

ESTUDIOS

Sectoral Growth Dynamics: Inequality Tradeoff and Sustainability in Central America¹

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Abstract: This study is concerned with both the interlinks between inequality, extreme poverty reduction, and economic growth and estimates the dampening impact on economic growth and on extreme poverty rates using the Central American countries annualized level data. These dynamic complexities, are analyzed within the auto regressive distributed lag bounds testing approach to cointegration. The results show that when extreme poverty reduction is decomposed into two separate impacts, the growth impact on poverty reduction was lessened by the incidence of high-income inequality. The total dampening impact of inequality, varies from 1.1522% for El Salvador to 2.0589% for Honduras, due to a 1% increase in inequality. Reducing inequalities can be doubly beneficial for the extreme poor in Central American countries. The magnitude of changes in poverty reduction depends on each country-specifics, which leads to the implementation of a different strategy for extreme poverty reduction to different countries.

Keywords: *Central America, Extreme Poverty, Economic Growth, Inequality, Dampening, ARDL, Short and Long-Run Elasticities.*

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Dinámica del crecimiento sectorial: compensación de desigualdades y sostenibilidad en Centroamérica

Resumen: Este estudio se ocupa de las interrelaciones entre la desigualdad, la reducción de la pobreza extrema y el crecimiento económico, y estima el impacto amortiguador en el crecimiento económico y en las tasas de pobreza extrema utilizando los datos a nivel anualizado de los países centroamericanos. Estas complejidades dinámicas, se analizan dentro del enfoque de pruebas de límites de retardo distribuido autorregresivo a la cointegración. Los resultados muestran que cuando la reducción de la pobreza extrema se descompone en dos impactos separados, el impacto del crecimiento sobre la reducción de la pobreza fue disminuido por la incidencia de la desigualdad de altos ingresos. El impacto amortiguador total de la desigualdad, varía de 1,1522% para El Salvador a 2,0589% para Honduras, debido a un aumento de 1% en la desigualdad. La reducción de las desigualdades puede ser doblemente beneficiosa para los pobres extremos de los países centroamericanos. La magnitud de los cambios en la reducción de la pobreza depende de las especificidades de cada país, lo que lleva a la aplicación de una estrategia de reducción de la pobreza extrema diferente a los distintos países.

Keywords: *Centroamérica, pobreza extrema, crecimiento económico, desigualdad, amortiguación, ARDL, elasticidades a corto y largo plazo.*

Dynamique de la croissance sectorielle : compromis sur l'inégalité et durabilité en Amérique centrale

Résumé : Cette étude s'intéresse aux liens entre l'inégalité, la réduction de l'extrême pauvreté et la croissance économique et estime l'impact de l'amortissement sur la croissance économique et sur les taux d'extrême pauvreté en utilisant les données annualisées des pays d'Amérique centrale. Ces complexités dynamiques sont analysées dans le cadre de l'approche de la cointégration par le test des limites des retards distribués auto-régressifs. Les résultats montrent que lorsque la réduction de l'extrême pauvreté est décomposée en deux impacts distincts, l'impact de la croissance sur la réduction de la pauvreté est réduit par l'incidence de l'inégalité des hauts revenus. L'impact total de l'inégalité varie de 1,1522% pour le Salvador à 2,0589% pour le Honduras, en raison d'une augmentation de 1% de l'inégalité. La réduction des inégalités peut être doublement bénéfique pour les personnes extrêmement pauvres dans les pays d'Amérique centrale. L'ampleur des changements dans la réduction de la pauvreté dépend des spécificités de chaque pays, ce qui conduit à la mise en œuvre d'une stratégie de réduction de l'extrême pauvreté différente selon les pays.

Mots clés : *Amérique centrale, extrême pauvreté, croissance économique, inégalités, amortissement, ARDL, élasticités à court et à long terme.*

I. Introduction

Concerns about the interlinks between economic growth, inequality and extreme poverty reduction have grown substantially in recent years. Policy makers in developing as well as in developed countries, academics, the international community, practitioners, and the public at large express frequently on the increase in inequality as a danger dampening effect to economic and social integration stability (Cingano, 2014; Croes and Vanegas, 2008; UNCTAD, 2008, 2021; Vanegas and Roe, 2021; Vanegas, 2022).

Has extreme poverty and income inequality decreased in the developing countries of the Central America region (CA), composed by: Costa Rica (CR), El Salvador (ES), Guatemala (GU), Honduras (HO), and Nicaragua (NI), during the last four decades? What we see in tables 1, 2, and 3, at best, mixed results. The massive job losses and decline in income during the Covid-19 health crisis affected the lower income strata of the CA societies. As a result, the average rates of extreme poverty and inequality increased and turned for the worse (ECLAC, 2021, 2022; United Nations, 2020; Valensisi, 2020; Vanegas and Roe, 2021, Vanegas et al, 2015; Vanegas, 2022).

