Diaspora Income, Financial Development and Ecological footprint in Africa

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ABSTRACT

This study examines the impact of diaspora income on the ecological footprint of 22 countries African countries. Methodologically, we used the Driscoll-Kraay (1998) fixed-effect model, fixed effect instrumental variable regression, Machado and Silva (2019) panel quantile regression, and Dumitrescu and Hurlin (2012) causality test. There are four main important findings from this empirical study: (1) diaspora income has a negative and statistical impact on ecological degradation, (2) financial development plays a crucial role in mitigating the environmental impact of diaspora income, and African countries must achieve an annual estimated threshold of financial development before they could reap the environmental quality impact of diaspora income, (3) the role of financial development in reducing the environmental degradation impact of diaspora income is less for higher polluting countries in Africa, (4) unidirectional causality from diaspora income to ecological footprint. In ensuring a sustainable environment, we recommend that African governments provide a tax credit to the recipient of the diaspora income who invests in environment-friendly technologies.

JEL Classification:

Keywords: Diaspora income, Driscoll-Kraay fixed-effect model, fixed effect instrumental variable regression, Machado and Silva (2019) MMQR, Dumitrescu and Hurlin (2012) causality test, Financial development, Ecological footprint, Africa

1.0 Introduction

Environmental degradation and its attendant consequences have assumed a central position in academic and international debates in recent years, owing to its ominous implications for not only sustainable development, but even humanity's survival (Cramer et al., 2018). Over the years, the anthropogenic activities of humankind have continued to overstretch the biocapacity, thus making it increasingly difficult for nature to reclaim its ecosystem (Destek and Sarkodie

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2019; Khan and Ulacak 2020). This situation has engendered many undesired and deleterious environmental repercussions such as fluctuating sea levels, melting ice caps, ocean acidification, depletion of water, forest and food resources, recurrent precipitation and climate change. The case is so pathetic that it has been estimated by the Global Footprints Network (GFN) that more than 80% of the global space is presently in ecological deficit[1]. Thus, it is apparent that the development of ecological footprints (EF) as a global phenomenon derives from the issues around the continuous depletion of biocapacity by human actions vis-à-vis the need to improve the recovery of the ecosystem (Ahmad et al. 2020; Udemba 2020). Meanwhile, a key challenge in this regard has continued to boil down to finding the best ways to reduce the negative impacts of human activities on the environment without slowing down the pace of the much needed growth and development (Alam et al. 2011; Boutabba 2014; Dar and Asif 2017; Landman 2010). This has led not only to unremitting academic debates, but also to regular convocations of global leaders to tackle the environmental problems (Ozcan et al. 2020) through signing and reviewing important treaties and consequent to which the 2021 Glasgow conference is named COP26.

In recent times, diaspora income has received huge attention from researchers and policymakers due to its growing importance in the development process, especially in relation to developing countries. For example, because of its financial benefits, it has been regarded as a major source of external financing for lower and middle-income economies and a key ingredient in the development process (Meyer and Shera 2017; Rahman et al. 2019). For many developing economies, it constitutes a major part of capital inflows, ahead of export earnings, official development assistance (ODA) and foreign direct investment (Meyer and Shera 2017). According to World Bank (2020) global remittance quintupled ODA in 2019. Furthermore, it is seen as a direct device for poverty alleviation and ancillary to the promotion of micro small and medium enterprises (MSMEs) among the highly impoverished population in developing countries (Zadja 2015). Therefore, as expected, studies have predominantly concentrated on its relationship with economic growth as well as its impact on poverty and income inequality (Apergis and Cooray 2018; Bang et al. 2016; Benhamou and Cassin 2021; Sobiech 2019; Jouini 2015; Senbeta 2013; Vacaflores 2018).

Meanwhile, despite the huge importance and the above-mentioned features of diaspora income, its impact on environmental outcomes is, astonishingly, not given adequate attention and thus, still quite unclear in the literature. Diaspora income could impact the environment in a variety of ways. First off, environmental economists are in accord regarding the central role those economic activities play as a determinant of environmental degradation. Diaspora income constitutes an important driver of economic activities by improving the consumption of households, thereby increasing the level of aggregate demand in the economy (Amuedo and Pozo 2004; Chami et al. 2005; Thapa and Acharya 2017). It also provides the much-needed low-cost fund for domestic investment (McKenzie and Sasin 2007; Wagle 2012). Thus, diaspora income could drive economic activities through its impact on aggregate demand, savings and investment, which subsequently increase human anthropogenic activities that overuse the earth's natural resources, resulting in environmental degradation (Clemens and McKenzie 2018; Kadozi 2019; Ziesemer 2012). Nevertheless, it has been argued that the nature of the impact of diaspora income on the environment is a function of how it is utilized in the economy. For instance, in a case where diaspora income is largely expended on acquisition of cleaner energy (such as nuclear or solar energy) or environment-friendly production equipment (Sharma et al. 2019), it might result in favourable environmental outcomes. Therefore, the literature on the precise impact of diaspora income on the environment is unclear and needs to be investigated.

A few attempts have been made to empirically examine the impact of diaspora income on the environment (Ahmad et al. 2019; Elbatanony et al. 2021; Khan et al. 2020; Kibria 2021; Rahman et al. 2019; Usman and Jahanger 2021; Yang et al. 2020; Yang et al. 2021; Zafar et al. 2021). While the research outcomes predominantly suggest that diaspora income contributes to environmental degradation, it is noteworthy that Zafar et al. (2021) report that diaspora income reduces environmental degradation, while Rahman et al. (2019) find no relationship between the two variables for China and India. This suggests that the impact of diaspora income on the environment may vary across countries or regions. Yet, to our best knowledge, the link between diaspora income and environmental outcomes has not been studied for Africa, despite its huge inflows into the continent. From $55 billion in 2010, remittances inflows to Africa grew to $85 billion in 2019 (World Bank 2021). Furthermore, diaspora income has constituted an important source of finance for Africa over the years, helping many households and indeed accounting for more than 5% of GDP for several countries in the continent (For example, South Sudan – 33.3%, Lesotho - 21%, Gambia - 15.5%) (World Bank 2021). Thus, this study will add to the existing literature by providing insight into how diaspora income impacts the different quantiles of environmental quality in Africa, by employing the technique of moments quantile regression with fixed effect (MMQR) of Machado and Silva (2019). Furthermore, in measuring environmental quality, most existing studies on the remittance-environment nexus employed CO_2, which is a narrow definition, as it concerns only air pollution (Ulacak and Lin 2017). For Africa, there is a need to capture the different segments of the environment, considering the predominance of the primary sector in the continent (UNCTAD, 1999). This study therefore uses EF to measure environmental quality, as it captures environment from important areas that comprise built-up land, carbon footprint, cropland, fishing ground, forestry and grazing land.

