area, the planted area, and the already deforested area due to be reforested

in the near future. This definition was proposed by FAO and is commonly used in most empirical studies such as Cropper and Griffiths (1994), Shafik (1994), Koop and Tole (1999), Bhattarai and Hammig (2001), and Duval and Wolff (2006). The interest of this definition is that it takes into account a wide variety of measures of forest types (wooded area, plantations, fallow forests, wooded savannas, etc.). The FAO definition is certainly not exclusive, but it has the merit of being intuitive and covering most countries (Allen and Barnes, 1985, and Koop and Tole, 1999).

### *Variables*

Firstly, we use personal remittances received (% of GDP) to measure the effect of remittances on deforestation.

Secondly, we use deforestation's explanatory variables generally present in the literature described in Section 2. This section lists these determinants, mentioning the names of variables tested in our empirical analysis.

To take into account the effect of the level of development in our model, we introduce GDP per capita (constant 2005 US\$) and its annual growth rate (GDP pc growth, 2005 constant).

Population pressure is measured by the country's average population density (population density: thousands of people per square km).

Agricultural expansion is known to be the main cause of forest conversion. We therefore consider an annual agricultural production index (agricultural production index (2004-06 = 100)).

We also test the role of cropland (agricultural land as a percentage of the country's land area), because greater agricultural land expansion could increase forest clearing.

A supplementary variable for agricultural trade is taken from the FAO statistical database: total lagged value (unavailable) of exports of forestry and agricultural products. All of these variables were extracted from the FAO website in January 2016.

The Gini index is also introduced into our model following Duval and Wolff (2006).

Finally, the influence of international trade is controlled for the use of the opening rate (openness at constant 2005 prices: the sum of imports and exports as a percentage of total GDP) and relative comparative advantage (terms of trade: relative export prices in terms of imports). The variables are extracted from the World Bank database, see appendix 4 for the descriptive statistics.

It should be noted that the determinants of deforestation that we use in this study are consistent with those used by Damette and Delacote (2011).

We use different variables in terms of institutional quality. To account for the influence of institutional quality, we test on remittances received, control of corruption, rule of law, political stability and absence of violence, and government effectiveness, all provided by the Worldwide Governance Indicators (WGI) database. The measures of institutional quality range from approximately -2.5 to +2.5, with higher values corresponding to better governance.

### *Methodology*

In the first stage, we introduce remittances according to equation 1 and estimate their impact on deforestation.

$$Deforestation_{it} = \beta_0 + \beta_1 Remitances_{it} + \beta_2 X_{it} + \mu_t + \eta_i + \varepsilon_{it} \quad (1)$$

Where  $Remitances_{it}$  represent personal remittances received in countries  $i$  at time  $t$ ,  $X_{it}$  is the other explanatory variables, such as population density, agricultural production index, etc.  $\mu_t$  is a time-specific effect,  $\eta_i$  is an unobserved country-specific fixed effect, and  $\varepsilon_{it}$  is the error term.

To estimate Equations (1), we employ the fixed effects (FE) and random model, and to take into account the EKC hypothesis, we incorporate into all estimates (FE, RE) a GDP squared term following Damette and Delacote (2011).

We lag the potentially endogenous variable stacked in X (Agricultural production index, Crop production index, GDP per capita, and its squared value, Openness, Agricultural and forest export value per surface exploited) in order to avoid reverse causality issues in our regressions.

To test the robustness of our results, we use an alternative method to the previous OLS, namely a System-GMM model (equation 2) that addresses the issue of plausible endogeneity of the independent variables used to explain deforestation. The System-GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998) is supposed to solve the problem of Nickell (1981) in the OLS model.

$$Deforestation_{it} = \alpha + \beta_0 Deforestation_{it-1} + \beta_1 X_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

Where  $i$  refers to the country and  $t$  refers to the time period from 1996 to 2014 and  $|\beta_0| < 1$ . The disturbance term has two orthogonal components: the fixed effects  $\mu_i$  and idiosyncratic shocks,  $\varepsilon_{i,t}$  given the fact that in both equations the error term is correlated with the lagged dependent variable. The following time conditions below (equation 3) associated with System-GMM allow us to estimate the coefficients of the model:

$$\left\{ \begin{array}{l} E(\mu_i) = 0, E(\varepsilon_{it}) = 0, E(\varepsilon_{it}\mu_i) = 0, \text{ for } i = 1, \dots, N \text{ and } t = 2, \dots, T \\ E(\varepsilon_{it}\varepsilon_{is}) = 0, \text{ for } i = 1, \dots, N \text{ and } \forall t \neq s \\ E[(Deforestation_{it})(\varepsilon_{it})] = 0 \text{ for } i = 1, \dots, N \text{ and } t = 2, \dots, T \\ E[(Deforestation_{it-1})(\varepsilon_{it})] = 0 \text{ for } i = 1, \dots, N \text{ and } t = 2, \dots, T \\ E[(X_{it})(\varepsilon_{it})] = 0 \text{ for } i = 1, \dots, N \text{ and } t = 2, \dots, T \end{array} \right. \quad (3)$$

The System-GMM approach addresses issues of lagged dependent variables, unobserved fixed effects, endogenous independent regressors, and the presence of heteroskedasticity and autocorrelation across and within individuals or countries (Roodman 2009).<sup>1</sup> The system-GMM is perceived as being better than the difference-GMM for addressing lagged dependent variables issues. Arellano and Bover (1995) and Blundell and Bond (1998) develop the system-GMM by including an

---

<sup>1</sup> See also Harris et al. (2008) for an overview of different dynamic panel models.

equation in levels in addition to the differenced equations. Lagged levels of the regressors are used as instruments for the first difference regressors. However, for variables that closely follow a random walk, lagged levels can be poor instruments for first differences. Efficiency is gained through the use of additional instruments, and the system-GMM makes the assumption that the differenced variables instruments used are uncorrelated with country-fixed effects.

We used a two-step robust estimation that adjusts standard errors for autocorrelation and heteroskedasticity<sup>2</sup>. The first is the Sargan/Hansen test of over-identifying restrictions. The second examines the hypothesis that there is no second-order serial correlation in the first-differenced residuals. To avoid the problem of instrument proliferation (Roodman, 2009), the matrix of instruments is collapsed and the number of lags is set at a level which ensures that the number of instruments is lower than the number of cross sections.

#### **IV- Results and discussion**

Table 1 shows for the three models, OLS (FE and RE) and S-GMM, that remittances significantly reduce deforestation in the full sample. This result could have several interpretations. First, as Duval and Wolff (2009) stipulate, financial flows from international emigration allow developing countries to import more agricultural goods from other countries, consequently reducing forest conversion to arable land. Second, this result also confirms some of the hypotheses made by López-Feldman and Chávez (2017), and Hecht et al. (2006), for whom the remittance of external funds could have a negative impact on deforestation. Indeed, as López-Feldman and Chávez (2017) point out, remittances from migrants living abroad provide additional income to the beneficiaries and are therefore an effective tool for reducing poverty. This improvement in the monetary conditions of the recipient populations enables them to consume market goods and thus diverts them from the extraction of forest resources for their survival. Migrants' financial transfer may be perceived as

---

<sup>2</sup> Note that country-fixed effects are not explicitly included in system-GMM estimations. The system includes equations in levels and differences. They are purged in the differenced equations and are not included in the level equations since they would introduce bias (Roodman, 2009).

successful migration. As a result, from this point of view, a highly restrictive immigration policy in developed countries does not help to protect the environment.