TABLE I. Average Evolution of Extreme Poverty and Gini Coefficient

Period/Year	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
<i>POE, %</i>					
1980-1990	10.06	31.31	26.78	49.31	24.14
1990-2000	7.27	23.19	25.21	47.94	23.40
2000-2010	4.92	16.07	14.74	43.39	17.10
2010-2020	6.10	9.54	19.51	44.03	10.25
1980-2020	7.09	19.94	21.62	46.40	17.05
1980	9.79	28.37	23.42	57.46	19.53
1990	9.14	30.48	32.60	41.31	32.47
2000	6.13	19.25	15.74	48.60	15.76
2010	3.94	14.10	13.89	39.10	13.90
2020	8.52	8.38	20.32	48.20	12.87
2021 ¹	7.31	7.36	19.85	—	12.00
2022 ²	6.63	6.47	18.88	—	11.76

Period/Year	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
<i>GINI, 0-1</i>					
1980-1990	41.60	53.78	54.86	52.24	56.19
1990-2000	35.45	51.11	50.47	54.90	56.54
2000-2010	43.30	49.73	51.38	56.60	44.70
2010-2020	51.60	38.42	47.74	52.62	38.27
1980-2020	42.99	47.95	51.09	54.08	48.60
1980	44.32	51.83	55.14	58.36	54.51
1990	37.60	54.96	52.42	53.98	50.39
2000	41.30	54.03	51.85	54.70	51.08
2010	50.70	47.00	49.82	54.05	38.04
2020	51.90	37.84	47.08	51.90	41.98
2021 ¹	51.90	36.90	47.95	54.92	44.19
2022 ²	52.40	35.93	47.00	—	43.12

Source: Authors' calculations using the national or official datasets of the statistics offices of the Central American countries. ¹ Preliminary and under revision. ² Author's estimates.

The objective of this study is to examine the magnitude of the total dampening impact of inequality on extreme poverty in CR, ES, GU, HO and NI. The total dampening impact is decomposed into the direct and indirect dampening impacts, where the direct dampening impact is equal to the estimate of income inequality elasticity of extreme poverty. The indirect dampening impact is calculated as the difference between the estimate of a benchmark income growth elasticity of extreme poverty and the estimate of income growth elasticity of extreme poverty while allowing inequality to be different from zero. The dynamic complexities of this extreme poverty framework are analyzed within the auto regressive distributed lag bounds testing approach to cointegration (ARDL), proposed by Pesaran, et al., 2001.

**TABLE 2. Evolution of Annual Compound Average Growth Rates¹:
Income, Extreme Poverty² and Gini Coefficient**

Country Statistics	1980-1990	1990-2000	2000-2010	2010-2020	1980-2020
<i>Income</i>					
Costa Rica ³	3.09	5.14	4.81	3.55	4.15
El Salvador ⁴	1.59	4.66	2.17	1.71	2.53
Guatemala ⁵	2.13	4.08	3.31	3.27	3.20
Honduras ⁵	3.46	3.33	4.53	3.02	3.59
Nicaragua ⁵	-1.97	4.51	3.08	2.68	2.08
<i>Extreme Poverty</i>					
Costa Rica ³	-1.58	-5.58	-5.51	4.08	-2.15
El Salvador ⁴	-0.99	-6.20	-3.74	-7.00	-4.48
Guatemala ⁵	2.71	-7.16	-0.93	3.36	-0.51
Honduras ⁵	-0.15	0.18	-0.35	-1.01	-0.33
Nicaragua ⁵	4.35	-3.82	-3.05	0.06	-0.63
<i>Gini Coefficient</i>					
Costa Rica ³	-1.43	0.61	0.95	0.10	0.58
El Salvador ⁴	0.31	-0.66	-1.63	-2.23	-1.05
Guatemala ⁵	-0.76	-0.37	-0.54	-0.51	-0.55
Honduras ⁵	-0.15	0.18	-0.35	-0.92	-0.39
Nicaragua ⁵	0.39	1.26	-3.58	0.19	-0.44

Source: Authors' calculations based on national/official datasets. Due to methodology change, consultations with Honduras as related to extreme poverty and Gini coefficient values between 2014 and 2020 still ongoing. ¹ The growth rate is calculated using the following exponential equation: $\ln Y = \alpha + \beta \text{Time}$ where β multiplied by 100 provides the growth rate value. ² Defined as a specific share of the country's population whose income or consumption of a basic food basket is below the official poverty line, that is, the percentage of population that cannot afford to buy a defined basic basket of food. ³ Costa Rica's values for 1970-1980 can be provided upon request. ⁴ Starting year is 1983. ⁵ Starting year is 1982.

2. Theoretical framework

To reduce extreme poverty, expansion of the economy constitutes a prerequisite. The positive effects of economic growth on extreme poverty reduction are at the basis of the alleged trickle-down theory which emerged in the 1950s. It theorizes that the benefits of economic expansion will trickle-down and automatically eliminate poverty (Kuznets, 1955; Kaldor, 1956). Today, the stance around the role of economic growth on extreme poverty reduction is not the same as it was in 1950s, 1960s, or even the 1970s.