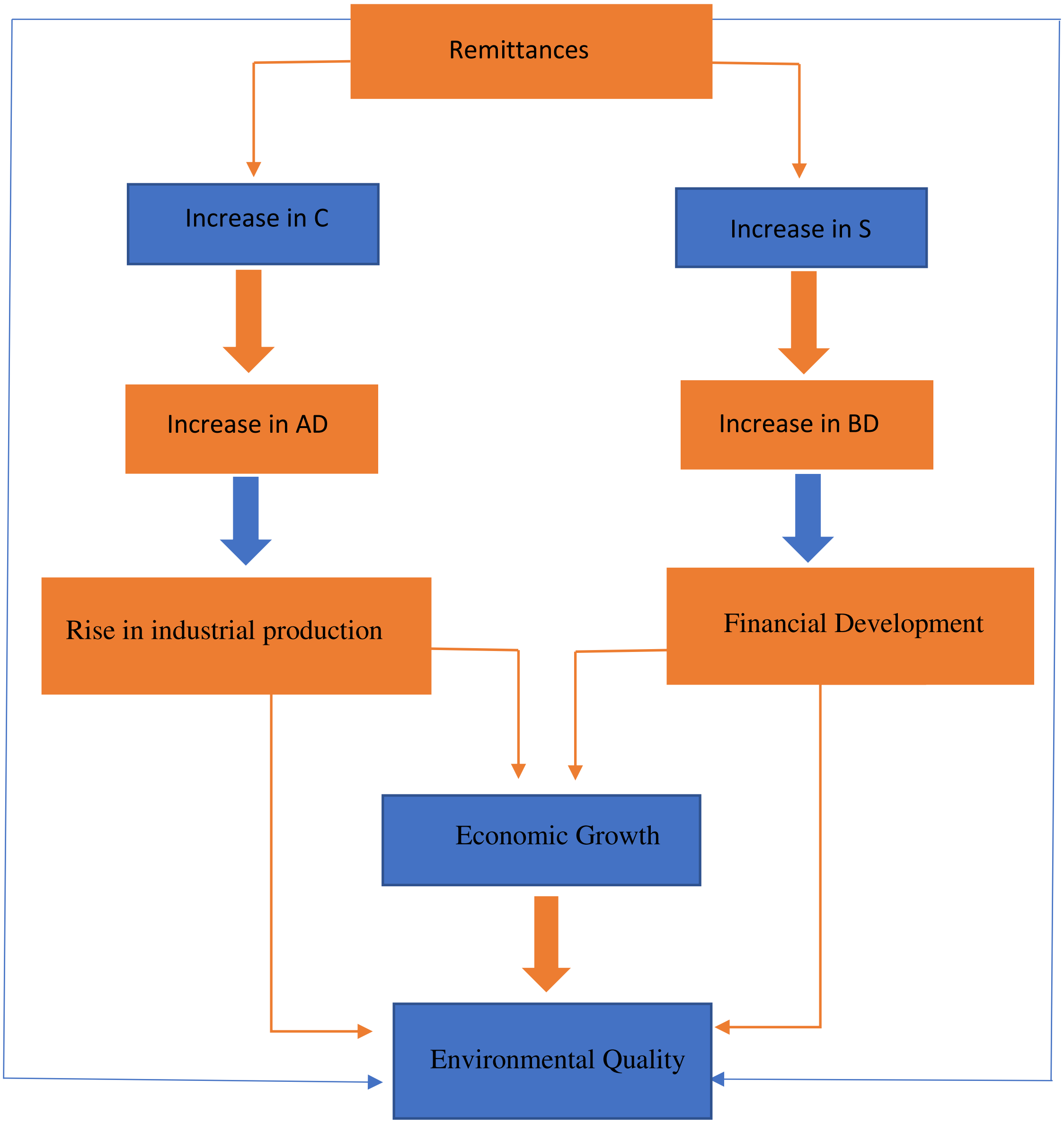
Besides, financial development has been identified as a channel through which diaspora income may impact the environment. The literature has established that remittance inflows could boost financial development by providing complementary capital for business and easing credit constraints, thereby enhancing the demand for financial services in the economy (Farhani and Ozturk 2015; Fromentin 2017). Many studies have investigated the relationship between financial development and environmental quality, and the results are generally mixed (Boufateh and Saadaoui 2020; Charfeddine and Kahia 2019; Li et al. 2015, Nasir et al. 2019; Xing et al. 2017). However, the moderating effect of financial development in the diaspora income-environmental quality nexus has not been investigated, especially within the context of Africa. Such investigation is important considering the argument that diaspora income could be a substitute, rather than a complement to financial development (Giuliano and Ruiz-Arranz 2009; Nyamongo et al. 2012). Therefore, this study expands the literature on the remittance-environment nexus by investigating the role of financial development. Another significant contribution of this study is the use of the newly developed IMF financial development measure. Unlike other measures, this new measure captures the multidimensionality of the financial system (International Monetary Fund 2019).

The remainder of this paper is organized as follows. Section 2 houses the literature review on the link between diaspora income and ecological footprint. The methodology and estimation techniques are discussed in Section 3. Section 4 discusses the presentation and discussion of empirical estimations, while section 5 presents the summary of findings, concluding thoughts and policy implications.

2.0 Literature Review

Given the scarcity of literature on the link between remittances and environmental outcomes, we adapted Ahmad et al. (2019)'s five-stage-interaction-mechanism to identify the nexus between remittances and environmental outcome. The theoretical nexus shown in Figure 1 indicates various transmission mechanism through which remittances could influence environmental outcomes.