The other remittance explanation variables also show interesting results. GDP growth has a direct and significant relationship with deforestation. However, the square of GDP per capita does not reduce deforestation. Thus, the EKC is not verified. This result is consistent with Choumert et al. (2013). Moreover, population density (see the FE and RE models), agricultural land (see the RE model) and openness (see the RE model) are significant drivers of deforestation. These findings are in accordance with Leblois et al. (2017), Cropper and Griffiths (1994) for population density, Barbier (2004), and Damette and Delacote (2011) for agricultural land, and Faria and Almeida (2016) for openness to trade. Faria and Almeida (2016) argue that the more open a country is to the world, the greater the impact on land use due to variations in agricultural commodity prices. However, Nguyen-Van and Azomahou (2007) did not find a significant effect on deforestation when using an openness rate. Agricultural production, proxied by the lag of crop production index, is positively related to the deforestation rate in the GMM model.

This finding is in line with the results of Damette and Delacote (2011). Institutional quality variables, namely, control of corruption and government effectiveness, significantly reduce deforestation in the 3 estimated models (FE, RE and GMM). These results are in line with many previous empirical studies, such as Aroujo et al. (2009), and Nguyen-Van and Azomahou (2007) for corruption, and Liscow (2013) for government effectiveness (i.e. the land title system works). However, note that institutions are not significant in other studies using FAO data, such as Aisbert et al. (2013). The differences in the period considered probably lead to this contradictory result. The increase in inequalities is an aggravating factor in deforestation and this result is significant in the GMM model. As highlighted by Koop and Tole (2001), the more egalitarian a country's distributional profiles, the greater the amelioration of negative effects of growth and development on forest cover.

[Table 1]

We now analyze the results in Tables 2 and 3 by distinguishing countries according to their level of income. We make this distinction because of differences in forest composition according to income level (Damette and Delacote 2011).

Table 2 provides the results for low-income countries. We find here a negative link between remittances and deforestation (FE and RE models). Thus, remittances make it possible to lift people out of poverty and divert them from the extraction of forest resources, as mentioned previously in the general model (Table 1). Table 3 presents the results of middle-income countries. The relationship between remittances and deforestation is also negative with respect to RE and S-GMM models. It should be noted that the coefficient of the impact of remittances on deforestation in middle-income countries (-0.313; -0.512; 0.813) is greater than that of low-income countries (-0.019; 0.001; 0.125) respectively in the FE, RE and S-GMM models. These results invalidate our basic assumption. Remittances reduce deforestation in middle-income countries more than in low-income countries. Remittances could not have improved the standard of living of the population in low-income countries because of the extent of extreme poverty and therefore the reduction of deforestation is significantly less than in low-income countries.

[Table 2]

[Table 3]

In Table 2, there seems to be an EKC, but the results of square GDP per capita reflecting the concavity are not significant. GDP per capita is positively and significantly related to forest losses (RE model) and this might be explained by the fact that in these poorest countries, economic activity is more strongly focused on primary production. This explains why deforestation is directly related to GDP per capita. Trade increases deforestation in the S-GMM model and the same effect is observed for crop production in all three models. Note that crop production seems to be driving deforestation globally because it is found to be non-significant in middle-income countries (Table 3). This can be



explained by the fact that agriculture is more extensive in low-income countries, accentuating the link between agricultural production and forest clearance.

The same kind of rationale may explain the non-significance of population density in low-income countries where population density is low, which could blur its relationship with deforestation. As before, the variable of institutional quality, such as control of corruption, is positive and significant for forest regeneration (FE and RE models). Moreover, the other variables of institutional quality (political stability) significantly reduce the rate of deforestation for the 3 econometric estimates. The latter observation is consistent with Kuusela and Amacher (2015), who find that in tropical countries, new democratic regimes increase the agricultural expansion and thus deforestation. At the same time, our result contradicts Kuusela and Amacher (2015), who demonstrate that a new autocracy is significantly positive for the rate of deforestation although this effect is relatively smaller in Africa. However, these findings reflect those of Buitenzorgy and Mol (2011), who show that deforestation rates are higher in semi-democratic and transitional countries.

In Table 3, EKC is not verified; population density (S-GMM) and openness (S-GMM) significantly increase deforestation in this group of countries. The population density impact is due to the fact that in middle-income countries, population density is high, strengthening the link with the destruction of woodlands. Degradation in terms of trade decreases deforestation in the S-GMM model. This finding is in line with Barbier et al. (2005) and Arcand et al. (2008) and can be explained by the fact that commercial agriculture has a larger impact on deforestation (Hosonuma et al., 2012). The institutional quality variables (control of corruption, political stability, effectiveness, rule of law) significantly reduce deforestation. These results correspond to those of Kuusela and Amacher (2015) for political stability, Aroujo et al. (2009), and Nguyen-Van and Azomahou (2007) for control of corruption, and Liscow (2013) for effectiveness.

We also observe in middle-income countries a positive impact of inequality on the deforestation rate (models FE and RE) reflecting once again the observations of Koop and Tole (2001).

### *The role of institutional quality*

While remittances have the potential to reduce deforestation, a strong institutional quality in the host country could strengthen this relationship. We test whether the quality of institutions in recipient countries reinforces the effects of remittance inflows on deforestation. In other words, we attempt to establish whether the level of institutional quality in recipient countries affects the impact of remittances on deforestation. To our knowledge, this is the first such exercise measuring how the impact of remittance flows on deforestation interacts with institutional quality. To this end, we interact the remittance variable with our four previous institutional quality variables and test for the significance of the interacted coefficient. A positive coefficient would indicate that institutional quality does not enhance the capacity of remittances to reduce deforestation. On the other hand, a negative coefficient would imply that the reduction effects of remittances on deforestation are enhanced in the presence of a strong institutional environment.

We therefore estimate the equation (4) where  $Remittances_{it} * institutional\_quality_{it}$  represents the interaction term of remittances and institutional quality.

$$Deforestation_{it} = \beta_0 + \beta_1 Remittances_{it} * Institutional\_quality_{it} + \beta_2 X + \mu_t + \eta_i + \varepsilon_{it} \quad (4)$$

We estimate the equation (4) using OLS regressions and the results are presented in Tables 4, 5 and 6 respectively for the entire sample, low-income countries, and middle-income countries.

Table 4 presents how institutional quality affects the impact of remittances on deforestation in developing countries (low- and middle-income countries). We observe that control of corruption and effectiveness significantly accentuates the negative impact of remittances on deforestation in the three estimated models. This decisive impact of institutional quality is much more visible in low-income countries.

[Table 4]

Table 5 informs us that the cross-effect of institutional quality and remittances on deforestation is not significant in any of the econometric models in low-income countries. Institutional quality does not result in remittances having a significant impact on deforestation. Low-income countries have a low institutional quality, and this environment can be a handicap for remittances to play their full role in combating deforestation. Some people, although benefiting from these financial resources, may still be tempted to continue extracting forest resources if there is no effective institutional environment to discourage them. Thus, remittances, although necessary to reduce deforestation, do not constitute a sufficient condition to perpetuate this reduction in deforestation because the institutional environment is highly significant. Low-income countries need to be encouraged to improve their institutional quality in order to enhance remittances to sustainably reduce deforestation activities.

Contrary to the results in Table 5, in middle-income countries, the influence of institutional quality on the capacity of remittances to reduce deforestation is significant for all variables of institutional quality in Table 6. Middle-income countries have a more credible institutional environment than much poorer countries. As a result, people who emerge from poverty through remittances are constrained to adopt new behaviors.