TABLE 3. Counting the Numbers of Extreme Poor

Country/Year	POE%	Population Millions	Extreme Poor People
<i>Costa Rica</i>			
1980	9.79	2.30	225,571
1990	9.14	3.03	276,881
2000	6.13	3.87	237,375
2010	3.94	4.53	178,635
2020	8.52	5.11	435,478
2021	7.31	5.16	377,418
2022	6.63	5.21	345,647
<i>El Salvador</i>			
1980	28.37	4.62	1,309,405
1990	30.48	5.13	1,563,083
2000	19.25	6.27	1,207,428
2005	15.90	6.05	961,296
2010	14.10	6.17	809,390
2015	9.03	6.26	582,171
2020	8.38	6.32	529,703
2021	7.36	6.33	465,566

Country/Year	POE%	Population Millions	Extreme Poor People
Guatemala			
1980	23.42	6.89	1,613,719
1990	32.60	9.05	2,950,338
2000	15.74	11.59	1,824,228
2010	13.89	14.26	1,980,671
2020	20.32	15.57	3,505,783
2021 ¹	19.85	16.86	3,425,618
Honduras			
1980	57.46	3.63	2,080,878
1990	41.31	4.92	1,988,367
2000	48.60	6.53	2,753,547
2010	39.10	8.34	3,265,003
2020	48.20	9.30	4,493,445
2021 ¹	—	9.45	—
Nicaragua			
1980	19.35	3.25	628,724
1990	32.47	4.14	1,343,159
2000	20.42	4.96	1,012,212
2010	13.90	5.82	808,358
2020	12.87	6.60	848,863
2021 ¹	12.00	6.66	799,724

Source: Author's calculations using the data from Tables 1 and 2 and the official or national population estimates. ¹ Author's estimates.

The literature provides some insights into the relationship between the economy, distribution, and poverty. In an economy of a developing country distribution is linked to the: (i) level of economic growth, (ii) saving-investment rate, (iii) accessibility to credit markets, (iv) political economy, and (v) institutions. Based on the relationships or models of these transmission mechanisms, it has been found that the relationship between income inequality and economic growth can be positive, negative, or non-significant. In the face of confronting theoretical ambiguity, it also has been, empirically proven, using cross-sectional data, that

these empirical findings are highly debatable. Moreover, there is a relatively high probability that these findings may be both of limited relevance and applicability to a developing country case.

In the context of the relationship between extreme poverty reduction and inequality, how they are linked? There are two competing theoretical propositions. The first one indicates that inequality is associated with increased rates of extreme poverty. The second one indicates that inequality is good for extreme poverty reduction, at least, through the favorable effects leading to relatively higher economic growth. The end result, in a way, the overall economic growth impact benefiting poor people.

The most important hypothesis in this type of relationship is the one postulated by Kuznets (1955): the presence of an inverted U relationship. It means that as a country starts its economic development there is an initial worsening of the income distribution, but later on, as a country reaches higher levels of development, the income distribution recuperates, that is, it becomes relatively more equal. The testing of this relationship, however, at its early stages, was based only on both a comparative static analysis and Kuznets empirical analysis of just three developed countries: The United States, the United Kingdom, and Germany (Adelman and Morris, 1973; Ahluwalia, 1976; Benhabib, 2003; Gallo, 2002; Papanek and Kyn, 1986, among others). Moreover, Kuznets (1955, pp. 18, 19, 26) stated that his analysis was perhaps 5 percent empirical information and 95 percent speculation, some of it possibly tainted by wishful thinking (Vanegas, 2022).

From my viewpoint, the argument here is that in the long-run or in the future the developing countries, including the Central American countries, will have a better income distribution, while it should be an imperative to pay the cost of having an increase in income inequality today. As related to Central American countries goals: poverty reduction, inclusion and sustained economic growth, there is a fundamental question that I would like to put forward: today should we really not worry about the challenge of income inequality because an automatic or magic mechanism making its presence in the long-run or future will improve income inequality? Since the late 1990s, an extensive number of studies, suggest that Kuznets (1955) hypothesis does not hold.

There are, at least, three policy reflections and one of a methodological type that I want to make on the above issue: (i) what would happen if that automatic or magic mechanism of income and/or wealth redistribution does not appear? (ii) not to worry about the wellbeing of the extreme poor today. It should be sacrificed for the wellbeing of the future generation, and (iii) the time or long-run factor is key.

For how long the extreme poor have to wait that automatic top-inflection point and start to count a relative progress in their wellbeing condition?

On the other hand, the methodological type consists of three challenges: the first one consists in that not all developing countries will follow the same pattern of development. It calls for specific country-by-country analysis and not cross-section analysis. The second challenge is related to time series data. Only time series data give you the possibility to obtain time trends. However, it is important to note here that in the developing world, regardless of the use of cross-section or time series analysis and the use of a variety of different inequality and poverty measures the empirical evidence has showed that income inequality is associated with increased rates of poverty and increases in income inequality are associated with increases in poverty (Fosu, 2017; Karagiannaki, 2017; Yang and Vizard, 2017, among others).

What theoretical relationship exists between income inequality and economic growth? Due to the relentless increases in income inequality, the focus of analysis has shifted to estimating the reverse relationship (the impact of inequality on economic growth), with research trying to establish whether inequality promotes economic growth or is harmful for growth. Trying to find an answer, the empirical evidence has showed a positive and negative relationship between income inequality and economic growth. In short, the results have been ambiguous. Other studies have explored if the relationship between inequality and economic growth is non-linear.

If it is undoubtedly established that income inequality is detrimental for economic growth then, from the policy perspective, a much stronger case for reducing inequality can be made than if evidence suggests that inequality is beneficial for growth. In this negative theoretical context, income inequality could lead to un-sustainable economic growth, higher rates of poverty, and lower the levels of economic, political and social inclusion.