Figure 1: Theoretical nexus between remittances inflow and Environmental Quality[2]



Source: Ahmad et al. (2019)

2.2 Remittance and Environment nexus

Remittances have been seen as one of the household's income sources and core determinants of economic development in emerging and developing economies (Elbatanony et al. 2021). However, despite this importance, its impact on the environment triggered by an increase in household's consumption and thereafter aggregate demand and industrialization has been

[2] C=Consumption; S=Saving; AD=Aggregate Demand; BD=Bank Deposit.

widely neglected. Nonetheless, some studies have tried to investigate the impact that remittance inflow has on environment degradation across different geographical locations, see for example (Elbatanony et al. 2021; Jamil et al. 2021; Yang et al. 2021; Kibria 2021; Usama et al. 2020; Qingquan et al. 2020; Yang et al. 2020; Neog and Yadava 2020; Doryn 2020; Khan et al. 2020; Rahman et al. 2019; Sharma et al. 2019; Ahmad et al. 2019). These studies establish different channels through which an increase in remittances affects the quality of the environment.

For example, Elbatanony et al. (2021) employed the method of the moment quantile regression to investigate the environmental impact of remittance inflow in developing countries. Their results indicate that remittance has a different impact across sub-samples and quantiles. This also corroborates with the findings of Jamil et al. (2021), who demonstrate a positive relationship between remittances and CO_2 emission in India using the fully modified ordinary least square (FMOLS) and the dynamic ordinary least square (DOLS). Furthermore, Yang et al. (2021) used different econometric techniques such as the Westerlund error correction method (ECM), the dynamic seemingly unrelated regression (DSUR) approach and FMOLS methods to investigate the extent to which remittance inflow affects the ecological footprint in BICS countries. The study argues that an increase in remittance inflow significantly harms the environmental quality. Along the same lines, Kibria (2021) employed a nonlinear autoregressive distributive lag (NARDL) to investigate Bangladesh's environmental downfall. The results show that an increase in remittance inflow positively affects the CO_2 intensity in Bangladesh. Likewise, Khan et al. (2020) used the common correlated effect mean group and data ranging from 1986 to 2016 to investigate the link between remittances, energy consumption, income, FDI and CO_2 emission for BRICS. The study concluded that remittances positively influence CO_2 emission in Brazil, Russia, and China, while the impact is negative impact on the CO_2 emissions in India. Moreover, using the NARDL approach, Ahmad et al. (2019) argue that remittances have an asymmetric effect on CO_2 emissions in China

However, some literature argues that remittances have a positive impact on environmental quality. For instance, Zafar et al. (2021) used the Westerlund and Edgerton cointegration approach on a panel of 22 countries concluded that remittances reduce CO_2 emission and therefore reduces environmental degradation. Other studies argue that remittances do not have any significant impact on the environmental outcome. For instance, Doryn (2020) and Rahman et al. (2019) conclude that remittance inflow does not significantly impact the ecological outcome.

2.3 Financial Development and Environment nexus

The theoretical nexus between financial development and environmental degradation can be explained through various channels such as income, technology, regulation, and capitalization (Lahiani 2019; Yuxiang and Chen 2011). Although financial development boosts household income and consumption of environmentally harmful goods, it can also increase the consumption of environmentally friendly goods. This indicates that financial development may have either a positive or negative impact on the quality of the environment. Aiming for different environmental policies, different scholars carried out studies on the impact of financial development on environmental quality, and the results are ambiguous. For instance, some studies found a positive relationship between financial development and environmental quality (Ahmed et al. 2021; Saud et al. 2020; Javid and Sharif 2016; Shahbaz et al. 2016). Other studies found a negative relationship between financial development and environmental sustainability (see Lahiani 2020; Dogan and Seker 2016; Salahuddin and Alam 2015; Tamazian et al. 2009).

Among the studies that found a positive relationship, Ahmed et al. (2021) employed the ARDL model to analyse the linkage between Japan's financial development and ecological footprint. The study suggests that an increase in financial development is associated with an increase in the ecological footprint. Likewise, Saud et al. (2020) found the same relationship in a group of selected countries. Specifically, they used the PMG technique and concluded that financial development increases environmental degradation. Similarly, Shahbaz et al. (2020) examined the impact of financial development on the environment of the United Arab Emirates. The study concludes that financial development is positively linked to environmental degradation. Similar results were also found for Shah et al. (2019), Javid and Sharif (2016), and Boutabba (2014).

Unlike those that found a positive impact between financial development and environmental degradation, some studies found a negative impact, i.e. financial development improves the environmental quality. For example, Dogan and Serek (2016) used FMOLS and the DOLS to analyse the influence of financial development on carbon emission. The study concludes that financial development reduced the CO_2 emission of top renewable energy countries. Shahbaz et al. (2016) reached a similar conclusion for Pakistan. More precisely, the study used a nonlinear ARDL approach and concluded that financial development positively influences environmental quality

Salahuddin et al. (2015) also investigated the long-run relationship between financial development and CO_2 emission in Gulf Cooperation Council (GCC) using the DOLS, FMOLS and DFE model. The study found a negative relationship between financial development and CO_2 emission.

Given the dearth of literature on the link between remittances and environmental outcomes in Africa. This study contributes to the literature by: (1) examining the impact of remittances on the ecological footprint in Africa, (2) examining the role of financial development on the nexus between remittances and ecological footprint, (3) determining the distributional impact of remittances, and (4) examine the direction of causality between remittances and ecological footprint.

3.0 Data and Methodology

3.1 Data

This study uses a panel dataset of 22 countries in Africa, with annual data over the period of 1990-2017. The choice of countries (see appendix 1) and period were contingent on data availability. In the analysis of this study, we follow Yang et al. (2020) and Ahmad et al. (2019) by measuring diaspora income as remittances in current U.S. dollars. In measuring financial development, we used the newly developed financial development index by the International Monetary Fund (2019). The justification for this index is that other measures such as credit to private sector, stock market capitalization, monetary aggregates among others have their shortcomings as they do not capture the multidimensionality of the financial system. Another appeal of this index is that it is a combination of 20 indicators, including financial institutions (banking and non–banking sector) and financial market (stock and bond market) indicators. For robustness of our empirical estimation, we used the aggregate financial development index, financial institution, and financial market index. Studies such as Khan (2019) and Shobande and Ogbeifun (2021) have also used this measure. We used ecological footprint (EF) as a measure of environmental degradation. The EF (measured in global hectares area per head) is a comprehensive framework for assessing a population's consumption of renewable resources and its anthropogenic activities on the productive land and ocean areas. This measure encompasses built-up land, carbon footprint, cropland, fishing grounds, forest products and grazing land. This measure has been utilized by Yang et al. (2020) and Ulucak et al. (2020). Availability of natural resources is measured by total natural resource rents (% of GDP). Studies such as Wang et al. (2020) and Usman et al. (2021) have also used it in their ecological footprint model. We followed Ahmad (2021) and Yang et al. (2020) by including real GDP per capita in (2010) $USD and urbanisation (measured by percentage of urban population to total population) in the model. All of the variables are changed to their natural logarithms to account for heteroscedasticity, possible outliers and to create elasticity correlations.