[Table 5]

[Table 6]

### ***Robustness check***

In light of the main empirical results analysis, a simple robustness test consists in dividing the sample according to the level of institutional quality and comparing the impact of its interaction with remittances on deforestation. We divide the sample according to the median level (Giuliano and Ruiz-Arranz, (2009); Afawubo and Couchoro, (2017)) of the four variables of institutional quality and we estimate the equation (5). We expect to find a greater reduction effect of remittances on

deforestation in the subsample of countries where institutional quality is more developed (above the median level). In the sub-sample in which institutional quality is weak (below the median level), the effect on deforestation should be weak. The results are presented in Tables 7, 8, 9 and 10.

$$\left\{ \begin{array}{l} \text{Deforestation}_{it} = \beta_0 + \beta_1 \text{Remittances}_{it} * \text{institutional\_quality}_{it} + \beta_2 X + \mu_t + \eta_i + \varepsilon_{it}, \\ \text{if } \text{Institutional\_quality}_{it} \geq \text{median of Institutional\_quality}_{it} \\ \text{Deforestation}_{it} = \beta_0 + \beta_1 \text{Remittances}_{it} * \text{institutional\_quality}_{it} + \beta_2 X + \mu_t + \eta_i + \varepsilon_{it}, \\ \text{if } \text{Institutional\_quality}_{it} < \text{median of Institutional\_quality}_{it} \end{array} \right. \quad (5)$$

[Table 7]

Tables 7 and 8 present OLS estimates for low-income countries and show that the interaction impact of remittances and institutional quality is negative for the sample of countries with high institutional quality (above the median level) of control of corruption, political stability, government effectiveness and rule of law. On the other hand, the interaction impact of remittances and institutional quality on deforestation for the sample of countries with weak institutional quality (below the median level) is negative but not significant. The results are due to two effects: the first is that migration transfers considered as a share of GDP are particularly high in developing countries and are recognized as an instrument for combating poverty for the populations benefiting from them. However, as the World Bank (2006) points out, deforestation concerns large forestry companies just as much as poor people. In this perspective, by reducing the poverty of local populations, migratory transfers can help reduce deforestation and should have a beneficial impact on the environment. The second effect, as pointed out by Deacon (1994), Didia (1997) and Bhattarai and Hammig (2001), is that deforestation is accentuated in countries where democracy is weak and political institutions are poor. Moreover, property rights and the difficulties encountered in enforcing them in certain developing countries may also be factors that explain deforestation (Angelsen 1999; Deacon 1994). Conversely, strong institutional quality, public administration, and a government's ability to implement policy programs are necessary conditions for the capacity of remittances to reduce deforestation.

[Table 8]

[Table 9]

[Table 10]

## **V- Concluding remarks**

The aim of this paper was twofold: first, to analyze whether remittances perform better in reducing deforestation in low-income countries than in middle-income countries; and second, to examine the role played by institutional quality in shaping the role of remittances to reduce deforestation over the period 1996 to 2014.

Our results show that remittances contribute significantly to the reduction of deforestation both in low- and middle-income countries, but that the effect is stronger in middle-income countries than in low-income countries, invalidating our basic assumption. Governments of low-income countries should strive to reduce extreme poverty in order to complete the effect of remittances to improve people's living conditions and thus divert them from deforestation activities. Migration transfers can increase agricultural productivity through the purchase of new machinery or higher food imports, reducing pressure on land. At the same time, these income flows can also lead to migration between rural and urban areas, which affects demographic pressure and therefore puts pressure on forests. In terms of development policy, this implies that increasing financial support through remittances could reduce deforestation.

Furthermore, institutional quality in low-income countries does not play a significantly steady role in this relationship, while in middle-income countries remittances are complementary to institutional quality in reducing deforestation. Moreover, considering institutional quality above (strong) and below (weak) the median level, we show that strong institutional quality shapes the behavior of remittances in determining its deforestation reduction role. Therefore, remittances work to reduce deforestation in countries with a strong institutional quality, whatever their income level.

As a recommendation, developing countries should be encouraged to establish the conditions for better-quality institutions with stronger environmental policies so that remittances can contribute to reducing deforestation

Our results also show that higher inequality is therefore found to lead to more rapid deforestation. This is consistent with the results of earlier studies on this issue (Heerink, Mulatu and Bulte, 2001). Redistributing income is desirable in its own right to prevent environmental damage.

**Funding:** This work did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Conflicts of interest:** None

## References

- Afawubo K. and Couchoro, M. k., 2017. 'Do remittances enhance the economic growth effect of private health expenditures in West African Economic and Monetary Union?. *Economics Bulletin* 37(2), 1247-1264.
- Angelsen A., 1999. Agricultural expansion and deforestation: modelling the impact of population, market forces and property rights. *Journal of Development Economics* 58(1), 185-218
- Aisbett, E., Doupe, P., Tacconi, L., 2013. Disequilibrium adjustment and the rate of tropical deforestation. Technical Report 13-10. Crawford School Research Paper.
- Allen, J.C., Barnes, D.F., 1985. The causes of deforestation in developing countries. *Annals of the Association of American Geographers* 75(2), 163-184.
- Angelsen, A., Kaimowitz, D., 1999. Rethinking the causes of deforestation : lessons from economic models. *The world Bank Research Observer* 14(1), 73-98.
- Araujo, C., Bonjean Araujo, C., Combes, J.-L., Motel Combes, P., Reis, J.E., 2009. Property rights and deforestation in the Brazilian Amazon. *Ecological Economics* 68 (8-9), 2461-2468.
- Arcan, J.-L., Guillaumont, P., Jeanneney-Guillaumont, S., 2008. Deforestation and the real exchange rate. *Journal of Development Economics* 86(2), 242-262.
- Barbier, E.B., Burgess, J.C., 2001. The economics of tropical deforestation. *Journal of Economic Survey* 15(3), 413-433.
- Barbier, E.B., 2004. Explaining agricultural land expansion and deforestation in developing countries. *American Journal of Agricultural Economics* 86(5), 1347-1353.
- Barbier, E.B., Damania, R., Leonard, D., 2005. Corruption, trade and resource conversion. *Journal of Environmental Economics and Management* 50(2), 229-446.
- Bhattari, M., Hamming, M., 2001. Institutions and the environmental kuznets curve for deforestation : a crosscountry analysis for Latin America, Africa and Asia. *World Development* 29(6), 995-1010.
- Bohn, H., Deacon, R.T., 2000. Ownership risk investment and the use of natural resources. *American Economic Review* 90(3), 526-549.
- Buitenzorgy, M., Mol, A.P.J., 2011. Does democracy leads to better environment ? Deforestation and the democratic transition peak. *Environment Resource Economics* 48(1), 59-70.
- Choumert, J., Motel, P.C., Dakpo, H.K., 2013. Is the environmental Kuznets curve for deforestation a threatened theory? A meta-analysis of the literature. *Ecological Economics* 90, 19-28.
- Cropper, M., Griffiths, C., 1994. The interaction of population growth and environmental quality. *The American Economic Review* 84(2), 250-254.
- Culas, R.J., 2007. Deforestation and the environmental kuznets curve : an institutional perspective. *Ecological Economics* 61(2-3), 429-437.
- Culas, R.J., 2012. Redd and forest transition : tunneling through the environmental kuznets curve. *Ecological Economics* 79, 44-51.