However, if income inequality seen to be good for economic growth, then according to this theory, tackling inequality can be harmful for growth. Moreover, concerning this relationship, much of the theory suggesting a positive relationship is based on two assumptions: (i) that inequality leads to greater human capital effort and innovation which in turn generates higher levels of economic growth, and (ii) that the saving rate of well-off people is relatively higher than that of the poor. Therefore, this income redistribution from well-off people to poor people reduces the saving rate of the economy as a whole and thus could lead to a decline in economic growth.

3. Literature review

At the regional and global levels, an increasing number of empirical studies have found that inequality weakens magnitudes of economic growth on poverty reduction (Adams, 2004; Bourguignon, 2003, 2004; Fosu, 2017; Kalwij and Verschoor, 2007; Ravallion, 2001, 2005; Ravallion and Chen, 1997, among others). In their work, Mansi et al. (2020), analyzed the factors that impact poverty and compare these results between countries within the European Union and Western Balkan countries. The results, showed that income inequality does weaken the income growth impact on poverty, and indeed impact the further progress of poverty for both the *European Union and Western Balkan* countries.

At the developing country-specific level, among others, *Algeria*, Ayad (2016); *Brazil*, Silva-Tabosa, et al. (2016) and Araujo et al. (2017); *Costa Rica and Honduras*, Vanegas (2022); *Ethiopia*, Gelaw (2010); *Mexico*, Iniquez-Montiel and Kurosaki (2018); and *Zambia*, Mphuka et al. (2016) studies found that: (i) in some countries income growth has been the major driving force behind both the declines and increases in poverty; and (ii) in others, however, inequality exerted the central role in poverty performance.

In their study, Attanasio and Birelli (2000), argued that a better distribution of economic growth is needed to overcome the challenge of increased inequality and that the provision of inclusive programs or strategies aimed to reduce inequality could be a sound alternative policy to deal with the sustained extreme poverty reduction challenge.

In a developed country, such as the United States Nasir and Mridha (2017, p. 167 and p. 176), estimated the dampening effect of rising inequality on growth effect on poverty rates using county level data from 2006 to 2010. They found that income growth does alleviate poverty but growing inequality, directly and indirectly, dampens the income growth effect on poverty rates. Moreover, their estimated total dampening effect of inequality indicated that the rising inequality to have lifted 129,405 fewer people out of poverty annually between 2006 and 2010.

4. Methodology

4.1. The ARDL approach to cointegration

The ARDL, is the methodology used in this study, which is a cointegration analysis developed within an autoregressive distributed lag framework. The ARDL approach is the most efficient cointegration technique when it comes to small or finite sample data sizes as is the case with this study, and it can be applied even in the case where the variables of the model are of mixed order of integration, that is to say, they are $I(0)$ and $I(1)$. Nonetheless, within the ARDL framework, the series should not be $I(2)$, because this integration order invalidates the F-statistics and all critical values established (Pesaran and Pesaran, 1997; Pesaran et al., 2001).

From the error correction model, a dynamic specification that integrates short-run dynamics with long-run equilibrium without losing long-run information, can be derived. The country by country estimation strategy allows the opportunity to compare the cross-country distribution of the slope coefficients. Given the fact that the ARDL method may tolerate different lags in different variables, this makes the method very appealing, adaptable, and flexible (Ali et al, 2017; Bayer and Hanck, 2013; Harris and Sollis, 2003; Jalil and Ma, 2008; Menegaki, 2019; Vanegas, 2018).

4.2. Modeling framework

Inequality dampens extreme poverty reduction in CR, ES, GU, HO, and NI, both due to its dampening impact on the economic growth elasticity of extreme poverty (indirect), and due to its impact on the inequality elasticity of extreme poverty (direct). To measure these magnitudes the models are labeled as: benchmark model 1, which set inequality equal to zero and unrestricted model 2, which allows inequality to change. In the ARDL framework, these models are set as equation (1) and (2), respectively.

$$\Delta \log \text{POE}_{it} = \alpha_0 + \sum \alpha_{1it} \Delta \log \text{GDP}_{it-j} + \sum \alpha_{2it} \Delta \log \text{POE}_{it-j} + \psi_{1it} \log \text{GDP}_{it-1} + \psi_{2it} \log \text{POE}_{it-1} + \mu_{it} \quad (1)$$

$$\Delta \log \text{POE}_{it} = \beta_0 + \sum \beta_{1it} \Delta \log \text{GDP}_{it-j} + \sum \beta_{2it} \Delta \log \text{GINI}_{it-j} + \sum \beta_{3it} \Delta \log \text{POE}_{it-j} + \delta_{1it} \log \text{GDP}_{t-1} + \delta_{2it} \log \text{GINI}_{t-1} + \delta_{3it} \log \text{POE}_{it-1} + \mu_{it} \quad (2)$$

