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The Relationship between Public Debt and Income Inequality in Advanced and Developing Economies: Empirical Evidence on the Difference

Summary: In the context of increasing globalization, income inequality becomes one of the severe problems in both advanced and developing economies. Meanwhile, public spending financed by public debt may be an appropriate instrument of fiscal policy to narrow this inequality in society. However, high public debt can lead to an economic crisis and social instability. Does public debt differently affect income inequality between advanced and developing economies? For the answer, the paper applies the two-step system GMM Arellano-Bond estimator and the PMG estimator to test the effect of public debt on income inequality for a group of 30 advanced economies and a group of 34 developing economies between 2002 and 2020. The paper notes some exciting results. First, public debt narrows income inequality in advanced economies but widens it in developing economies. Second, by contrast, economic growth increases income inequality in advanced economies but decreases it in developing economies. Third, unemployment in advanced economies and education in developing economies enhance income inequality. These findings suggest some policy implications for governments in developing economies in using appropriately spending financed by public debt to narrow income inequality in society.

Keywords: Public debt, Income inequality, Advanced economies, Developing economies, System GMM estimator, PMG estimator.

JEL: D31, E24, H63.

Income inequality in society is a severe challenge in both advanced and developing economies, as it may lead to social instability. Narrowing the income gap across countries is one of the eight Millennium Development Goals of the United Nations. Public spending plays a crucial role in the fiscal policy of governments and, compared to tax revenue, government spending is the expression of the active instrument of government in running the economy and overcoming economic cyclicality. Governments actively spend more under a recession economy with a high unemployment rate (an expansionary fiscal policy with increased government spending) and less under a fast-growing economy with high inflation (a contractionary fiscal policy with decreased government spending). Notably, governments can spend more to support the poor and low-income individuals through social transfers to reduce the income gap between the

rich and the poor, thus narrowing income inequality. However, increasing public spending that is financed by borrowing leads to high public debt.

Despite the significant role of public debt in the fight against income inequality, its effect on income inequality remains a controversial topic among economists and policymakers. Thus far, no existing studies have provided empirical evidence to validate the opposite effect of public debt on income inequality between advanced and developing economies. This paper therefore does so and contributes to the literature by using the two-step system general method of moments (S-GMM) Arellano-Bond estimator and the pooled mean group (PMG) estimator to examine the effect of public debt on income inequality for a group of 30 advanced economies and a group of 34 developing economies from 2002 to 2020.

The remainder of the paper is structured as follows. After this introductory section, Section 1 provides an overview of public debt and income inequality. Section 2 presents the literature review, and Section 3 describes the methodology. Section 4 notes the results, and Section 5 concludes.

1. Overviews on the Global Public Debt and Global Income Inequality

According to Kyodo News (2021), global public debt accounted for 97.8% of world GDP in 2021. Although it is 0.8% lower than one year ago, it still stands at record-high levels due to a massive fiscal response from governments to deal with the waves of the coronavirus pandemic. Statistical data from the IMF note that in 2022, global public debt will decrease by 1% of the world's GDP and then remain steady at 97% GDP. Notably, low-income and emerging economies accounted for only 7% of the accumulation of worldwide debt in 2020, while advanced economies and China captured 90%. In advanced economies, it is expected to remain around 20% higher through 2026. Accordingly, the ratio of public debt to GDP for the United States will decline 0.6% to 133.3% in 2021 and stand at 133.5% in 2026. Similarly, Japan's public debt will come to 256.9% GDP this year, up 2.8% from one year ago, before decreasing to 251.9% in 2026.

Business Standard (2021) reports that high public debt need not increase immediate concerns on debt sustainability, but highly indebted developing and emerging economies find it hard to borrow more. To handle the sharp increase in public debt in developing economies, international financial institutions including the World Bank and the IMF provided debt relief, concessional loans and grants in 2020. In particular, low-income developing economies needed urgent financing for coronavirus control measures, health and education and social services, especially support for food programmes in economies facing malnutrition risk. Notably, in 2021, global public debt was forecast to increase further from 98% of GDP in 2020 to nearly 100% of GDP, driven by both advanced and emerging economies.

Regarding global income inequality, United Nations (2020) says that many economies that experience high income gaps have enjoyed a decrease in income inequality, and several economies and regions that had low levels of income inequality in 1990 have seen increases in the income gap. Germany, many Eastern European economies and the Nordic economies have suffered increases in income inequality. Furthermore, some large middle-income economies have experienced increases in income

inequality since 1990. Notably, China's income inequality increased in both urban and rural areas.

Although Africa and Latin America are still the regions with the highest levels, income inequality has declined in 17 out of the 19 Latin American economies. Differences in income continued to increase in South Africa during the post-apartheid period despite the expansion of social protection and sustained economic growth. Persistently high unemployment, high wage gaps and polarization in the labour force were the causes of high-income inequality in this economy in 2015. Income inequality in most Latin American and Caribbean economies rose during the 1990s due to a decade of economic instability and increasing wage gaps, but has fallen since 2000. However, it has risen in Brazil, Mexico and Argentina since 2010. Most Asian economies experienced high income inequality in the 1990s. Notably, China's income gap rose in the 1990s and early 2000s, but declined since 2008 as it effectively enforced policies focusing on handling income inequality and poverty, while regional income inequalities have been reduced.