3.1.1 Descriptive statistics of the variables

Table 1 provides descriptive statistics of the variables and the sources of the data used in this study. With emphasis on the main variables of interest, the average value of ecological footprint (EF) from 1990 to 2017 across the 22 countries is 1.36 per person. Rwanda had a minimum of 0.65 in 2005, while South Africa had the highest of 3.82 per person in 2008. Remittances range from $22.04 billion to $0.03 million, with an average value of $689.30 million, and the standard deviation of $2.8 billion indicates that the region hovers around the sample mean. Nigeria amasses the highest value in 2017, while the least recipient country was Sierra Leone in 1990. The average value of the overall financial development index is 0.132; Congo has the minimum at 0.0291, while South Africa has the maximum at 0.638.

Similarly, the financial institution index has an average value of 0.211, with a minimum value of 0.0385 and a maximum value of 0.110. The financial market index also ranges from 0.000 to 0.525, with an average of 0.05 and a standard deviation of 0.0922. The pairwise correlation measures the relative association among the regressors, and dependent variable is also presented in Table 2. A cursory look at the results shows that there is a high correlation among the financial development measures. To avoid the problem of multicollinearity, this study used a stepwise regression as presented in Table (3).

Table 1: Summary Statistics

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	N	Mean	SD	Min	Max	Source (s)
EF	616	1.362	0.632	0.654	3.818	GFN
Rem (Million, $U.S.)	615	689.30	2,811.00	0.03	22,040.00	W/B, WDI
Fin. Devt	616	0.132	0.0975	0.0291	0.638	IMF
Fin. Inst	616	0.211	0.110	0.0385	0.740	IMF
Fin. Mkt	616	0.0496	0.0922	6.39e-11	0.525	IMF
GDP per capita	616	1,431	1,730	178.8	7,864	W/B, WDI
Urbanisation	616	34.32	15.89	5.416	68.70	W/B, WDI
Natural resources	616	10.14	8.729	0.721	58.65	W/B, WDI

Authors' computation from World Bank-WDI (W/B), International Monetary fund (IMF) database, and Global footprint network (GFN). EF= Ecological footprint; Rem= Remittances or diaspora income; Fin. Devt= Financial development index; Fin. Inst= financial institution index; Fin. Mkt= Financial market index.

Table 2: Pairwise Correlation

	EF	NRR	Urban	GDPC	Fin. Devt	Fin. Inst	Fin. Mkt	Rem
EF	1							
NRR	-0.302***	1						
Urban	0.564***	0.126**	1					
GDPC	0.857***	-0.0817*	0.749***	1				
Fin. Devt	0.832***	-0.278***	0.485***	0.859***	1			
Fin. Inst	0.822***	-0.357***	0.419***	0.798***	0.958***	1		
Fin. Mkt	0.752***	-0.152***	0.509***	0.836***	0.939***	0.800***	1	
Rem	0.00200	0.0305	0.146***	0.112**	0.183***	0.0558	0.314***	1

* p < 0.05, ** p < 0.01, *** p < 0.001. Authors' computation from World Bank-WDI (W/B), International Monetary fund (IMF) database, and Global footprint network (GFN). EF= Ecological footprint; Rem= Remittances or diaspora income; Fin. Devt= Financial development index; Fin. Inst= financial institution index; Fin. Mkt= Financial market index.

3.2 Methodology

This study utilizes the Driscoll and Kraay (1998) robust standard errors-type technique, which accounts for cross-sectional dependence, serial correlation and heteroskedasticity. This is nested into the fixed-effect model and fixed effect instrumental variable regression model[3] used in this study. In setting up the empirical form of the model, we follow studies such as Yang et al. (2020) and Ahmad et al. (2019), and Elbatanony et al. (2021) by specifying the following equation:

$$lnEF_{i,t} = \beta_0 + \beta_1 lnREM_{i,t} + \beta_2 lnREM * FD + \beta_3 lnX_{i,t} + \gamma_t + \mu_{i,t} \quad (1)$$

Where β_0 is the constant, γ_t is the time-invariant country-specific effect, and $\mu_{i,t}$ is the error term, $lnEF$ measured by the log of total ecological footprint per capita is an NT $\times$ 1 vector of spatial unit stacked by period, $lnREM_{i,t}$ is the proxy for diaspora income. $X_{i,t}$ is a vector of the host control variables which include, financial development measures, gross domestic product per capita, squared GDP per capita, urbanisation, and natural resource availability. $GDPC_{i,t}$ and $GDPC_{i,t}^2$ are included as part of $X_{i,t}$ to test for the EKC hypothesis following previous empirical literature. $REM * FD_{i,t}$ in equation (1) is the interaction term of diaspora income with the financial development measures[4]. Both REM and the financial development measure (FD) were included in equation (1) to ensure that the interaction term does not proxy for either REM

[3] The fixed-effect instrumental regression is used to address endogeneity which may arise from reverse causality and omitted variables in the model. lagged FDI was used as instruments in the model.
[4] This includes the overall financial development, financial market, and financial institution index.

or the FD measure. If $\beta_1 < 0$ and $\beta_2 > 0$, it means FD mediate positively the negative impact of REM on ecological footprint. If $\beta_1 > 0$ and $\beta_2 < 0$, it means FD negatively mediate the positive impact of REM on ecological footprint (see Appendix 2 for the calculation of the threshold estimates).

Due to the limitations of the fixed effect and fixed effect instrumental regression, this study employed a panel quantile regression technique to examine the distributional and heterogeneous effect across quantiles. The panel quantile regression was initially introduced by Koenker and Bassett (1978). Unlike regular least-squares regressions, which yield estimates of the conditional mean of the endogenous variable subject to certain values of the exogenous variables, quantile regressions are used to estimate the conditional median or a variety of different quantiles of the response variables subject to certain values of the exogenous variables. However, we used the Machado and Silva (2019) Method of Moments Quantile Regression (MMQR) with fixed effects in this study. While a quantile regression is robust against outliers, it does not account for unobserved heterogeneity among individuals in a panel. The MMQR method allows for the identification of conditional heterogeneous covariance effects of ecological footprint determinants by allowing individual effects to affect the entire distribution rather than just moving means, as in the work of Koenker (2004) and Canay (2011), among others. The MMQR estimation technique is extremely relevant in situation where the panel data model has individual effects and endogenous explanatory variables.