- Chiu, Y.-B., 2012. Deforestation and environment kuznets curve in developing countries : a panel smooth transition regression approach. *Canadian Journal of Agricultural Economics/Revue Canadienne d'Agonomie* 60(2), 177-194.
- Damette, O., Delacote, P., 2011. Unsustainable timber harvesting, deforestation and the role of certification. *Ecological Economics* 70 (6), 1211-1219.
- Deacon R. T., 1994. Deforestation and the Rule of Law in a Cross-Section of Countries, *Land Economics* 70 (4), 414-430
- Didia, O.D., 1997. Democracy, political instability and tropical deforestation. *Global Environmental Change* 7(1), 63–76
- Duval, L., Wolff, F.C, 2009. L'effet des transferts des migrants sur la déforestation dans les pays en développement . *Revue d'économie du développement* 17(3), 109-135.
- Faria, W.R., Almeida, A.N., 2016. Relationship between openness to trade and deforestation : empirical evidence from the Brazilian Amazon. *Ecological Economics* 121, 85-97.
- Food and Agricultural Organization of the United Nations (FAO), 2015. Global forest resources assessment 2015 : how have the world's forests changed ? Technical report Rome, Italy.
- Galinato, .G.I., Galinato, S.P., 2013. The short-run and long-run effects of corruption control and political stability on forest cover. *Ecological Economics* 89, 153-161.
- Gaveau, D.L.A., Sheil, D., Salim, M.A., Arjasakusuma, S., Ancrenaz, M., Pacheco, P., Meijaard, E., 2016. Rapid conversions and avoided deforestation : examining four decades of industrial plantation expansion in Borneo. *Scientific Reports*, 6, 32107, DOI : 10.1038/srep32017.
- Giuliano P. , Ruiz-Arranz M. 2009. Remittances, financial development, and growth. *Journal of Development Economics* 90(1), 144-152
- Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V. et al., 2013. High-resolution global maps of 21st-century forest cover change. *Science* 342 (6160), 850-853.
- Hecht, S.B., Kandel, S., Gomes, I., Cuellar, N., Rosa, H., 2006. Globalization, forest resurgence, and environment politics in El Salvador. *World Development* 34 (2), 308-323.
- Heilmayr, R., 2014. Conservation through intensification ? the effects of plantations on natural forests. *Ecological Economics* 105, 204-210.
- Heerink N., Mulatu A. and Bulte E., 2001. Income inequality and the environment: aggregation bias in environmental Kuznets curves. *Ecological Economics* 38(3), 359-367.
- Hosonuma, N., Herold, M., Sy, V.D., Fries, R.S.D., Brockhaus, M., Verchot, L., et al., 2012. An assessment of deforestation and forest degradation drivers in developing countries. *Environmental Research Letters* 7(4), 044009, Available from: <http://iopscience.iop.org/1748-9326/7/4/044009>
- Kim, D-H., Sexton, J.O., Townshend, J.R. (2015). Accelerated deforestation in the humid tropics from the 1990s to the 2000s. *Geophysical Research Letters*.
- Kuusela, O-P., Amacher, G.S., 2015. Changing political regimes and tropical deforestation. *Environment Resource Economics* 64(3), 445-463.



- Leblois, A., Damette, O., Wolfersberger, J., 2017. What has driven deforestation in developing countries since the 2000s ? Evidence from new remote-sensing data. *World Development* 92, 82-102.
- Liscow, Z.D., 2013. Do property rights promote investment but cause deforestation ? Quasi-experimental evidence from Nicaragua. *Journal of Environmental Economics and Management* 65(2), 241-261.
- López-Feldman, A., Chávez, E., 2017. Remittances and natural resources extraction : evidence from Mexico. *Ecological Economics* 132, 69-79.
- Nguyen-Van, P., Azomahou, T., 2007. Nonlinearities and heterogeneity in environmental quality : an empirical analysis of deforestation. *Journal of Development Economics* 84(1), 291-309.
- Koop, G., Tole, L., 2001. Deforestation, distribution and development. *Global Environmental Change* 11(3), 193-202.
- Koop, G., Tole, L., 1999. Is there an environmental Kuznets curve for deforestation?. *Journal of Development Economics* 58 (1), 231-244.
- Ratha, D., 2005. Workers remittances: an important and stable source of external development finance, in Mainbo S., Ratha R., *Remittances: development impact and future prospects*, Washington, World Bank, 19-52.
- Shafik, N., 1994. Economic development and environmental quality: and econometric analysis. *Oxford Economic Paper* 46, 757-773.
- Wolfersberger, J., Delacote, P., Garcia, S., 2015. An empirical analysis of forest transition and land-use change in developing countries. *Ecological Economics* 119, 241-251.
- World Bank, 2006. *At loggerheads? Agricultural expansion, poverty reduction and environment in the tropical forests*, Washington DC, World Bank Publications.

Table 1: Impact of remittances on deforestation, OLS (FE and RE) and System-GMM regressions in the full sample (low- and middle-income countries), 1996 to 2014

Variables	(OLS, FE)dfrst (standardized)	(OLS, RE)dfrst (standardized)	(System-GMM)Annual deforestation (log km2)
Constant	1.851***(7.726)	-0.038***(-4.277)	-1.083(-0.494)
L.Annual deforestation (log km2)			0.486*(1.806)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.029(0.495)	-0.014(-0.358)	-0.006(-0.121)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	0.045(1.428)	0.028*(1.840)	0.053(1.941)
GDP pc growth (2005 constt) (standardized)	0.235***(3.640)	0.181**(2.348)	0.089*(1.601)
Population density (log) (standardized)	0.226***(8.116)	0.004**(2.105)	0.017(0.407)
Agricultural land (% country area, -1) (standardized)	0.230(0.916)	0.407*(1.783)	0.107(1.523)
Openness at 2005 constant prices (% , -1) (standardized)	0.001(0.609)	0.017**(2.067)	0.905(0.098)
Terms of trade (standardized)	0.827(0.712)	0.217(0.402)	0.131(0.097)
Crop production index (2004–06 = 100, -1) (standardized)	-0.001(-0.506)	-0.003(-0.904)	-0.014**(-2.232)
Control of corruption	-0.071***(-3.951)	-0.042***(-4.181)	-0.054***(-3.549)
Political stability	-0.005(-0.599)	-0.003(-0.548)	-0.008(-1.060)
Effectiveness	-0.075***(-3.726)	-0.029***(-2.715)	-0.051***(-2.952)
Rule of Law	-0.015(-0.745)	-0.007(-0.246)	0.017(0.985)
Remittances (% , -1) (standardized)	-0.712***(-3.121)	-0.033**(-2.187)	-0.212**(-2.628)
GINI(-1) (standardized)	0.002(0.245)	0.156(0.754)	0.004**(2.516)
Observations	2014	2014	1779
R <sup>2</sup>	0.109	0.172	
Ajusted R <sup>2</sup>	0.102	0.126	
Between	0.106	0.117	
Within	0.006	0.006	
Overall	0.0485	0.087	
X <sup>2</sup>	51.40	60.90	
AB p-value of AR(2)			0.6877
P-Value of Sargan test			0.0000
P-Value of Wald test			0.0000

t-Statistic in parentheses, robust to country clustering. \* p < .1, \*\* p < .05, \*\*\* p < .01.