The share of income held by the top 1% of the population increased in 59 out of 100 economies. In 2015, the richest 1% earned more than 20% of all income in 18 economies, including the United States, the United Arab Emirates, Turkey, Thailand, the Russian Federation, India, Chile and Brazil. Although income inequality in Brazil has decreased, the income share of the top 1% before transfers and taxes increased to 28.3% in 2015 from 26.2% in 2001.

2. Theoretical Framework and Literature Review

2.1 Theoretical Framework

Wilkista Lore Obiero and Seher Gülşah Topuz (2021) proposed a theoretical framework that elucidates two mechanisms by which public debt can either reduce or exacerbate income inequality. Their study examined the effects of various forms of financing, particularly debt financing, on the economy. As governments contemplate options to generate funds for expenditures, such as debt financing and/or tax increases, economists have extensively analysed the consequences.

One theoretical perspective, known as Ricardian equivalence, was introduced by David Ricardo and has been the subject of significant debate among economists regarding the relationship between public debt and inequality. According to this concept, employing either form of financing has no impact on the national output of the economy (David Ricardo 1817). Robert J. Barro (1989) coined the term "Ricardian equivalence", and its implications have garnered substantial attention. When the government reduces its budget deficit, the decrease is offset by an increase in private savings, which results in no net change in the overall national savings level. This phenomenon occurs because forward-thinking consumers tend to allocate more of their income towards savings rather than consumption, anticipating potential future tax hikes as a consequence of expanding government debt. The augmented savings can thus be invested in the bond market, further escalating government debt. Typically, individuals with higher wealth in society tend to save more, while those with lower incomes, such as the poor, are more inclined to allocate any increased disposable income towards

consumption. As a result, the government borrows from the wealthy while taxing both the affluent and the less privileged to repay those debts. Thus, the financing choices made by the government can influence the level of inequality, even if those choices do not directly affect the overall output, as Ricardo posited.

An alternative explanation for the potential links between public debt and inequality suggests that public debt contributes to income redistribution (Obiero and Topuz 2021). According to this perspective, public debt leads to income redistribution within the economy because wealthy individuals are the primary purchasers of government bonds and treasury bills. The responsibility of repaying the debt, meanwhile, falls on the broader tax base. As a result, throughout the debt repayment process, affluent individuals not only contribute through taxes but also receive interest payments from their investments in treasury bills and bonds. This additional income allows wealthy lenders to accumulate even greater wealth, thereby widening the gap between rich and poor. Several scholars have discussed this pattern of increasing inequality (Frederic S. Mishkin 2014; Nisreen Salti 2015; Juan Pablo Bohoslavsky 2016). In the short term, the impact of this phenomenon may not be immediately apparent, as the wealthy rely predominantly on capital income, while the poor primarily depend on labour income. During a debt crisis triggered by excessive debt in the economy, a decline in output is likely, which leads to reduced capital and labour incomes. However, over the long term, owners of capital income receive compensation for their investments, which results in further wealth accumulation. In contrast, the poor lack such compensatory mechanisms, which deepens their economic struggles, ultimately exacerbates poverty and inequality.

This paper finds that public debt affects income inequality between advanced and developing economies in different ways. More specifically, public debt narrows income inequality in advanced economies but widens it in developing economies. What leads to this situation? It could be the result of one distinct feature in the public spending financed by public debt between advanced and developing economies. Esteban Ortiz-Ospina and Max Roser (2016) note that advanced economies spend more on social protection than developing countries. These economies have higher levels of social spending. They spend a much larger share of the national income on social transfers. By contrast, social spending in developing economies (sub-Saharan Africa, Latin America and Asia and the Pacific) is much lower across the board, and social transfers play a less crucial role. More importantly, advanced economies use public spending to support the poor and low-income individuals through social transfers throughout economic development, thus decreasing the income gap between the poor and the rich. However, developing economies mainly use public spending on infrastructure, and partly on health and education, which benefit all citizens in society equally, thus increasing the income gap between the poor and the rich.