The conditional quantiles' estimation $Q_y(\tau|\text{X})$ for a model of the location-scale variant takes the following form:

$$Y_{i,t} = \alpha_i + X_{i,t}\beta + (\delta_i + Z_{it}\gamma)U_{i,t} \quad (2)$$

The probability $P\{\delta_i + Z_{it}\gamma\} > 0 = 1. (\alpha, \beta, \delta, \gamma)$ are the parameters to be estimated. $(\alpha_i, \delta_i), i = 1 \dots, n$, indicates the individual i fixed effect and Z is a k-vector of identified components of X which are differentiable transformations with element l is given by:

$$Z_l = Z_l(X), l = 1 \dots, k \quad (3)$$

For each fixed i, $X_{i,t}$ is distributed independently and identically, and it is time independent (t). $U_{i,t}$ is distributed independently and identically across individuals i and over time (t), and is orthogonal to $X_{i,t}$. $U_{i,t}$ is also normalized to satisfy the moment criteria in Machado and Silva (2019), which do not necessitate strict exogeneity among other things. Equation (2) can be re-written as:

$$Q_y(\tau|X_{i,t}) = (\alpha_i + \delta_i q(\tau)) + X_{it}\beta + Z_{it}\gamma q(\tau) \quad (4)$$

$X_{i,t}$ is a vector of explanatory specified in equation (1), $Q_y(\tau|X_{i,t})$ is the quantile distribution of ecological footprint, which is conditional on the location of the explanatory variables ($X_{i,t}$), $\alpha_i(\tau) \equiv \alpha_i + \delta_i q(\tau)$ is the scalar coefficient, and it is indicative of the quantile- τ fixed effect for individual $i. Y. q(\tau)$ is the τ-th quantile sample which is determined through an optimization problem (See Ike et al., 2020 for more).

Finally, the extended version of the Granger causality test, which is the Dumitrescu and Hurlin (2012) is used to explore the direction of causality between diaspora income and ecological footprint. This bi-variate test's underlying regression is specified thus as:

$$y_{i,t} = \propto_i + \sum_{k=1}^{k} \beta_{i,k} y_{i,t-k} + \sum_{k=1}^{k} \gamma_{i,k} x_{i,t-k} + \varepsilon_{i,t} \quad (5)$$

The observed (stationary) variables for individual country i and time t are y and x, respectively, and the lag order, K, is assumed to be the same for all the countries in the balanced panel. The method and intuition are in similitude with the Granger causality test. The null hypothesis of no causality for any of the panel's individuals is compared to the alternative hypothesis of causality for some of the countries in the panel.

4.0 Empirical Results and Discussion

4.1 Baseline Results

The baseline results on the impact of diaspora income on ecological footprint in Africa is presented in Table 3. The interpretation is based on the fixed-effect model since the p-value of the Hausman test (not reported in this study but available on request) is significant. The estimated coefficient of natural resources availability has a positive and statistically significant impact on ecological footprint. This is in line with Danish et al. (2019) and Hassan et al. (2019), who argue that excessive extraction and consumption of natural resources leads to deforestation, pollution, and lower environmental quality. However, this finding is at odds with the empirical outcome of Balsalobre-Lorente et al. (2018) and Zafar et al. (2019), who demonstrate that natural resources extraction improves environmental quality.

Our results further indicate that urbanisation has a negative and statistically significant impact on ecological degradation. This result is consistent with the empirical outcomes of Danish and Wang (2019) and Ulucak and Khan (2020), who argue that urbanisation promotes environmental quality. The underlying intuition of this findings is that urbanisation is a source of positive externalities and may increase the return to scale, public services provision such pipeline water, health services, proper waste management, and environment-friendly infrastructure. All of these make it easy to build, operate and sustain the environment. Similarly, city dwellers have greater options for higher education, which raises awareness and encourages people to care for the environment. People in cities have a higher standard of living; therefore, they buy energy-efficient equipment and ecologically beneficial products.

Furthermore, the estimated coefficient of GDP per capita and squared GDP per capita authenticate a nonlinear relationship between economic growth and environmental quality in Africa. This indicates that economic growth initially improves environmental quality, but further economic growth beyond a threshold income level deteriorates the environmental quality of African countries. Beyene and Kotosz (2020) also authenticate the U-shaped relationship for Eastern African countries.

The estimated coefficient of diaspora income measured by remittances is negative and statistically significant across all the models. From the conceptual framework presented in figure 1, remittances could influence environmental quality through consumption or financial sector channel. The intuition behind our empirical results is that since the recipient of this remittances inflow might have a higher standard of living, they may consume energy saving or efficient equipment that may be environmentally friendly. This result is consistent with Sharma et al. (2019) and Usama et al. (2020), who also document those remittances may reduce ecological degradation since there is a shortage of power supply in many African countries. A more expensive electricity tariff may shift consumers demand for renewable energy. Elbatanony et al. (2021) also found similar results for upper-middle-income countries. However, our empirical finding is at odds with the studies of Ahmad et al. (2019) and Yang et al. (2020), who revealed that remittances increase environmental degradation due to an increase in aggregate demand and industrial production.

Financial development measured by the overall financial development index, financial institution, and financial market positively impact ecological footprint. This infers that the activity of financial institutions (banks, insurance companies, mutual funds, and pension funds) and the financial market (stock and bond markets) increases environmental degradation in Africa. This is in tandem with the argument of Mahmood (2021) and Bekhet et al. (2017) who posit that the financial sector provides finances for expansion of local and foreign investments, business activities, and consumer credits which may have negative environmental effects.