Table 2: Impact of remittances on deforestation, OLS (FE and RE) and System-GMM regressions in low-income countries, 1996 to 2014

Variables	(OLS, FE)dfrst (standardized)	(OLS, RE)dfrst (standardized)	(System-GMM)Annual deforestation (log km2)
Constant	1.037**(2.240)	0.094(1.183)	1.011***(6.268)
L.Annual deforestation (log km2)			0.015*(1.592)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.359(1.398)	0.052*(1.581)	0.078(1.478)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	-0.074(-0.181)	-0.058(-0.461)	-0.004(-0.442)
GDP pc growth (2005 constt) (standardized)	0.105**(2.162)	0.006(1.097)	0.082***(6.528)
Population density (log) (standardized)	0.409(0.111)	0.508(0.294)	0.308(0.204)
Agricultural land (% country area, -1) (standardized)	0.305(1.182)	0.705(0.363)	0.805(0.639)
Openness at 2005 constant prices (% , -1) (standardized)	0.316(0.543)	0.217(0.195)	0.215*** (10.265)
Terms of trade (standardized)	-0.585(-0.729)	-0.105(-0.502)	-0.235(-0.922)
Crop production index (2004–06 = 100, -1) (standardized)	0.081*** (5.037)	0.079*** (4.875)	0.064*** (3.192)
Control of corruption	-0.014**(-2.2689)	-0.009**(-2.284)	0.136(0.439)
Political stability	-0.095***(-4.299)	-0.073***(-4.750)	-0.052*(-1.918)
Effectiveness	-0.041(-0.252)	-0.028(-0.445)	0.040(1.819)
Rule of Law	0.213(0.637)	0.044(0.321)	0.113(0.276)
Remittances (% , -1) (standardized)	-0.019*(-1.573)	-0.001*(-1.824)	-0.125*(-1.734)
GINI(-1) (standardized)	0.011*** (3.673)	0.054*** (3.429)	0.045** (2.574)
Observations	494	494	361
R <sup>2</sup>	0.095	0.158	
Ajusted R <sup>2</sup>	0.082	0.103	

Between	0.096	0.117	
Within	0.047	0.046	
Overall	0.054	0.079	
X	53.68	62.81	
AB p-value of AR(2)			0.765
P-Value of Sargan test			0.0000
P-Value of Wald test			0.0000

t-Statistic in parentheses, robust to country clustering.\* p < .1,\*\* p < .05,\*\*\* p < .01.

Table 3: Impact of remittances on deforestation, OLS (FE and RE) and System-GMM regressions in middle-income countries, 1996 to 2014

Variables	(OLS, FE)dfrst (standardized)	(OLS, RE)dfrst (standardized)	(System-GMM)Annual deforestation (log km2)
Constant	0.059*(1.814)	-0.049(-0.597)	0.056(1.539)
L. Annual deforestation (log km2)			0.183(0.248)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.019**(2.519)	0.056**(1.968)	0.322(0.492)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	-0.019(-0.804)	-0.011(-1.090)	-0.026(-0.857)
GDP pc growth (2005 constt) (standardized)	0.015(0.584)	0.009(0.345)	0.012(0.946)
Population density (log) (standardized)	0.035(1.449)	0.093(1.392)	0.034*(1.896)
Agricultural land (% country area, -1) (standardized)	0.727(1.291)	0.067(0.948)	0.707(1.968)
Openness at 2005 constant prices (% , -1) (standardized)	0.014*(1.802)	0.002*(1.916)	0.014*(1.899)
Terms of trade (standardized)	-0.516(-1.240)	-0.017(-1.145)	-0.516*(-1.967)
Crop production index (2004–06 = 100, -1) (standardized)	0.019(0.753)	0.985(0.981)	0.067(0.850)
Control of corruption	-0.056(-1.056)	-0.018(-1.086)	-0.056*(-1.964)
Political stability	-0.041**(-2.117)	-0.056(-1.230)	-0.044(-1.092)
Effectiveness	-0.035(-1.413)	-0.079(-1.449)	-0.031*(-1.691)
Rule of Law	-0.018(-1.877)	-0.011(-1.242)	-0.099*(-1.955)
Remittances (% , -1) (standardized)	-0.313*(-1.512)	-0.512*(-1.876)	-0.813**(-2.463)
GINI(-1) (standardized)	0.514**(2.239)	0.023**(1.838)	0.054(1.588)
Observations	1520	1520	1313
R <sup>2</sup>	0.095	0.105	
Ajusted R <sup>2</sup>	0.093	0.087	
Between	0.085	0.076	
Within	0.055	0.056	
Overall	0.058	0.067	
X	71.46	59.95	
AB p-value of AR(2)			0.787
P-Value of Sargan test			0.0000
P-Value of Wald test			0.0000

t-Statistic in parentheses, robust to country clustering.\* p < .1,\*\* p < .05,\*\*\* p < .01.

Table 4: Impact of on deforestation of remittances interacting with institutional quality, OLS (FE and RE) and System-GMM regressions in low- and middle-income countries, 1996 to 2014

Variables	(OLS, FE)dfrst (standardized)	(OLS, RE)dfrst (standardized)	(System-GMM)Annual deforestation (log km2)
Constant	1.870***(7.937)	1.037***(3.745)	-0.149(-0.902)
L.Annual deforestation (log km2)			0.405***(3.509)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.019(0.325)	0.028(0.496)	0.015(0.289)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	0.045(1.424)	0.025(0.842)	0.051*(1.859)
GDP pc growth (2005 constt) (standardized)	0.233***(3.587)	0.167***(2.696)	0.081*(1.441)
Population density (log) (standardized)	0.227***(8.198)	0.036*(1.559)	0.032(0.762)
Agricultural land (% country area, -1) (standardized)	0.707(0.847)	0.307(1.031)	0.607(1.265)
Openness at 2005 constant prices (% , -1) (standardized)	0.002(0.799)	0.053(1.126)	0.135(0.258)
Terms of trade (standardized)	-0.917(-0.598)	-0.267(-0.337)	-1.817(-0.171)
Crop production index (2004–06 = 100, -1) (standardized)	-0.025*(-1.893)	-0.038*(-1.584)	-0.003***(-2.452)
Remittances (% , -1) (standardized)*Control of corruption	-0.381*(-1.797)	-0.451*(-1.887)	-0.812***(-2.301)
Remittances (% , -1) (standardized)*Political stability	-0.853(-0.062)	-0.823(-0.056)	-0.612(-1.080)
Remittances (% , -1) (standardized)*Effectiveness	-0.621***(-2.363)	-0.421***(-3.384)	-0.911*(-1.905)
Remittances (% , -1) (standardized)*Rule of Law	-0.211(-0.621)	-0.362(-0.261)	-0.461(-0.898)
Remittances (% , -1) (standardized)	-0.511***(-2.517)	-0.912***(-2.475)	-0.761*(-1.546)
GINI(-1) (standardized)	0.049(0.463)	0.028(0.572)	0.004(0.484)
Observations	2014	2014	1779
R <sup>2</sup>	0.115	0.146	
Ajusted R <sup>2</sup>	0.093	0.118	
Between	0.094	0.105	
Within	0.005	0.006	
Overall	0.062	0.064	
X <sup>2</sup>	51.40	60.90	
AB p-value of AR(2)			0.709
P-Value of Sargan test			0.000
P-Value of Wald test			0.000

t-Statistic in parentheses, robust to country clustering.\* p < .1,\*\* p < .05,\*\*\* p < .01.