2.2 Literature Review

Most of the studies on the relationship between income inequality and public debt have been carried out recently. Regarding the effect of income inequality on public debt, some studies (Ryo Arawatari and Tetsuo Ono 2017; Sigrid Röhrs and Christoph Winter 2017; Christoph March and Robert K. von Weizsäcker 2020; Noritaka Maebayashi

and Kunihiko Konishi 2021) have developed theoretical models while others (Cheol-Sung Lee 2005; Ewa Aksman 2017; Weijie Luo 2020; Jorge Carrera and Pablo de la Vega 2021; Obiero and Topuz 2021) have carried out empirical investigation. Arawatari and Ono (2017) developed a theoretical model to show the conflict over fiscal policy across and within generations in which public debt and income inequality vary. Their analysis notes that a low-inequality country implements a contractionary fiscal policy with low public debt, but a high-inequality country realizes an expansionary fiscal policy with high public debt. Similarly, Röhrs and Winter (2017) suggested a theoretical model indicating the effect of public debt reduction on wealth and income inequality. Their model shows that a decline in public debt leads to good distribution of wealth and income. Recently, March and von Weizsäcker (2020) determined a theoretical model to highlight the mediating role of coordination in the effect of wealth inequality on government debt. More recently, Maebayashi and Konishi (2021) reported an endogenous growth model focusing on the relationship between income inequality and the sustainability of public debt. The analytical results indicate that the sustainability of public debt affects not only its relative size but also income inequality. Meanwhile, Aksman (2017) did not find the effect of income inequality on public debt using the bias-corrected LSDV estimator for all European Union countries from 1995 to 2015. Recently, Luo (2020) used an FEM for a sample of OECD members between 1970 and 2010 and found that capital income inequality decreased public debt, but labour income inequality increased it. More recently, Carrera and de la Vega (2021) applied the S-GMM estimator and the dynamic least square dummy variable (D-LSDVC) estimator for a group of 158 countries over the period 2000-2019 and reported a positive effect of income inequality on public debt.

Regarding the effect of public debt on income inequality, Lee (2005) uses the fixed effects model (FEM) and random effects model (REM) for a sample of 64 developed and developing countries between 1970 and 1994. He notes that public debt increases income inequality in limited democracies or nondemocracies, but decreases it in fully institutionalized democracies. Similarly, Le Thanh Tung (2020) finds that public debt narrows income inequality using the FEM and REM for 17 emerging and developing economies in the Asia and Pacific from 1980 to 2018. More recently, Glen Biglaiser and Ronald J. McGauvran (2021) use the FEM for a group of 71 developing countries between 1986 and 2016; they find that debt restructurings widen income inequality. In the same vein, Obiero and Topuz (2021) employ the autoregressive distributed lag (ARDL) model for the time series data of Kenya from 1970 through 2018; they note that both public and internal debt increase income inequality in the long term.

Regarding the effect of institutional quality on income inequality, Antonio R. Andres and Carlyn Ramlogan-Dobson (2011) argue that public officials in countries with high corruption can change the composition of social expenditure to benefit the rich at the expense of the poor, thus increasing income inequality. Most studies – such as those by Zrelli Ben Hamida Nadia and Zribi El Ghak Teheni (2014), Kosta Josifidis, Novica Supić, and Emilija Beker Pucar (2017), Chee-Hong Law and Siew-Voon Soon (2020), Mark Edem Kunawotor, Godfred Alufar Bokpin, and Charles Barnor (2020) and Bertrand Blancheton and Dina Chhorn (2021) – note that institutional improvement reduces income inequality. Nadia and Teheni (2014) apply non-parametric correlation

tests for 39 countries from 1996 to 2009, while Josifidis (2017) employs the fixed effects vector decomposition (FEVD) method for 21 OECD economies between 1990 and 2010. Similarly, Law and Soon (2020) use the two-step S-GMM Arellano-Bond estimator for 65 advanced and developing economies, while Kunawotor, Bokpin, and Barnor (2020) applies the two-step difference GMM (D-GMM) Arellano-Bond estimator for 40 African economies over the period 1990-2017. More recently, Blancheton and Chhorn (2021) employ panel fully modified ordinary least squares (FMOLS) and the dynamic ordinary least squares (DOLS) estimations for 8 Asian economies during the period 1988-2014; they also report that public spending narrows income inequality. By contrast, Liyanage Devangi H. Perera and Grace H. Y. Lee (2013) find that institutional quality increased income inequality in 9 Asian developing economies from 1985 to 2009 using the one-step S-GMM Arellano-Bond estimator. They suggest that measures for institutional improvement in East and South Asian developing economies should focus on income distribution and poverty. Notably, Lawrence Adu Asamoah (2021) finds institutional quality has the opposite effect on income inequality between 24 advanced and 52 developing economies between 1996 and 2017 using the dynamic panel threshold model. Institutional improvement narrows income inequality in advanced economies but widens it in developing economies; he also notes an inverted U-shaped relationship between economic growth and income inequality from developing to advanced economies.