Table 3: Impact of Diaspora Income on Ecological Footprint in Africa

	(1)	(2)	(3)	(4)	(5)	(6)
Variables		**Fixed effect Model**			**Fixed effect IV-2SLS**	
Natural resource	0.0524***	0.0503***	0.0550***	0.0495***	0.0477***	0.0549***
	(0.00756)	(0.00748)	(0.00781)	(0.00888)	(0.00868)	(0.00947)
Urbanization	-0.212***	-0.217***	-0.207***	-0.244***	-0.247***	-0.236***
	(0.0501)	(0.0498)	(0.0485)	(0.0402)	(0.0420)	(0.0369)
GDP Per Capita	-0.720***	-0.706***	-0.724***	-0.839***	-0.788***	-0.929***
	(0.193)	(0.192)	(0.203)	(0.187)	(0.180)	(0.225)
GDP Per Capita^2	0.0745***	0.0724***	0.0758***	0.0847***	0.0792***	0.0946***
	(0.0172)	(0.0171)	(0.0180)	(0.0168)	(0.0154)	(0.0208)
Remittances	-0.0319*	-0.00447	-0.0381***	-0.0535*	-0.00873	-0.0928*
	(0.0163)	(0.00921)	(0.0117)	(0.0270)	(0.0170)	(0.0466)
Overall Financial Development	0.323**			0.504**		
	(0.127)			(0.209)		
Financial Mkt.		0.0571*			0.0788	
		(0.0284)			(0.0731)	
Financial Institution			0.455***			0.996**
			(0.109)			(0.437)
Remittances* Financial Devt.	-0.0177**			-0.0276**		
	(0.00657)			(0.0118)		
Remittances* Financial Mkt.		-0.00296**			-0.00403	
		(0.00142)			(0.00364)	
Remittances* Financial Inst.			-0.0263***			-0.0579**
			(0.00574)			(0.0258)
Estimated Threshold	**0.165**	**0.221**	**0.235**	**0.1439**	**0.115**	**0.201**
R-squared	0.2508	0.2431	0.2572	0.2634	0.2551	0.2370
Prob > χ^2	29.42***	13.27***	34.00***	37.76***	41.28***	44.57***
Instrument relevance test	-	-	-	25.20***	4.11**	14.04***
Hansen J statistic	-	-	-	0.000	0.000	0.000
Observations	601	601	601	578	578	578
Number of Countries	22	22	22	22	22	22

Driscoll-Kraay standard errors in parentheses, *** denotes significance at 1 %, ** at 5 % and * at 10%. All regressions are estimated using fixed-effect estimator. Hansen J statistic tests for the overidentification test of all instruments and the null hypothesis is rejected indicating that the equations are exactly identified. For the fixed effect instrumental regression (FE-IV), we used the lag of FDI as instruments. The instrument relevance test is the F-statistics of the reduced model.

This study concludes that financial development in African countries could improve environmental quality by extending investment/funds to businesses that use green technologies.

In gauging the moderating effects of financial development on the impact of diaspora income on ecological footprint, the coefficient of the interaction term, which indicate whether financial development impedes or enhances the impact of remittances on environmental degradation is negative and significant. This discloses that an increased diaspora income flow coupled with a rise in financial sector development encourages the financial sectors to channel lending to eco-friendly investors who have the technologies to reduce ecological footprint. This is consistent with the empirical outcome of Yang et al. (2020) for BICS economies. Our empirical model further reveals that the financial sector of African economies is able to allocate more funds for eco-friendly technologies firms via the diaspora income they receive if they can maintain an annual threshold of between 0.144-0.165 for the overall financial development, 0.115-0.221 for financial market, and 0.201-0.235 for financial institution. However, many African countries are still below this estimated threshold. For instance, only 6/22 African selected countries are above the threshold of overall financial development[5], 2/22 countries for financial market[6], and 6/22 for financial institutions[7]. Since many African countries are still below this threshold (see Appendix 1 for more), a lot still needs to be done to achieve a robust financial system before reaping the improving environmental benefit of diaspora income.

The empirical result is also robust to the fixed effect instrumental model, which addresses the problem of endogeneity that may arise from reverse causality from ecological footprint to FDI and a possible correlation between FDI and the residuals. The only difference is that the financial market and the interaction of the financial market with diaspora income is not significant in the fixed effect instrumental regression model.

4.2 Distributional Effect of Diaspora Income on Ecological Footprint in Africa

This section examines if the impact of diaspora income, financial development, and their interaction differ across the conditional distribution of ecological footprint using the Machado and Silva (2019) approach.

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[5] Botswana, Kenya, Nigeria, South Africa, Togo, and Tunisia

[6] Botswana and South Africa

[7] Botswana, Kenya, Lesotho, South Africa, Togo, Tunisia

Table 4: Distributional Effect of Diaspora Income on Ecological Footprint in Africa

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Q = 0.25	Q = 0.50	Q = 0.75	Q = 0.25	Q = 0.50	Q = 0.75	Q = 0.25	Q = 0.50	Q = 0.75
Natural resource	0.0598***	0.0520***	0.0450***	0.0637***	0.0546***	0.0462***	0.0596***	0.0498***	0.0403***
	(0.0162)	(0.0115)	(0.0146)	(0.0160)	(0.0115)	(0.0148)	(0.0160)	(0.0117)	(0.0151)
Urbanization	-0.205***	-0.213***	-0.220***	-0.201***	-0.208***	-0.214***	-0.217***	-0.217***	-0.217***
	(0.0558)	(0.0396)	(0.0503)	(0.0553)	(0.0396)	(0.0511)	(0.0542)	(0.0396)	(0.0513)
GDP Per Capita	-0.726***	-0.719***	-0.713***	-0.719***	-0.724***	-0.729***	-0.703***	-0.706***	-0.709***
	(0.209)	(0.149)	(0.189)	(0.206)	(0.148)	(0.190)	(0.199)	(0.145)	(0.188)
GDP Per Capita^2	0.0733***	0.0746***	0.0757***	0.0738***	0.0759***	0.0778***	0.0709***	0.0724***	0.0739***
	(0.0171)	(0.0121)	(0.0154)	(0.0169)	(0.0121)	(0.0157)	(0.0160)	(0.0117)	(0.0151)
Remittances	-0.0320*	-0.0319**	-0.0318*	-0.0385**	-0.0381***	-0.0377**	-0.00105	-0.00465	-0.00815
	(0.0185)	(0.0131)	(0.0167)	(0.0173)	(0.0124)	(0.0160)	(0.0106)	(0.00775)	(0.0100)
Overall Financial Development	0.350***	0.322***	0.297**						
	(0.133)	(0.0947)	(0.120)						
Financial Institution				0.491***	0.453***	0.418***			
				(0.155)	(0.111)	(0.144)			
Financial Mkt.							0.0523*	0.0574**	0.0623**
							(0.0316)	(0.0231)	(0.0299)
Remittances* Financial Devt.	-0.0191***	-0.0176***	-0.0163**						
	(0.00716)	(0.00508)	(0.00646)						
Remittances* Financial Inst.				-0.0282***	-0.0263***	-0.0244***			
				(0.00879)	(0.00629)	(0.00812)			
Remittances* Financial Mkt.							-0.00277*	-0.00297***	-0.00316**
							(0.00156)	(0.00114)	(0.00148)
Observations	601	601	601	601	601	601	601	601	601

The ecological footprint is the dependent variable, and all regressions include country fixed effects. Clustered standard errors (calculated via bootstrap resampling nations) are in parenthesis. The results of the scale and location are not reported in this study due to brevity, but they are available on request.