Table 5: Impact on deforestation of the interaction between remittances and institutional quality, OLS (FE and RE) and System-GMM regressions in low-income countries, 1996 to 2014

Variables	(OLS, FE)dfrst (standardized)	(OLS, RE)dfrst (standardized)	(System-GMM)Annual deforestation (log km2)
Constant	1.045***(4.702)	-1.029***(9.118)	0.967***(6.891)
L.Annual deforestation (log km2)			0.054(1.214)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.063***(2.649)	0.078***(4.317)	0.166(0.816)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	0.024(-0.524)	0.915***(4.125)	0.061(0.547)
GDP pc growth (2005 constt) (standardized)	0.019***(4.293)	0.274***(7.199)	0.549(0.754)
Population density (log) (standardized)	0.408(0.388)	0.308(1.469)	0.016(0.965)
Agricultural land (% country area, -1) (standardized)	0.805(1.594)	0.206(0.712)	0.139(0.078)
Openness at 2005 constant prices (% , -1) (standardized)	0.096(0.590)	0.315***(8.171)	0.446(0.336)
Terms of trade (standardized)	-0.625(-1.525)	-0.010(-0.603)	-0.416*(-1.798)
Crop production index (2004–06 = 100, -1) (standardized)	0.613(0.616)	0.093(0.7873)	0.206(0.458)
Remittances (% , -1) (standardized)*Control of corruption	-0.713(-0.822)	-0.011(-0.533)	-0.613(-1.226)
Remittances (% , -1) (standardized)*Political stability	-0.913(-1.429)	-0.313(-0.823)	-8.514(-0.636)
Remittances (% , -1) (standardized)*Effectiveness	-0.114(-0.908)	-0.513(-0.898)	-0.813(-1.183)
Remittances (% , -1) (standardized)*Rule of Law	-0.843(-1.346)	-0.813(-0.688)	0.974(0.375)
Remittances (% , -1) (standardized)	-0.018***(-3.819)	-0.705**(-2.495)	-0.473*(-1.991)
GINI(-1) (standardized)	0.818***(3.224)	0.705***(2.499)	0.705***(2.742)
Observations	494	494	361
R <sup>2</sup>	0.125	0.148	
Ajusted R <sup>2</sup>	0.092	0.104	
Between	0.093	0.096	
Within	0.052	0.055	
Overall	0.051	0.079	
X	61.40	72.91	
AB p-value of AR(2)			0.847
P-Value of Sargan test			0.000
P-Value of Wald test			0.000

t-Statistic in parentheses, robust to country clustering. \* p < .1, \*\* p < .05, \*\*\* p < .01.

Table 6: Impact on deforestation of the interaction between remittances and institutional quality, OLS (FE and RE) and System-GMM regressions in middle-income countries, 1996 to 2014

Variables	(OLS, FE)dfrst (standardized)	(OLS, RE)dfrst (standardized)	(System-GMM)Annual deforestation (log km2)
Constant	0.054***(1.973)	0.006****(3.125)	-0.975(-1.754)
L.Annual deforestation (log km2)			0.404*(1.851)
GDP per capita, (log, 2005 constt, -1) (standardized)	-0.012(-0.622)	-0.043(-1.052)	-0.069(-0.027)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	-0.210(-0.750)	-0.066(-1.180)	-0.012(-0.743)
GDP pc growth (2005 constt) (standardized)	-0.015(-0.525)	0.003(1.3249)	-0.083(-0.975)
Population density (log) (standardized)	0.014*(1.779)	-0.507(-1.126)	-0.243(-1.132)
Agricultural land (% country area, -1) (standardized)	-0.807(-1.367)	-0.068(-0.898)	-0.77(-1.3219)
Openness at 2005 constant prices (% , -1) (standardized)	-0.027(-0.841)	-0.118(-0.254)	-0.018(-0.968)
Terms of trade (standardized)	-0.207**(-2.194)	0.003(0.944)	-0.117(-1.465)
Crop production index (2004–06 = 100, -1) (standardized)	0.025(0.776)	0.282(0.957)	0.014(0.895)
Remittances (% , -1) (standardized)*Control of corruption	0.592(0.878)	-0.892*(-1.779)	0.962(0.697)
Remittances (% , -1) (standardized)*Political stability	-0.893**(-2.265)	-0.192*(-1.731)	-0.321**(-1.963)
Remittances (% , -1) (standardized)*Effectiveness	-0.412(-0.594)	-0.851(-1.377)	-0.460**(-2.731)
Remittances (% , -1) (standardized)*Rule of Law	-0.752(-0.393)	-0.952*(-1.933)	-0.056(-0.836)
Remittances (% , -1) (standardized)	-0.932(-1.337)	-0.008**(-1.972)	-0.011(-1.708)
GINI(-1) (standardized)	0.036(0.549)	0.208(1.372)	0.067***(1.963)
Observations	1520	1520	1313
R <sup>2</sup>	0.116	0.121	
Ajusted R <sup>2</sup>	0.110	0.106	

Between	0.106	0.105	
Within	0.061	0.062	
Overall	0.047	0.051	
X	80.35	61.92	
AB p-value of AR(2)			0.776
P-Value of Sargan test			0.000
P-Value of Wald test			0.000

t-Statistic in parentheses, robust to country clustering.\* p < .1,\*\* p < .05,\*\*\* p < .01.

Table 7: Marginal impact of remittances on deforestation below and above the median level of institutional quality, OLS regressions in low-income countries, 1996 to 2014

	Control of corruption, Above median=0.60	Control of corruption, Below median=0.60	Political stability Above median=-0.50	Political stability Below median=-0.50
Constant	0.711(0.255)	1.801***(2.736)	1.331(0.611)	8.327(0.807)
L.Annual deforestation (log km2)	0.005***(2.982)	0.296***(1.996)	0.035***(9.276)	0.151***(6.404)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.618(0.676)	-0.879(-0.131)	0.294(1.061)	-0.841(-0.733)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	-0.452(-0.559)	0.738(0.231)	-0.450(-0.952)	0.606(0.950)
GDP pc growth (2005 constt) (standardized)	0.438(0.704)	-0.190(-0.730)	-0.510(-1.152)	-0.008(-0.975)
Population density (log) (standardized)	0.909*(1.582)	0.461***(2.784)	0.521(1.031)	0.649(1.005)
Agricultural land (% country area, -1) (standardized)	0.001(0.521)	0.406(0.131)	0.160(0.391)	0.926(0.816)
Openness at 2005 constant prices (% , -1) (standardized)	0.011(0.101)	0.001(0.034)	0.009(0.700)	0.037(0.939)
Terms of trade (standardized)	0.171(0.413)	0.135(0.042)	0.001(1.265)	0.425(0.362)
Crop production index (2004–06 = 100, -1) (standardized)	0.038***(2.737)	0.055(0.916)	0.042(1.083)	0.061(0.973)
Remittances (% , -1) (standardized)*Control of corruption	-0.077**(-1.982)	-0.009(-0.406)		
Remittances (% , -1) (standardized)*Political stability			-0.049**(-2.074)	-0.521(-0.717)
Remittances (% , -1) (standardized)	-0.497(-0.700)	-0.720(-0.417)	-0.009(-1.106)	0.610(0.528)
GINI(-1) (standardized)	0.114 (0.471)	0.143(0.554)	0.079(1.004)	0.020(0.438)
Observations	180	314	187	304
R <sup>2</sup>	0.234	0.163	0.200	0.152
Ajusted R <sup>2</sup>	0.097	0.030	0.078	0.022
Between	0.012	0.060	0.060	0.045
Within	0.083	0.031	0.065	0.049
Overall	0.011	0.005	0.023	0.003
X	74.282	96.200	60.125	70.076

t-Statistic in parentheses, robust to country clustering.\* p < .1,\*\* p < .05,\*\*\* p < .01.