Regarding the determinants of income inequality, N. P. Ravindra Deyshappriya (2017), Edmond Berisha, Rangan Gupta, and John Meszaros (2020), Frederick O. Asogwa et al. (2021) and Abebe Hailemariam, Tutsirai Sakutukwa, and Ratbek Dzhumashev (2021) examine the factors affecting income inequality. Deyshappriya (2017) uses the one-step D-GMM Arellano-Bond estimator for a sample of 33 Asian economies from 1990 to 2013 and finds that education, official development assistance and the labour force decrease income inequality, but political risk, unemployment, terms of trade and inflation increase it. In particular, he notes an inverted U-shaped relationship between economic growth and income inequality in these economies. Meanwhile, Berisha, Gupta, and Meszaros (2020) apply the PMG estimator and the common correlated effects estimator for the BRICS economies between 2001 and 2015 and discover that real interest rates, economic growth and inflation increase income inequality. More recently, Asogwa et al. (2021) employ the GMM (pooled OLS and FEM) estimators for a group of 28 African economies during the period 2001-2016 and note that education and unemployment increase income inequality, while the labour force, inflation and economic growth decrease it. In the same vein, Hailemariam, Sakutukwa, and Dzhumashev et al. (2021) use the panel vector auto-regression method on a sample of 17 advanced economies from 1870 to 2016 and reveal that public spending, financial development, interest rate and education reduce income inequality while economic growth enhances it.

The literature review reveals a limited number of studies examining the impact of public debt on income inequality. With the exception of Obiero and Topuz (2021), who employed the ARDL method to analyse time series data from Kenya, the remaining studies relied on traditional panel estimators, such as FEM or REM, for panel datasets encompassing multiple countries. It is worth noting that the use of traditional

panel estimators in estimation may introduce biases and inconsistencies due to their inability to account for endogenous phenomena and serial correlation. These studies also indicate that economic growth and education play crucial roles in determining income inequality, but they fail to analyse, examine and compare the effect of public debt on income inequality across advanced and developing economies. These limitations in the existing research thus highlight a significant research gap within the literature.

In short, the literature review reveals that no existing studies have investigated or provided empirical evidence to note the contradictory effects of public debt on income inequality between advanced and developing economies. Furthermore, no existing studies have applied the PMG or two-step S-GMM Arellano-Bond estimators, which can deal with serial autocorrelation and endogenous phenomena in empirical models. This paper thus highlights these two aspects as a research gap.

3. Methodology and Research Data

3.1 Methodology

Following the literature review, this paper uses the following empirical equation:

$$GIN_{it} = \gamma_0 + \gamma_1 GIN_{it-1} + \gamma_2 DEB_{it} + X_{it}\gamma' + \sigma_i + \tau_{it}, \quad (1)$$

where subscript i and t are the country and time index, respectively. GIN_{it} is the Gini index, a proxy for income inequality, with a value from 0 to 100, where 0 indicates complete equality (everyone has the same income) and 100 indicates the highest level of income inequality; GIN_{it-1} is the initial level of income inequality; and DEB_{it} is public debt. X_{it} is a set of control variables such as economic growth, education and unemployment; σ_i is an unobserved country-specific, time-invariant effect, and τ_{it} is an observed error term; γ_0, γ_1, γ_2 and γ' are estimated coefficients. Following related studies, such as Lee (2005) and Biglaiser and McGauvran (2021), this paper uses economic growth and education as control variables. Unemployment is also used in the empirical equations, as it can significantly contribute to income inequality. Economic growth has importance in enhancing income levels and raiding living standards. It fosters increased employment opportunities, thereby boosting the income of the impoverished population. Consequently, economic growth can effectively mitigate income inequality. Education serves as a fundamental pillar for individuals, especially those from disadvantaged backgrounds, as it enables them to acquire knowledge and skills essential for securing employment. By gaining pertinent knowledge through education, individuals from low-income groups can augment their earnings and ultimately reduce income inequality. Conversely, a high unemployment rate poses a significant disadvantage for individuals with limited financial resources. During bad periods of economic instability characterized by elevated unemployment rates, most impoverished individuals experience job losses and subsequent income reduction, thereby exacerbating income inequality.

This study applies Equation (1) to test the effect of public debt on income inequality for a group of 30 advanced economies and a group of 34 developing economies. Some severe problems in econometrics arise from estimating Equation (1). First,

public debt, economic growth and unemployment can be endogenous. They may correlate with σ_i, which results in endogeneity. Second, some unobserved effects such as culture, geography, customs and anthropology (fixed effects) may correlate with the regressors. They exist in σ_i. Third, a high autocorrelation comes from the presence of GIN_{it-1}. Fourth, the panel dataset has a relatively large unit of countries ($N = 34$) but a relatively short observation length ($T = 19$). These problems can make the OLS estimator inconsistent and biased. The REM and FEM cannot handle serial autocorrelation and endogenous phenomena, while the IV-2SLS estimator needs appropriate instrumental variables out of the regressors in the empirical model. Following the suggestions of Ruth A. Judson and Ann L. Owen (1999), this study applies the two-step S-GMM Arellano-Bond estimator for estimation and the PMG estimator for a robustness check.