Where POE_{it} , represents a proxy for the extreme poverty headcount index in country (i) at time (t); GDP_{it} represents the real gross domestic product (2015 = 100 prices), which is used as a proxy for income in country (i) at time (t); and inequality is proxied by the $GINI_{it}$ (1912) coefficient in country (i) at time (t); Δ is the first difference operator. The estimated coefficients δ_1 , δ_2 , and δ_3 are the long-run coefficients; β_1 , β_2 , and β_3 , the short run coefficients, and μ represent the residual. The selection of the optimal ARDL specification is on the basis of a set of criteria (e.g., Akaike, 1974 and Schwartz, 1978). The final step is the estimation of the short-run dynamic coefficients via the following error correction model (3):

$$\Delta \log POE_{it} = \psi_0 + \sum \psi_{1it-j} \log PIB_{it-j} + \sum \psi_{2it-j} \log Gini_{it-j} + \sum \psi_{3it-j} \log POE_{it-j} \quad (3) \\ + \phi EC_{it-1} + \varepsilon_{it}$$

The EC_{it-1} is the error correction term resulting from the verified long-run equilibrium relationship and ϕ is a parameter indicating the speed of adjustment to the equilibrium level after a shock. Five dummy variables were used to capture the impact of unexpected events: (D1) captures the terrorists attacks in the United States, 9/11/2001 and the aftermath; (D2) measures the impact of the global economic and financial crisis in 2008-2011; (D3) measures the Covid-19 pandemic and its aftermath, 2020-2021; (D4) measures the civil strife in Nicaragua, (1982-1989); and (D5) measures the protests in Nicaragua, (2018-2019). The dummy variables take the value of 1 in the year of the occurrence of the special event and 0 otherwise.

4.3. Data and sources

All Central American countries have adopted a relatively uniform practice in measuring extreme poverty, allowing them to conceptualize policy questions, target poor groups, and track progress in improving living standards. For all countries, the national or official extreme poverty line represents the cost of a minimum level of calories contained in a basic basket of food.

For the five Central American countries consistent, comprehensive, satisfactory, and reliable time series data comprising of sequential annualized observations on national or official extreme poverty and Gini index were obtained: CR (1970-2021) from the Instituto Nacional de Estadísticas y Censos (INEC-Accessibility via <http://www.inec.gob.cr>) <http://www.inec.cr>); ES (1983-2021) from the *Dirección General de Estadística y Censos* (DIGESTYC-Accessibility via: <http://www.digestyc.gob.sv> and since the end of 2022 from the *Banco Central de Reservas-BCR*: <http://>

www.bcr.gob.sv); GU (1982-2021) from the *Instituto Nacional de Estadística* (INE- Accessibility via <http://www.ine.gob.gt>); HO (1982-2020) from <http://www.ine.gob.hn>); and NI (1982-2020) from the *Instituto Nacional de Información y Desarrollo* (INIDE-Accessibility via <https://www.inide.gob.ni>). The 1970s and 1980s series were compiled in different onsite visits from official dispersed reports, publications, and individual files.

The GDP datasets are from their respective central banks: CR-Banco Central de Costa Rica (BCCR-Accessibility via <https://www.bccr.gob.cr>); ES-Banco Central de Reservas (BCR-Accessibility via <https://www.bcr.gob.sv>); GU-Banco de Guatemala (BANGUAT-Accessibility via <http://www.banguat.gob.gt>); HO-Banco Central de Honduras (BCHO-Accessibility via <https://www.bcho.gob.hn>); NI-Banco Central de Nicaragua (BCN-Accessibility via <https://www.bcn.gob.ni>). The series for Nicaragua was completed from (BCN, 2012, *50 años de estadísticas macroeconómicas*). In terms of quality and accuracy control, the data were cross-checked wherever possible, including physical visits, emails and telephone guided interviews with government officials to validate the information. The national or official datasets were based solely on the information that was available at the time of the research paper development, whereupon the terms of disclosure and use were agreed upon and adhered to with the original data producers.

5. Results

5.1. Unit root and bounds cointegration testing

The study used the modified Dicky-Fuller Generalized Least Squares test (GLS-DF), which was introduced by Elliot, et al. (1996). The DF-GLS test was applied to both levels and first differences of the variables. Table 4 below, displays the results according to which the set of variables used in our study is a mixture of $I(0)$ and $I(1)$. To rigorously reject the case of false identification of the exact order of integration of the variables, the LM-type test was used with one and two breaks, assuming initially only a level change in the series, and then a simultaneous change in the level and the trend of the series (Lee and Strazicich (2003a,b).

TABLE 4. Unit Root Results

Variable	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
<i>Level</i>					
logPOE	-2.3814 (2)	-2.2352 (2)	-1.8647 (1)	-1.8673 (2)	-1.9826 (1)
logGINI	-3.9462 (2)	-3.9368 (1)	-3.9863 (0)	-2.6334 (2)	-2.6572 (2)
logGDP	-1.8892 (1)	-1.9269 (1)	-1.6374 (1)	-1.8434 (1)	-1.7924 (1)
<i>First Differences</i>					
Δ logPOE	5.4723 (1)	-5.0954 (1)	-6.6328 (0)	-6.1086 (1)	-6.4403 (1)
Δ logGINI	-8.3046 (2)	-7.3347 (2)	-7.8321 (0)	-7.5326 (0)	-6.7629 (0)
Δ logGDP	-4.9185 (1)	-4.4671 (1)	-5.5127 (1)	-3.7438 (1)	-3.9449 (1)

Notes: (1) Estimates with intercept and trend. (2) The numbers in brackets are lag lengths used to remove serial correlation. The optimal lags are based on the minimum of the Akaike Information Criterion, and the Schwartz Information Criterion. (3) The corresponding critical values used for the statistics are from Dickey and Fuller (1981). (4) Since all series are $I(0)$ and/or $I(1)$ and none are higher than $I(1)$, we can proceed with the cointegration analysis.