Table 5: Dumitrescu-Hurlin (2012) heterogenous Granger-causality results

Variables	(1) EF	(2) FD	(3) FM	(4) FI	(5) REM
EF	-	2.4829	3.5952***	2.0570	2.4221
		(1.1325)	(3.7410)	(0.1337)	(0.9898)
FD	3.4521***	-	-	-	4.9293***
	(3.4055)				(6.8698)
FM	2.5922	-	-	-	2.6896
	(1.3887)				(1.6174)
FI	3.6332***	-	-	-	4.5167***
	(3.8301)				(5.9023)
REM	4.4945***	3.8104***	3.5572***	3.3771***	-
	(5.8500)	(4.2458)	(3.6519)	(3.2296)	

Note: The test statistics is the w-stat. z-stat is in parentheses, *** denotes significance at 1 %, ** at 5 % and * at 10%. lag length of 2 was used.

Restricting the interpretation to the variable of interest, the results shown in Table 4 reveal that diaspora income has a negative and significant impact on ecological footprint across the quantiles. However, a cursory examination of the quantile graph produced in Appendix 3 denotes that the elasticity of diaspora income across quantile is almost the same. This infers that regardless of the distribution of ecological degradation, diaspora income reduces environmental degradation in Africa.

Similarly, all the three financial development measures have a positive and significant impact on ecological degradation. However, the magnitude of the impact of these financial development measures differs across quantiles. For instance, the elasticity of financial development on ecological footprint reduces from 0.323 in the 10^{th} quartile to 0.277 in 90^{th} quartile. Also, the coefficient of financial institutions decreases from 0.518 in 10^{th} quartile to 0.392 in 90^{th} quartile. This indicates that the rate at which overall financial development and financial institution degrade the environment is less for higher polluting countries in Africa. However, the impact of the financial market on ecological degradation increases from 0.0482 in 10^{th} quartile to 0.065 in 90^{th} quartile. This suggests that the quantum of Africa's stock and bond markets sub-sector impact on ecological footprint is higher for higher polluting countries.

Furthermore, the interaction of diaspora income and financial development is negative and significant across the quantile. However, the magnitude of the impact differs, as the impact on ecological footprint increases from -0.0202 in 10^{th} quartile to -0.0152 in 90^{th}. This indicates that the role of financial development in mitigating the environmental degradation impact of diaspora income is less for higher polluting countries in Africa. However, the role of other measures of financial development on the nexus between diaspora income and ecological footprint is negative and significant across the quantile, but the size of their impact differs. For instance, the magnitude of financial market decreases from -0.002 in 10^{th} quartile to -0.003 in 90^{th} , while the elasticity of financial institution reduces from -0.0297 in 10^{th} quartile to -0.0230 in 90^{th}.

4.3: Causality results of Diaspora income and Ecological Footprint in Africa

The final phase of the econometric procedure of this study is to determine the direction of causality among the main variables of interest, such as diaspora income, ecological footprint, and financial development measures (financial institutions and market). This causality results would aid African governments and policymakers in developing appropriate environmental policies. The Dumitrescu-Hurlin panel causality results presented in Table 5 indicates a unidirectional causality from diaspora income to ecological footprint, diaspora income to financial market, financial development to ecological footprint, financial institution to ecological footprint, ecological footprint to the financial market. However, a bidirectional causality is recorded between diaspora income and financial development, diaspora income and financial institution. In achieving a robust financial system, reducing the ecological footprint, and attracting diaspora income, these findings are essential for African governments and policymakers.

5.0 Summary and Conclusion

The environmental consequences of diaspora income or remittances have been largely ignored in the empirical literature, despite its importance as a potential source of income and contribution to the economic growth of developing countries, especially Africa. In contributing to the empirical literature, this study examines the impact of diaspora income on the ecological footprint of 22 countries African countries. The study leans on a balanced panel from 1990 to 2017. In achieving this, four models were employed: (1) the fixed effect Driscoll and Kraay (1998) robust standard errors-type technique, (2) the fixed effect instrumental regression model to address endogeneity bias in the model, (3) the newly developed Machado and Silva (2019) MMQR to assess the distributional impact of diaspora income, (3) the Dumitrescu and Hurlin (2012) causality test is also used to examine the direction of causality between diaspora income, financial development, and ecological footprint.

The empirical findings from this study are as follows: (1) diaspora income has a negative and statistically impact on ecological degradation, (2) financial development deteriorates the environmental quality of African countries. However, it also plays a crucial role in mitigating the environmental degradation impact of diaspora income. In addition to this, our empirical outcome indicate that African countries must achieve an annual estimated threshold of 0.144-0.165 for the overall financial development, 0.115-0.221 for the financial market, and 0.201-0.235 for financial institution before diaspora income could improve environmental quality. This result is robust to the instrumental regression model, (3) the result of the quantile regression suggests that the quantum at which diaspora income reduces ecological footprint is the same across the conditional distribution. However, financial development contributes less to the ecological footprint of higher polluting countries in Africa. The quantile results further indicate that financial development's role in mitigating the environmental degradation impact of diaspora income is less for higher polluting countries in Africa, (4) the granger causality test indicates a unidirectional causality from diaspora income to ecological footprint.