Douglas Holtz-Eakin, Whitney Newey, and Harvey S. Rosen (1988) are the first to propose the GMM followed by Arellano and Stephen Bond (1991). For estimation, the first difference in Equation (1) is taken to remove country-specific fixed effects. Next, the regressors in the first differential are used as instrumental variables by their lags under the assumption that there are no serial correlations in time-varying error terms in the original models (Judson and Owen 1999). This is the D-GMM Arellano-Bond estimator strategy, which can handle simultaneity biases in regressions. The following equation can thus be formed from Equation (1) as follows:

$$HUM_{it} - HUM_{it-1} = \beta_1(HUM_{it-1} - HUM_{it-2}) + \beta_2(FDI_{it} - FDI_{it-1}) + (Z_{it} - Z_{it-1})\beta' + (\psi_{it} - \psi_{it-1}). \quad (2)$$

For the case of persistent variables, their past values give very little information about their future changes, which causes their lags to be weak instruments for their differential series. Therefore, Arellano and Olympia Bover (1995) recommend that Equation (1) and Equation (2) should be combined to form a system of two equations: one equation in levels instrumented by lagged differences and one equation in which the differential series are instrumented by lagged levels, to which GMM is applied – that is, the S-GMM strategy, which can improve efficiency by dealing with the problem of the weak instrument in the D-GMM and decreasing biases in its estimates. The consistency of S-GMM is based on assumptions such as uncorrelated error terms, valid instruments and uncorrelations between the changes in additional instruments and fixed country-specific effects.

The two-step GMM Arellano-Bond estimator is more asymptotically efficient than the one-step version, but the application of the two-step GMM Arellano-Bond estimator in small research samples, such as those in our paper, presents some problems (David Roodman 2009). They are posed by the proliferation of instruments that increase quadratically as the time dimension rises. In this case, the number of instruments is very large relative to the number of panel units. To eliminate this problem, Roodman (2009) suggests that the rule of thumb can be used to keep the number of instruments less than or equal to the number of countries (i.e. the number of panel units).

The Arellano-Bond, Sargan and Hansen statistics are applied to test the validity of instruments in the two-step GMM Arellano-Bond estimator. The Arellano-Bond test

is applied to search for the autocorrelation of errors in the first differential while the Sargan and Hansen tests are employed to detect endogenous phenomena. The first autocorrelation test of errors [AR(1)] is thus ignored, while the second autocorrelation test of errors [AR(2)] is kept. Indeed, AR(2) is used to search the phenomenon of AR(1).

This study uses the PMG estimator developed by M. Hashem Pesaran, Yongcheol Shin, and Ron P. Smith (1999) to check the robustness of the two-step S-GMM estimates. The PMG-based error correction model is shown as follows:

$$\Delta Y_{it} = \psi X_{it-1} + \sum_{j=1}^{p} \pi_{ij} \Delta Z_{it-j} + \sigma_{it} + \tau_{it} \text{ where } X_{it-1} = Y_{it-1} - \lambda Z_{it-1}, \quad (3)$$

where Y is the Gini index, a proxy for income inequality; X_{it-1} is the deviation from long-run equilibrium at any period for group i, and ψ is the speed of adjustment or the error-correction coefficient. The vector λ captures the long-run coefficients. They express the long-run elasticity of income inequality corresponding with each variable in Z_{it-1}. Meanwhile, the vector π captures the short-run responses of the Z variables. σ_i is a fixed effect, and τ_{it} is an error term. The study uses the value and significance level of the speed of adjustment ψ (negative, smaller than 1) to examine the validity of the PMG estimates.

3.2 Research Data

Data are the Gini index, public debt, GDP *per capita*, primary school enrolment and unemployment. The study extracts them from World Bank World Development Indicators (WDI) and the IMF World Economic Outlook (WEO) database. The research sample contains 30 advanced economies and 34 developing economies (Table F in the Appendix) over the period 2002-2020. The study presents the definition and descriptive statistics of the data and the matrix of correlation coefficients between variables in the Appendix (Table A, Table B, Table C, Table D and Table E).

The statistical results presented in Table B provide insights into the average Gini index across advanced economies from 2002 to 2020, which is 31.61 for this period, with Israel recording the highest value of 42.5 in 2010, while Slovenia had the lowest value of 23.6 in 2020. Conversely, in developing economies, the average Gini index for the same period is 40.51, with Honduras exhibiting the highest value of 59.5 in 2005, and Ukraine recording the lowest value of 24 in 2014. These figures highlight that the problem of income inequality is more severe in developing economies than in advanced economies, emphasizing the significant disparity in income inequality across countries.

In terms of the average public debt/GDP ratio, advanced economies display a ratio of 63.4% during the aforementioned period. Greece reported the highest ratio of 211.2% in 2020, while Estonia recorded the lowest ratio of 3.7% in 2007. Conversely, in developing economies, the average ratio is 42.2%, with Argentina presenting the highest ratio of 147.2% in 2002, and Chile registering the lowest ratio of 3.8% in 2007. These numbers emphasize the significant disparity in public debt/GDP ratios across countries, with advanced economies generally exhibiting higher ratios compared to developing economies. However, it is important to note that developed economies

possess high *per capita* income and relatively stable macroeconomic indicators, which indicate that high public debt is not a serious problem in these countries.