Table 8: Marginal impact of remittances on deforestation below and above the median level of institutional quality in low-income countries, OLS regressions, 1996 to 2014

Variable	Effectiveness	Effectiveness	Rule of Law	Rule of Law
	Above median=- 0.60	Bellow median=- 0.60	Above median=- 0.67	Bellow median=- 0.67
Constant	3.722(0.747)	6.325(0.811)	-1.387(-0.938)	-5.98(-0.779)
L. Annual deforestation (log km <sup>2</sup> )	0.970*** (6.515)	0.114*** (5.683)	0.067(0.059)	0.001(0.377)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.03(1.037)	-0.056(-0.758)	0.061(1.656)	-0.477(-1.014)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	0.237(0.98)	-1.596*(-1.868)	0.730(0.6779)	-0.909(-0.338)
GDP pc growth (2005 constt) (standardized)	-0.734(-1.016)	-0.587(-0.656)	0.742**(1.981)	-0.435(-0.535)
Population density (log) (standardized)	0.323*(1.941)	0.089**(1.999)	-0.486*(-1.867)	-0.091*(-1.872)
Agricultural land (% country area, -1) (standardized)	-0.105(-0.674)	-1.586(-0.288)	-0.325(-0.196)	-0.004(-0.467)
Openness at 2005 constant prices (% , -1) (standardized)	0.018(0.939)	0.026(0.970)	0.001(0.008)	0.094(0.421)
Terms of trade (standardized)	0.015(0.227)	0.025(0.541)	0.183**(1.831)	0.212**(1.968)
Crop production index (2004–06 = 100, -1) (standardized)	-0.005(-0.757)	0.106(1.063)	0.011(1.023)	0.441(1.194)
Remittances (% , -1) (standardized)*Effectiveness	-0.009***(-2.988)	-0.109(-0.946)		
Remittances (% , -1) (standardized)*Rule of Law			-0.021***(-3.093)	-0.609(-0.241)
Remittances (% , -1) (standardized)	-0.810(-0.956)	-0.028*(-1.946)	-0.945(-0.758)	-0.709(-0.240)
GINI(-1) (standardized)	0.047(0.933)	0.089*(1.866)	0.032(0.661)	0.221**(2.215)
Observations	174	320	189	305
R <sup>2</sup>	0.089	0.039	0.315	0.146
Ajusted R <sup>2</sup>	0.0656	0.007	0.163	0.047
Between	0.060	0.065	0.382	0.004
Within	0.065	0.023	0.029	0.015
Overall	0.023	0.025	0.043	0.063
X	80.1257	61.142	77.513	91.992

t-Statistic in parentheses, robust to country clustering. \* p < .1, \*\* p < .05, \*\*\* p < .01.

Table 9: Marginal impact of remittances on deforestation below and above the median level of institutional quality in middle-income countries, OLS regressions, 1996 to 2014

Variable	Effectiveness Above median=-0.51	Effectiveness Bellow median=-0.51	Rule of Law Above median=-0.62	Rule of Law Bellow median=-0.62
Constant	-9.907(-1.182)	6.167(0.969)	0.108(1.164)	1.899(1.061)
L.Annual deforestation (log km2)	0.069(1.21)	0.654(0.953)	0.494(0.647)	0.015(0.850)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.172(0.907)	0.643(0.103)	1.439(0.611)	-0.640(-0.748)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	-0.561(-0.975)	0.544(0.909)	0.23922(0.981)	-0.859(-0.922)
GDP pc growth (2005 constt) (standardized)	-0.756(-0.927)	-0.960(-0.990)	-0.119(-0.996)	0.140(0.143)
Population density (log) (standardized)	-0.044(-1.164)	1.485(0.989)	0.970(1.193)	0.283(1.081)
Agricultural land (% country area, -1) (standardized)	0.506(0.152)	-1.106(-0.896)	-0.505(-1.015)	-0.007(-0.254)
Openness at 2005 constant prices (% , -1) (standardized)	0.024(0.777)	-0.012(-0.701)	-0.020(-0.4491)	0.009(0.746)
Terms of trade (standardized)	-0.645(-0.548)	0.016(0.065)	0.16(0.126)	-1.715(-0.868)
Crop production index (2004–06 = 100, -1) (standardized)	0.040(1.022)	-0.020(-0.839)	-0.068(-1.017)	0.008(1.014)
Remittances (% , -1) (standardized)*Effectiveness	-0.210**(-2.113)	0.310(0.979)		
Remittances (% , -1) (standardized)*Rule of Law			-0.316**(-2.370)	-0.210(-0.915)
Remittances (% , -1) (standardized)	-0.170*(-1.872)	-0.408(0.97)	-0.009**(-1.981)	-0.211***(-2.946)
GINI(-1) (standardized)	0.057(0.681)	0.129*(1.880)	0.091(0.557)	0.019(0.180)
Observations	1078	442	1060	460
R <sup>2</sup>	0.116	0.200	0.160	0.334
Ajusted R <sup>2</sup>	0.083	0.090	0.049	0.009
Between	0.093	0.030	0.007	0.082
Within	0.038	0.069	0.041	0.091
Overall	0.001	0.811	0.017	0.024
X	78.230	81.979	64.228	93.964

t-Statistic in parentheses, robust to country clustering. \* p < .1, \*\* p < .05, \*\*\* p < .01.

Table 10: Marginal impact of remittances on deforestation below and above the median level of institutional quality in middle-income countries, OLS regressions, 1996 to 2014

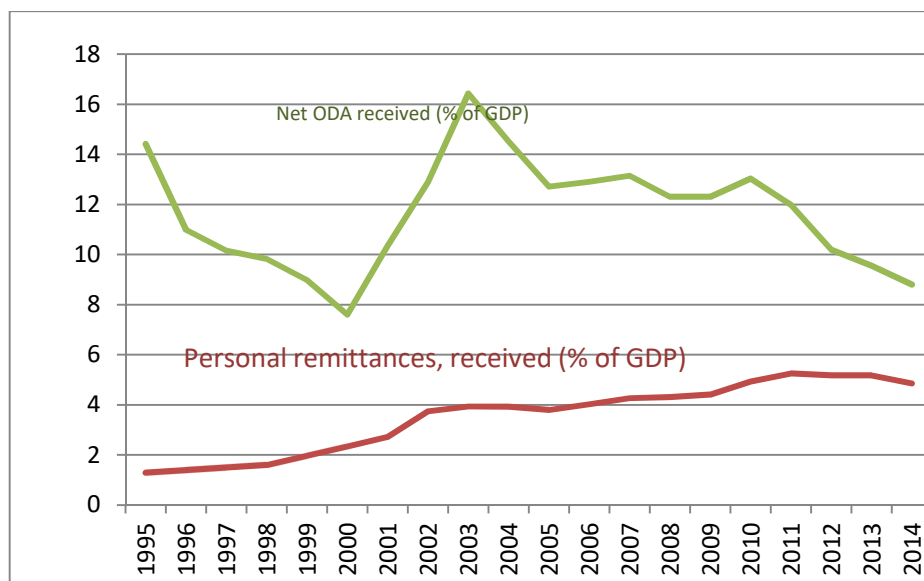
	Control of corruption Above median=-0.60	Control of corruption Bellow median=-0.60	Political stability Above median=-0.40	Political stability Bellow median=-0.40
Constant	3.291(1.006)	1.024(1.083252)	-0.451(-1.193)	3.583(1.029)
L.Annual deforestation (log km2)	0.044(0.731)	0.055(0.889)	0.050(0.503)	0.024(0.604)
GDP per capita, (log, 2005 constt, -1) (standardized)	0.586(1.081)	-0.005(-0.008)	0.243*(1.945)	0.174(0.44)
squared GDP per capita, WPT (log, 2005 constt, -1) (standardized)	0.217(0.971)	-0.764(-0.948)	-0.223(-0.830)	0.463(0.938)
GDP pc growth (2005 constt) (standardized)	-0.830(-1.149)	0.916*** (2.817)	-0.671(-1.021)	-0.565**(-1.968)
Population density (log) (standardized)	0.077(1.029)	0.068(1.100)	-0.647(-1.171)	0.667(1.042)
Agricultural land (% country area, -1) (standardized)	0.806(0.248)	-0.207(-0.464)	-0.506(-0.461)	-0.406(-0.528)
Openness at 2005 constant prices (% , -1) (standardized)	0.050(0.874)	0.004*(1.875)	0.003(0.353)	0.022(0.688)
Terms of trade (standardized)	-0.414(-1.235)	-0.516(-0.504)	0.314*(1.896)	-0.414(-0.941)
Crop production index (2004–06 = 100, -1) (standardized)	-0.121(-1.249)	0.004(1.014)	0.023(1.120)	-0.081(-0.987)
Remittances (% , -1) (standardized)*Control of corruption	-0.308***(-2.215)	-0.409(0.960)		
Remittances (% , -1) (standardized)*Political stability			-0.205**(-2.135)	-0.209*(-1.934)
Remittances (% , -1) (standardized)	-0.809(-1.232)	-0.140(-0.952)	-0.209(-1.218)	-0.310(-0.884)
GINI(-1) (standardized)	0.084*** (2.651)	0.001*** (2.723)	0.117(0.748)	0.128*(1.928)
Observations	1064	456	1068	452
R <sup>2</sup>	0.28	0.181	0.237	0.104
Ajusted R <sup>2</sup>	0.180	0.070	0.134	0.095
Between	0.080	0.084	0.110	0.042
Within	0.096	0.003	0.048	0.045
Overall	0.033	0.008	0.012	0.021
X	78.150	86.242	72.316	87.350