The testing of the null hypothesis of non-existence of the long-run relationship is defined by: $H_0: \delta_1 = \delta_2 = \delta_3 = 0$, against the alternative that at least one of these coefficients is different from zero. The F-statistics for testing are compared with the critical values developed by Pesaran et al. (2001). However, Narayan (2004, 2005), argued that these critical values are inappropriate in small samples which are the usual case with annual macroeconomic variables. For this reason, He provides a set of critical values for samples ranging from 30 to 80 observations for the usual levels of significance. The results displayed in Table 5 confirm both that the null hypothesis of zero cointegrating relationship is rejected and the existence of a long-run equilibrium relationship in the case of one and two lags, at the 5% level of significance.

5.2. Long-run interlink elasticities

As can be seen from table 6, the long-run predicted signs, magnitudes, and statistical significance of the estimates of the economic growth elasticities of extreme poverty are robust across all five Central American countries. The estimates range between -0.63 for HO and -1.74 for ES, for an average of nearly -1.16 . In CR and ES, the POE reduction in response to a 1% change in economic growth had been quite parallel. They both differ substantially from and are larger than GU, HO, and NI wherein POE reduction had been smaller and relatively much slower.

In the long-run, the impact of *inequality* is indisputably positive and statistically significant at the 1% confidence level. Its values are in the range of nearly 0.91 for ES to nearly 1.92 for GU, for an average of nearly 1.49. Therefore, a 1% increase in the Gini index, other things equal, leads to nearly 0.98%, 0.91%, 1.92%, 1.90% and 1.63%, increase in the POE rates of CR, ES, GU, HO, and NI respectively. From the above findings, it is clear that as inequality rises, the POE elasticity of inequality increases as a faster rate than the POE elasticity of economic growth. in GU, HO, and NI.

TABLE 5. Results of the ARDL Bounds Testing

Function	F-statistics calculated	
(CR) POE = f_1 (PIB, GINI, <i>Dummies</i>)	Cointegration	5.6712
(ES) POE = f_2 (PIB, GINI, <i>Dummies</i>)	Cointegration	5.7061
(GU) POE = f_3 (PIB, GINI, <i>Dummies</i>)	Cointegration	6.4786
(HO) POE = f_4 (PIB, GINI, <i>Dummies</i>)	Cointegration	5.81127
(NI) POE = f_5 (PIB, GINI, <i>Dummies</i>)	Cointegration	5.8342
Critical Values	Lower Levels	Upper Levels
Pesaran <i>et al.</i> (2001) ¹		
1% level	3.746	5.061
5% level	2.862	4.013
10% level	2.458	3.524
Narayan (2005) ²		
1% level	4.592	6.371
5% level	3.287	4.632
10% level	2.703	3.902

Notes: ¹ Table CI. Iii: Case III. ² As an illustration, the critical values developed by Narayan (2004, 2005) have been included: Appendix A4, A5, and A6 Case III.

5.3. Long and short-run inequality dampening impacts

As can be seen from the results in table 7, the economic growth impacts on extreme poverty in all five countries' unrestricted models weaken as we control for variation in inequality. As shown in table 7, allowing inequality to vary in the unrestricted

models, the *direct dampening* impact of inequality is equal to 0.9782 for CR, 0.9086 for ES, 1.9207 for GU, 1.9032 for HO, and 1.6338 for NI. indicating that a 1% increase in inequality *directly* increases extreme poverty rates by: 0.9784% for CR, 0.9086% for ES, 1.9207% for GU, 1.9032% for HO, and 1.6338% for NI.

Not only does the rising inequality directly dampen the economic growth impact on extreme poverty reduction, but also *indirectly* weakens the economic growth impact on extreme poverty. For example, the economic growth impacts on extreme poverty decline from benchmark estimate: of 1.9019 to 1.6928 (in absolute values) for CR and of 0.7817 to 0.6260 (in absolute values) for HO, indicating that growing inequality dampens the economic growth impact on extreme poverty indirectly by 0.2091 for CR and by 0.1557 for HO, which is the difference between benchmark economic growth elasticity estimate from benchmark model 1 and the economic growth elasticity from the unrestricted model 2.

The total dampening impact from model 2 shown in column 4 in table 7 is equal to: 1.1873 for CR, 1.1522 for ES, 2.0384 for GU, 2.0589 for HO, and 1.7906 for NI. which is the sum of *direct* and *indirect* impacts. All this means, for example in the case of CR and NI, the results indicate that the dampening impacts due to rising inequality are expected to cause the economic growth impacts to lift nearly 5,223 (at 1.1873% * 439, 891 = extreme poor people) and nearly 15,200 (at 1.7906% * 848,863 = extreme poor people) fewer people out of extreme poverty, respectively, in 2020.