The results in Table D (advanced economies) show that public debt, education and unemployment are positively associated with income inequality, but economic growth is negatively associated with it. Similarly, the results in Table E (developing economies) indicate that economic growth and education are positively linked with income inequality, but unemployment is negatively linked with it. Notably, the value of all correlation coefficients between control variables is low (lower than 0.8), so the study uses all of them in the empirical models.

4. Estimated Results and Discussion

4.1 The Two-Step S-GMM Estimates

Table 1 presents the two-step S-GMM estimates for advanced and developing economies. In the corresponding estimation procedures, public debt is detected as endogenous, so this paper uses public debt as an instrumental variable in the GMM-style and the remaining variables (income inequality, economic growth, education and unemployment) as instruments in the IV-style.

The results in Table 1 indicate that public debt narrows income inequality in advanced economies but widens it in developing economies. By contrast, economic growth enhances income inequality in advanced economies but reduces it in developing economies. Education in developing economies and unemployment in advanced economies also boost income inequality. What leads to the fact that public debt narrows income inequality in advanced economies but widens it in developing economies? We look at one distinct feature in government spending financed by public debt between advanced and developing economies. Compared with developing economies, advanced economies spend more on social protection (Ortiz-Ospina and Roser 2016); these economies have higher levels of social spending and use a much larger share of the national income on social transfers. Developing economies, by contrast, have much lower levels of social transfers that play a less crucial role. Governments in advanced economies use more government spending financed by public debt for high levels of social transfers to low-income individuals and the poor during economic development and growth, thus narrowing the income gap between the rich and the poor. However, governments in developing economies use high levels of public spending financed by public debt on infrastructure development, and only partly on services such as education and healthcare that benefit all citizens in society equally.

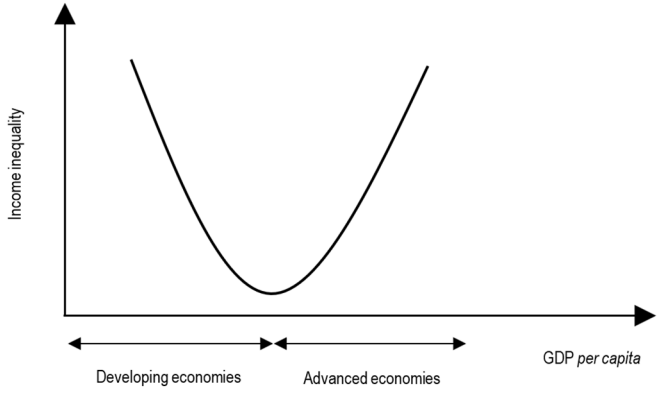
This leads to the suggestion that governments in developing economies use more public spending financed by public debt on social transfers, following the lead of the advanced economies. Governments in these economies should spend more on education and health to support the poor in improving their skills and knowledge, narrowing the income gap between the rich and the poor. Income inequality may be an inherent part of how human societies develop, which means that we cannot eliminate it, although we can reduce it. Equality and efficiency are two but opposing sides of the same coin, so when acting on one side, it affects the other side and *vice versa*. Governments should recognize that there is a trade-off between efficiency and equality

throughout economic development. Increasing equality (or decreasing inequality) leads to decreasing efficiency and vice versa. Governments should pay particular attention to controlling and managing public debt, because increasing public debt can lead to a public debt crisis and social instability.

Economic growth increases income inequality in developing economies but decreases it in advanced economies, as presented in Figure 1, with the U-shape curve of income inequality. On the whole, in economies with low levels of development (developing economies), income inequality decreases against *per capita* income throughout economic development; it then increases when these countries reach high levels of development (advanced economies). This finding contrasts the hypothesis of the inverted U-shape Kuznets curve when considering the shift of income inequality against *per capita* income from low (developing countries) to high (developed countries). Mathew Y. H. Wong (2017) and Obiero and Topuz (2021) report that economic growth decreases income inequality in Kenya and Latin American economies, but Lee (2005) and Nicholas Apergis (2021) note that it enhances income inequality in 21 advanced economies.

Education boosts income inequality in developing economies. Education is a public good that governments supply for free, and students do not pay money to attend public schools. However, wealthy families agree to pay to send their children to high-quality private schools. Students from these families receive better knowledge and skills than students from average families. Students from wealthy families thus easily find high-income jobs and are more likely to be promoted, which increases income inequality, as found in the studies by Teresia Kaulihowa and Charles Adjasi (2018) and Ayse Demir et al. (2020).

The high rate of unemployment often leads to increased poverty among the poor who lack the necessary knowledge and skills to get a high-income job, thus boosting the income gap. This finding suggests that governments in advanced economies should pay more attention to the poor and support them in accessing education and healthcare to get high-income jobs.



Source: Author's creation.