t-Statistic in parentheses, robust to country clustering. \* p < .1, \*\* p < .05, \*\*\* p < .01.



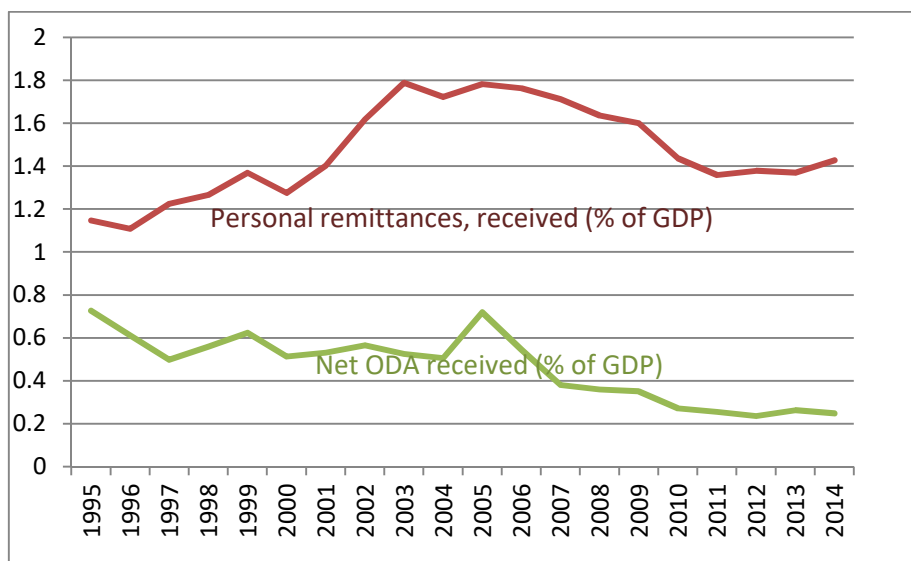
## Appendices:

### Appendix 1: Evolution of remittances and net ODA in low-income countries, 1995-2014



Source: From the authors using the 2014 World Bank data

### Appendix 2: Evolution of remittances and net ODA in middle-income countries, 1995-2014



Source: The authors using 2014 World Bank data

### Appendix 3: List of countries in the sample, by income level

Low-income countries		Middle-income countries	
Benin	Albania	Guatemala	Paraguay
Burkina Faso	Algeria	Guyana	Peru
Burundi	Angola	Honduras	Philippines
Central African Republic	Argentina	India	Romania
Chad	Bangladesh	Indonesia	Russian Federation
Comoros	Belarus	Iran, Islamic Rep.	South Africa
Congo, Dem. Rep.	Belize	Iraq	Sri Lanka
Ethiopia	Bolivia	Jamaica	Sudan
Gambia, The	Bosnia and Herzegovina	Jordan	Suriname
Georgia	Botswana	Kazakhstan	Swaziland
Guinea	Brazil	Kenya	Tajikistan
Guinea-Bissau	Bulgaria	Lao PDR	Thailand
Haiti	Cambodia	Lebanon	Tunisia
Liberia	Cameroon	Lesotho	Turkey
Madagascar	China	Macedonia, FYR	Turkmenistan
Malawi	Colombia	Malaysia	Ukraine
Mali	Congo, Rep.	Mauritania	Uzbekistan
Mozambique	Costa Rica	Mauritius	Venezuela, RB
Nepal	Cote d'Ivoire	Mexico	Vietnam
Niger	Cuba	Moldova	West Bank and Gaza
Rwanda	Djibouti	Mongolia	Yemen, Rep.
Samoa	Ecuador	Morocco	Zambia
Senegal	Egypt, Arab Rep.	Namibia	
Sierra Leone	El Salvador	Nicaragua	
Tanzania	Equatorial Guinea	Nigeria	
Togo	Fiji	Pakistan	
Uganda	Gabon	Panama	
Zimbabwe	Ghana	Papua New Guinea	

### Appendix 4: Descriptive statistics

Variables	Mean	Std. Dev.	Min.	Max.	N
Proportion of forest covered in 2000	0.463	0.422	0	0.898	2014
Forest land covered (km <sup>2</sup> )	345,482.643	917,267.451	0	8,851,353.9	2014
Annual average deforestation (km <sup>2</sup> )	816.752	2,854.817	0	40,149.789	2014
Annual deforestation rate (share of total forest land cover)	0.021	0.193	0	5.895	2014
Total deforestation (1996-2014)	9,657.779	41,446.806	0	329,468.856	2014
Annual deforest. rate (prop. of country area, dfrst)	0.002	0.003	0	0.019	2014
PPP GDP per capita, (log, 2005 constt)	2,967.349	2,935.168	153.18	17,085.343	2014
GDP pc growth (2005 constt)	4.143	6.045	63.577	102.769	2014
Population density (in Hectare/Km <sup>2</sup> )	0.089	0.157	0.003	1.297	2014
Agricultural land (% country area)	57.219	24.505	0.637	93.18	2014
Openness at 2005 constant prices (%)	91.872	36.657	19.781	243.567	2014
Terms of trade (standardized)	112.958	37.932	24.273	292.585	2014
Crop production index (2004–06 = 100)	105.048	20.981	47.33	291.89	2014
Control of corruption	-0.519	0.576	-1.98	1.67	2014
Political stability	0.68	0.57	0	1.02	2014
Effectiveness	-0.79	0.35	-1.67	0.57	2014
Rule of Law	-0.46	0.47	-1.98	0.27	2014
Remittances (%)	4.27	3.27	0.80	2.98	2014
GINI	51.99	10.76	16.2	65.8	2014