5.4. Short-run elasticities, speed of adjustment and dummies

As shown in table 6, the estimated *short-run* income growth and income inequality elasticities follow the same pattern and are lower than their long-run counterparts. Their income values are in the range of nearly -0.31 for HO to nearly -0.82 for CR. On the other hand, the short-run inequality elasticities of POE values are both positive and in the range of nearly 0.50 for CR to nearly 1.13 for HO, for an average of nearly 0.72. In each country specification, the coefficients of the error correction term (EC_{t-1}), are all negative and statistically significant at 5% level. Their values indicate that nearly 31.8%, 32%, 30%, 26% and 31.1% of the deviation of extreme poverty from its long-run level is adjusted for CR, ES, GU, HO, and NI in one year, respectively.

Most of the dummies were statistically significant at the 5% confidence level or better: D1, irrespective of its sign shows no significant impact in extreme poverty reduction

across all countries; D2-global crisis, has a positive sign and shows significant impact, only for GU and HO; D3-Covid-19 pandemic had bigger and significant repercussions of increasing extreme poverty in CR, HO and NI; and as expected, D4 and D5 increased significantly the extreme poverty rates in Nicaragua.

5.5. Robustness

All the model specifications pass the diagnostic tests: Ramsey (1969) test for specification; Jarque-Bera (1980) test for normality; Breusch-Godfrey (1978) test for serial correlation; White (1980) test for heteroscedasticity; ARCH-LM (Engle, 1982) test for autoregressive conditional heteroscedasticity; CUSUM and CUSUM squared for parameter stability Brown et al (1975). For additional robustness check, we estimated different specifications which entered the income variable both as real per capita gross domestic product in levels and as growth rates. The findings are similar in signs, magnitude of the coefficients and in significance. Finally, only for CR, ES, and HO, we provide further evidence with the adoption of an alternative extreme poverty measure, namely, the number of households in extreme poverty. The results showed that there are no significant differences in qualitative model performance and the coefficients are also quite similar in magnitudes and statistical significance.

TABLE 6. ARDL Long and Short-Run Elasticity Value Estimates

Model/ Variable	Costa Rica 1970-2021	El Salvador 1983-2021	Guatemala 1982-2020	Honduras 1982-2020	Nicaragua 1982-2020
<i>LONG-RUN</i>					
<i>Benchmark</i>					
logGDP	-1.9019*** (-3.7107)	-1.9834*** (-4.0727)	-0.9573** (-2.4013)	-0.7817** (-2.3798)	-1.0544** (-2.2823)
logGINI	—	—	—	—	—
R ² adjusted	0.9068	0.9011	0.9002	0.8731	0.8916
<i>Unrestricted</i>					
logGDP	-1.6928*** (-5.2709)	-1.7398*** (-3.6612)	-0.8396** (-2.6904)	-0.6260** (-2.7114)	-0.8976*** (-2.8007)
logGINI	0.9782*** (4.7437)	0.9086*** (4.3334)	1.9207*** (3.2861)	1.9032*** (5.6313)	1.6338*** (3.1778)
R ² adjusted	0.9389	0.9408	0.9277	0.9446	0.9260

Model/ Variable	Costa Rica 1970-2021	El Salvador 1983-2021	Guatemala 1982-2020	Honduras 1982-2020	Nicaragua 1982-2020
<i>SHORT-RUN</i>					
<i>Benchmark</i>					
logGDP	-0.8792*** (-3.6381)	-0.8071*** (-3.9174)	-0.5428** (-2.1082)	-0.3149* (-2.0078)	-0.6903** (-2.1242)
logGINI	— —	— —	— —	— —	— —
R ² adjusted	0.8937	0.9068	0.8986	0.8916	0.9067
<i>Unrestricted</i>					
logGDP	-0.6330*** (-4.8116)	-0.7142*** (-3.4017)	-0.4367** (-2.5589)	-0.2928* (-1.9473)	-0.5326** (-2.2978)
logGINI	1.0079*** (5.0736)	0.8016*** (4.1893)	1.1614*** (3.1265)	1.2325*** (4.7192)	1.1389*** (3.0671)
EC _{t-1}	-0.3179*** (-3.8843)	-0.3206*** (-3.3614)	-0.3006*** (-3.9138)	-0.2602*** (-3.8023)	-0.3108*** (-4.1790)
R ² adjusted	0.9261	0.9395	0.9204	0.9384	0.9489
D1	-0.0301 ^{ns} (-1.3309)	— —	-0.0327 ^{ns} (-1.1933)	— —	— —
D2	0.1207 ^{ns} (1.3241)	— —	0.1119* (1.9703)	0.1307** (1.9703)	— —
D3	0.7326*** (3.6879)	0.0218 ^{ns} (1.5109)	0.0109 ^{ns} (1.4311)	0.7183*** (4.2316)	0.3714*** (3.8566)
D4	— —	— —	— —	— —	0.3122*** (4.3734)
D5	— —	— —	— —	— —	0.4018*** (5.2169)

Source: Estimates were obtained using STATA version 12.

Note: Significant at ***(1%), **(5%), and *(10%) confidence levels.