Figure 1 The U Shaped Curve of Income Inequality

Table 1 Public Debt and Income Inequality: Two-Step S-GMM Estimates, 2002-2020

Dependent variable: Income inequality (GINI index)		
Variables	**Advanced economies**	**Developing economies**
Income inequality (-1)	0.938*** (0.020)	0.935*** (0.006)
Public debt	-0.004*** (0.001)	0.026*** (0.007)
Economic growth	0.001** (0.000)	-0.002** (0.001)
Education	0.000 (0.011)	0.033*** (0.009)
Unemployment	0.035*** (0.012)	0.000 (0.017)
Instrument	10	16
Country/Observation	30/540	34/578
AR(2) test	0.182	0.390
Sargan test	0.402	0.324
Hansen test	0.835	0.812

Notes: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Source: Author's calculations.

4.2 Robustness Check

The PMG estimator for Equation (2) is employed to check the robustness of the two-step S-GMM estimates. The PMG estimator requires the existence of co-integration between the dependent variable and regressors. So, all of the stationary variables in the empirical model are examined to ensure that they all have the same order of co-integration. The panel co-integration tests by Westerlund (2007) are then performed.

The stationary tests in Table 2 (advanced economies) and Table 3 (developing economies) report income inequality, public debt, economic growth, education and unemployment are significantly stationary at levels less than 10%, which means that all variables have co-integration of zero-order I(0). The Westerlund tests in Table 4 (advanced economies) and Table 5 (developing economies) indicate that at least three in four tests deny the null hypothesis of no co-integration, which suggests that income inequality co-integrates with public debt, economic growth, education and unemployment.

The results from the PMG estimator are shown in Table 7 (both advanced and developing economies). In line with the two-step S-GMM estimates, public debt narrows income inequality in advanced economies but widens it in developing economies. By contrast, economic growth increases income inequality in advanced economies but decreases it in developing economies, while education in developing economies and unemployment in advanced economies enhance income inequality. The significance level and value of the speed of adjustment at the bottom of Table 7 report that the PMG estimates are highly reliable.

Table 2 Fisher Type Unit Root Tests: 2002-2020 (30 Advanced Economies)

Variables	Augmented Dickey-Fuller test		Phillips-Perron test	
	Prob > chi2		Prob > chi2	
	Without trend	With trend	Without trend	With trend
Income inequality	52.894	42.426	69.221	104.949***
Public debt	59.773	80.610**	26.197	24.853
Economic growth	83.006**	46.863	62.778	27.851
Education	74.315	127.513***	48.405	49.452
Unemployment	80.274**	50.305	62.491	39.629

Notes: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Source: Author's calculations.

Table 3 Fisher Type Unit Root Tests: 2002-2020 (34 Developing Economies)

Variables	Augmented Dickey-Fuller test		Phillips-Perron test	
	Prob > chi2		Prob > chi2	
	Without trend	With trend	Without trend	With trend
Income inequality	47.345	121.670***	104.424***	224.891***
Public debt	44.893	60.781	105.115***	58.336
Economic growth	89.301**	46.413	158.443***	99.259***
Education	69.787	87.478**	122.886***	121.460***
Unemployment	79.560	60.627	107.384***	44.471

Notes: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Source: Author's calculations.

Table 4 Westerlund Panel Co-integration Tests: 2002-2020 (30 Advanced Economies)

Normalized variable: Income inequality (GINI index)

Covariates	G_t	G_α	P_t	P_α
Public debt	-2.523**	-7.992	-12.728***	-7.318***
Economic growth	-2.624***	-8.234	-12.766***	-7.907***
Education	-2.363***	-8.117	-9.778**	-5.624*
Unemployment	-2.875***	-15.096***	-9.694**	-6.115**

Notes: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Source: Author's calculations.

Table 5 Westerlund Panel Co-integration Tests: 2002-2020 (34 Developing Economies)

Normalized variable: Income inequality (GINI index)

Covariates	G_t	G_α	P_t	P_α
Public debt	-2.581***	-8.907**	-10.322**	-6.549***
Economic growth	-2.740***	-10.555***	-13.892***	-9.531***
Education	-3.842***	-10.991***	-17.896***	-10.299***
Unemployment	-2.774***	-9.005**	-14.281***	-7.051***

Notes: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Source: Author's calculations.

Table 6 Public Debt and Private Investment: PMG Estimates, 2002-2020, Long Run Co-integrating Vectors

Dependent variable: Income inequality (GINI index)		
Variables	**Advanced economies**	**Developing economies**
Public debt	-0.016*** (0.003)	0.030*** (0.010)
Economic growth	0.010*** (0.001)	-0.000* (0.011)
Education	0.027 (0.011)	0.011** (0.002)
Unemployment	0.327** (0.036)	-0.245*** (0.057)
Error correction	-0.590***	-0.587***
Observation	540	612
Log likelihood	-359.213	-691.804

Notes: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Source: Author's calculations.