Based on the aforementioned findings, this study suggests the following policy recommendation to stakeholders, policy makers and African governments. First, though diaspora income reduces ecological footprint, African governments are still encouraged to create incentive programs that encourage investors and consumers to purchase environmentally friendly technology using earnings from remittances. These governments should also provide a tax credit to recipients of these remittances who invest in environment-friendly technologies. Doing this would enhance ecologically sustainable GDP benefits of remittance inflow. Secondly, since financial development plays a crucial role in improving the environmental quality impact of diaspora income. And since many African countries are still below the estimated threshold of financial development in this study, we recommend that these countries should put in place policies to improve their financial sector. They can also learn from the success story of the South African Financial Sector Development and Reform Program (FSDRP). Similarly, African governments, via their central banks, should create lending policies that encourage banks and other financial institutions to lend money to businesses that use environmentally friendly production techniques. The study also highlights the importance of regional economic cooperation. This is to permit African countries to have coordinated policies on environmental sustainability measures. African governments through the AfDB or relevant organisation are encouraged to develop a strategy on the environmental sustainability in Africa.

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Appendix 1: United Nation Regional Classification

Benin	Guinea	Niger	Tunisia
Botswana	Kenya	Nigeria	
Burkina Faso	Lesotho	Rwanda	
Cameroon	Madagascar	Sierra Leone	
Congo	Malawi	South Africa	
Ethiopia	Mali	Tanzania	
Ghana	Mozambique	Togo	

Countries below the financial development threshold		Countries above the financial development threshold
Benin	Mali	Botswana
Burkina Faso	Mozambique	Kenya
Cameroon	Niger	Nigeria
Congo	Rwanda	South Africa
Ethiopia	Sierra Leone	Togo
Ghana	Tanzania	Tunisia
Guinea		Lesotho
Madagascar		
Malawi		

Appendix 2: calculation of the threshold estimates

The threshold is determined by differentiating ecological footprint ($EF_{i,t}$) with respect to diaspora income (REM_{it}) and setting the resulting derivative to zero:

$$lnEF_{i,t} = \beta_0 + \beta_1 lnREM_{i,t} + \beta_2 lnREM * FD + \beta_3 lnX_{i,t} + \gamma_t + \mu_{i,t}$$

$$\frac{\partial lnEF_{i,t}}{\partial lnREM_{it}} = \beta_1 + \beta_2 FD = 0$$

By dividing the equation by FD gives the following equation:

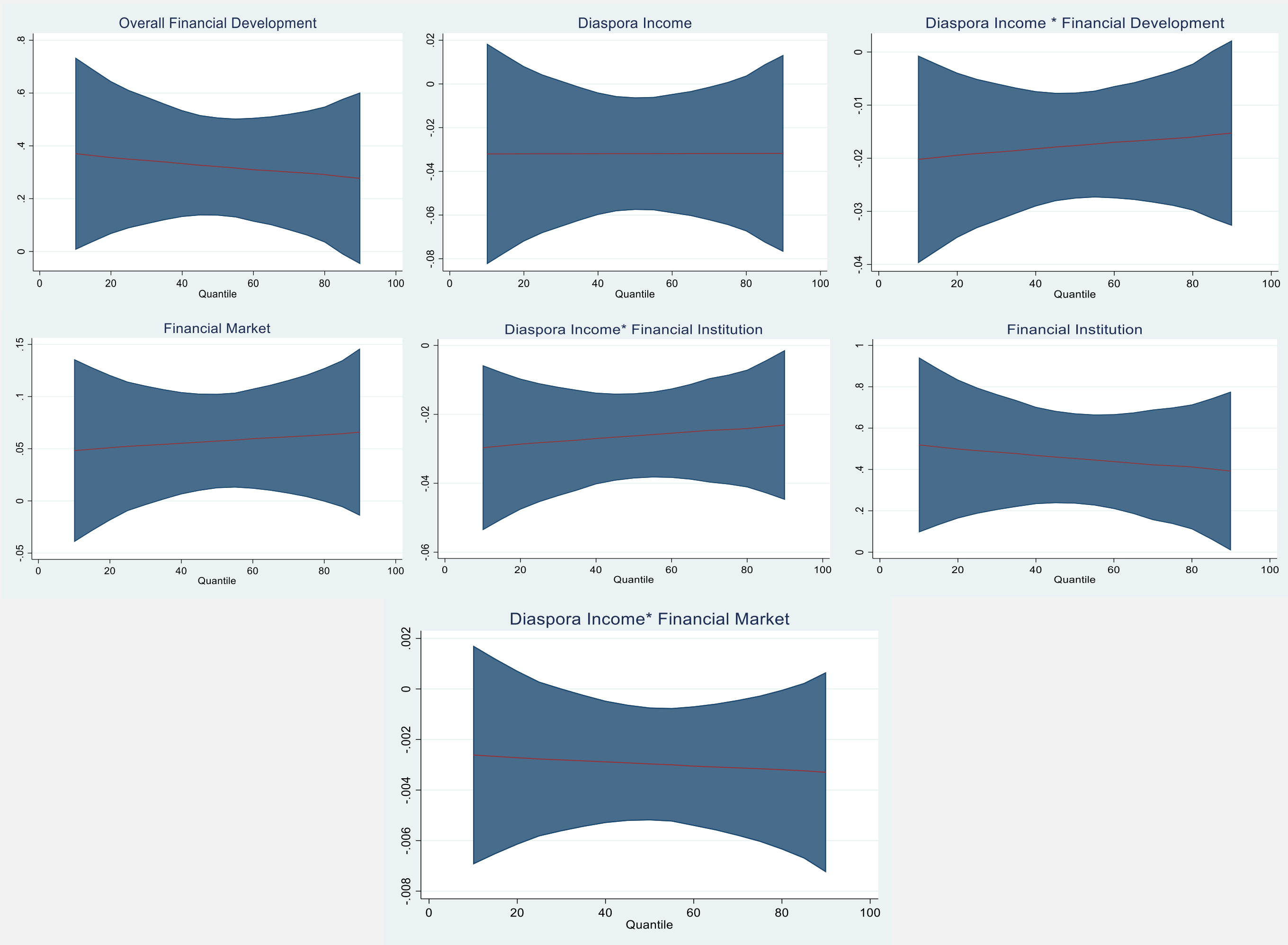
$$FD = \frac{-\beta_1}{\beta_2}$$

Since the variables are logged, we need to transform them using the following:

$$e^{\frac{-\beta_1}{\beta_2}}$$

This equation is the threshold point of financial development on the nexus between diaspora income and ecological footprint.

Appendix 3: Graphical representation of the MMQR estimates



Notes: the shaded in each panel represent the 90% corresponding confidence intervals, while the solid line indicates the various quantiles. Y-axis represent the elasticity of explanatory variables on ecological footprint, while the X-axis shows the quantiles of ecological footprint.