TABLE 7. ARDL Long and Short-Run Estimates of Inequality Dampening Impacts

Country/Model		Direct dampening impacts- Estimates of inequality elasticity of extreme poverty	Indirect dampening impacts- Estimates of income growth elasticity of extreme poverty from benchmark model minus estimates from unrestricted model	Total dampening impacts- Direct impacts plus indirect impacts	Long and short-run income growth elasticity of extreme poverty
LONG-RUN					
<i>Costa Rica</i>	Benchmark	0	0	0	-1.9019
	Unrestricted	0.9782	0.2091	1.1873	-1.6928
<i>El Salvador</i>	Benchmark	0	0	0	-1.9834
	Unrestricted	0.9086	0.2436	1.1522	-1.7398
<i>Guatemala</i>	Benchmark	0	0	0	-0.9573
	Unrestricted	1.9207	0.1177	2.0384	-0.8396
<i>Honduras</i>	Benchmark	0	0	0	-0.7817
	Unrestricted	1.9032	0.1557	2.0589	-0.6260
<i>Nicaragua</i>	Benchmark	0	0	0	-1.0544
	Unrestricted	1.6338	0.1568	1.7906	-0.8976
SHORT-RUN					
<i>Costa Rica</i>	Benchmark	0	0	0	-0.8792
	Unrestricted	1.0079	0.2462	1.2541	-0.6330
<i>El Salvador</i>	Benchmark	0	0	0	-0.8071
	Unrestricted	0.8016	0.0929	0.8945	-0.7142
<i>Guatemala</i>	Benchmark	0	0	0	-0.5428
	Unrestricted	1.1614	0.1061	1.2675	-0.4367
<i>Honduras</i>	Benchmark	0	0	0	-0.3149
	Unrestricted	1.2325	0.0221	1.2546	-0.2928
<i>Nicaragua</i>	Benchmark	0	0	0	-0.6903
	Unrestricted	1.1389	0.1577	1.2966	-0.5326

Source: Author's calculations using the estimated results from table 6.

6. Conclusions and policy recommendations

6.1. Conclusions

Extreme poverty analysis of the five developing countries in Central America, unequivocally, indicates that a country's change in extreme poverty can be fully determined by the change in income growth and income inequality. The income growth impact dominates in Costa Rica and El Salvador. On the other hand, in a significant number of countries, similar to Guatemala, Honduras, and Nicaragua small changes in income inequality can have a very large effect on extreme poverty reduction. Moreover, the results also show that the magnitude of the direct income inequality impact on extreme poverty is more important than the economic expansion impact in Guatemala, Honduras, and Nicaragua. The results from pressing inequality to be reduced, also suggest that the number of extreme poor people in all Central American countries could have been reduced more.

To recap, reducing income inequality in the short as well as in the long-run matters most for Guatemala, Honduras, and Nicaragua than Costa Rica and El Salvador, when holding within-country income growth unchanged. The above evidence confirms that distribution is central to fighting extreme poverty and that income growth and better distribution are complementary, rather than competing objectives in the fight against extreme poverty in Central American countries. The numbers indicate that the total dampening impacts due to increasing inequality are expected to cause the economic growth impacts to lift nearly: 5,223, 6,103, 69,828, 100,497, and 15,203 fewer people out of extreme poverty in Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua, respectively, in 2020.

The study has shown that, in the case of developing countries such as the Central American countries, relying only on economic growth impacts alone was not enough to reduce extreme poverty significantly during the last four decades. Why? Because the relatively high level of inequality that accompanied such economic growth. Overall, it is clear that there are at least two factors that determine a developing country's performance in extreme poverty reduction. First is the magnitude of the income growth rate, which directly impact the overall income of a developing country's society. Second is the inequality index which relates to both the distribution of benefits of income growth and its dampening impacts. Unless we can demonstrate that income growth remains distributional neutral over time.

6.2. Policy recommendations

The magnitude of changes in extreme poverty reduction depends on each country-specifics, which leads to the implementation of a different strategy for poverty reduction to different countries. Therefore, from the above results clear policy recommendations have emerged. Due to the major relevance of inequality: Guatemala, Honduras, and Nicaragua and perhaps many other developing countries with similar features, are in greater need to adopt and/or to enhance targeted strategies or programs in favor of the most vulnerable groups of their society with the specific objective of reducing inequality. On the other hand, enhancing economic growth policies may be more adequate for Costa Rica and El Salvador.

In support for SG-SICA, SIECA-CEIE, BCIE-CRIT and ODI's process of development and integration in Central American countries, there is a need to establish a comprehensive research program on the dynamic complexities between income inequality and economic growth relationship, namely, "Integration, Poverty and Inclusion: Improving the Empirical Evidence Base for Understanding the Links Between Inequalities and Economic Growth" Its focus is on exploration of the following research questions:

- Is economic growth good/bad for income inequality? Economic growth leads to lower/higher levels of income inequality.
- Is income inequality (reverse causality) good/bad for economic growth? Income inequality promotes/suppresses economic growth.
- Is the relationship between economic growth and income inequality Non-Linear? Is it an inverted U or not for Central American countries?

Why the above policy recommendations? Because if this study should communicate any policy message, it should give a sufficient advice to institutions, governments, and scholars that inequality is important because its direct and indirect disruptive impacts on economic growth sustainability, poverty reduction and inclusiveness, not only for Central American countries but as well as to other developing countries.

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