5. Conclusion and Policy Implications

Public spending financed by debt plays a crucial role in running the economy, while income inequality is one of the most severe problems in both advanced and developing economies. Governments in these economies can, however, use public debt to deal appropriately with the income gap in society. In view of these facts, the effect of public debt on income inequality was investigated for a group of 30 advanced economies and a group of 34 developing economies over the period 2002-2020. Two-step S-GMM was employed for estimation and the PMG estimator for a robustness check. The results show that public debt decreases income inequality in advanced economies but increases it in developing economies. By contrast, economic growth widens income inequality in advanced economies but narrows it in developing economies. Education in developing economies and unemployment in advanced economies boost income inequality.

The present findings suggests that governments in developing economies should use public debt to handle income inequality between the rich and the poor. They should increase public spending financed by debt to support the poor and low-income individuals through social transfers. More importantly, they should spend more on health and education to improve the skills and knowledge of the poor, which enhances the income among the poor and reduces the income gap in society. However, governments should be prudent in controlling and managing public debt to avoid a public debt crisis and social instability. It is thus essential to manage debt-financed public expenditures across various sectors carefully, including civil servants' salaries and military expenses. Striking a delicate balance is crucial, as it involves increasing investments in health and education while reducing spending on salaries to ensure a gradual reduction of public debt. A significant increase in public debt could worsen societal inequality. To address this issue, governments should consider implementing measures such as imposing taxes on the wealthy and directing the generated revenue toward

funding public education. This approach would provide support to students from disadvantaged backgrounds, which would enable them to enhance their knowledge and skills, thus contributing to the reduction of income inequality.

Developed countries, meanwhile, can leverage increased public debt to combat income inequality, but they must remain cautious to avoid potential public debt crises. These countries must prioritize debt-financed public expenditures towards initiatives that genuinely benefit low-income individuals and would lead to a meaningful reduction in income inequality. Governments in such countries could explore alternative strategies, such as imposing higher taxes on the wealthy or receiving social contributions from them. By allocating these additional funds to enhance public spending on initiatives that improve the standards of living among the poor, a positive impact on reducing income inequality could be achieved.

Future research should examine the role of institutional quality in the public debt-income inequality relationship, because institutions can strongly influence the rational use of public debt to narrow income inequality.

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Appendix

Table A Data Description

Variable	Definition	Type	Source
Income inequality (GIN)	"Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality."	Value	World Bank
Public debt (DEB)	"Gross debt consists of all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future (% GDP)."	%	IMF
Economic growth (GDP)	"GDP *per capita* is gross domestic product divided by midyear population."	ln	World Bank
Education (EDU)	"Gross primary school enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown."	%	World Bank
Unemployment (UNE)	"Unemployment refers to the share of the labor force that is without work but available for and seeking employment."	%	World Bank

Source: Author's calculations.

Table B Descriptive Statistics for 30 Advanced Economies

Variable	Obs	Mean	Std. dev.	Min	Max
Income inequality (GIN)	570	31.612	4.252	23.6	42.5
Public debt (DEB)	570	63.456	35.240	3.765	211.215
Economic growth (GDP)	570	40492.5	21573.03	8008.474	111968.4
Education (EDU)	570	102.189	4.177	95.648	126.575
Unemployment (UNE)	570	7.648	4.134	2.01	27.466

Source: Author's calculations.

Table C Descriptive Statistics for 34 Developing Economies

Variable	Obs	Mean	Std. dev.	Min	Max
Income inequality (GIN)	646	40.5167	8.688	24	59.5
Public debt (DEB)	646	42.294	20.190	3.879	147.203
Economic growth (GDP)	646	6662.29	4065.923	676.269	16661
Education (EDU)	646	103.812	9.020	70.894	146.827
Unemployment (UNE)	646	6.906	4.039	0.398	20.71

Source: Author's calculations.

Table D The Matrix of Correlation Coefficients for 30 Advanced Economies

	GIN	DEB	GDP	EDU	UNE
GIN	1				
DEB	0.242***	1			
GDP	-0.134***	0.053	1		
EDU	0.173***	-0.011	-0.001	1	
UNE	0.270***	0.407***	-0.418***	0.024	1

Notes: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Source: Author's calculations.

Table E The Matrix of Correlation Coefficients for 34 Developing Economies

	GIN	DEB	GDP	EDU	UNE
GIN	1				
DEB	-0.005	1			
GDP	0.119***	-0.081***	1		
EDU	0.505***	0.026	0.187***	1	
UNE	-0.126***	0.124***	0.205***	0.111***	1

Notes: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Source: Author's calculations.

Table F List of Countries in Samples

Advanced economies: Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, South Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, and the United States.

Developing economies: Argentina, Armenia, Belarus, Bolivia, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Dominican Republic, Ecuador, El Salvador, Georgia, Honduras, Hungary, Indonesia, Kazakhstan, Kyrgyz Republic, Malaysia, Mexico, Moldova, Pakistan, Panama, Paraguay, Peru, Poland, Romania, Russian Federation, Thailand, Turkey, Ukraine, and Vietnam.

Source: Author's compilation.