Does Progressive Income Taxation Alleviate Income Inequality in Developing Countries?

by

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I dedicate this paper to my late mother for her care and encouragement in all those dark periods of our lives.

Abstract

We use a panel data of thirty-two developing countries, covering a 1985−2005 time frame, to estimate the effect of progressive income taxation on income inequality. Using the country-level Gini coefficients (net-income based), quintile shares, and the measures of tax progressivity, we find that a progressive income tax generally alleviates income inequality. We also estimate the equity-efficiency trade-off using the per capita GDP growth, and find that progressive income tax generally reduces economic growth. Furthermore, we estimate the effect of a progressive income tax on the welfare of the poor. Using the poverty rate and the tax indicators, we find that an increase in overall tax progressivity decreases the percentage of the population that lives on less than $3.10 a day, albeit an increase progressivity at the top increases it. We also examine the effect of the interaction of democratic institutions and governance indicators with the tax indicators on income inequality in developing countries. Using political rights and civil liberties as proxies for democratic institutions, we find that countries with greater access to democratic institutions have a high chance of reducing income inequality when they adopt progressive income tax system. Moreover, using law-and-order and control of corruption, as proxies for governance indicators, we also find that countries with good law-and-order and high control of corruption have high chance of reducing income inequality.

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1 Introduction

It was not long ago that great minds in economics thought questions about distribution of income and which tax rates are appropriate were only suitable for a moral philosopher. However, the current literature contains numerous studies, theoretical and empirical, that have extensively answered these questions. Income inequality—the extent to which income is distributed unevenly in a country—is widely applied to the entire population in contrast to the closely related concepts of poverty and low incomes. While the poverty rate and low incomes (measured by low-income cut-offs or LICO) both increase income inequality, the latter exists even when the poverty rate is declining and low incomes are rising (Green, Riddell and St-Hilaire 2016, 89).[1]

Although there is wide disparity in the levels of inequality in the world, studies have shown that emerging and developing economies generally have higher income inequality than developed countries. The Gini coefficient—the most popular measure of income inequality—is measured on a zero-to-one scale (or equivalently zero-to-one hundred scale), where zero represents absolute equality and one represents perfect inequality.

The Gini coefficient is derived from the Lorenz curve, which sorts the population from the poorest to the richest and shows the cumulative proportion of the population on the horizontal axis and the cumulative proportion of income or expenditure on the vertical axis. The Gini coefficients of Scandinavian countries are the smallest among the developed countries, while those of the least developed countries, such as South Africa, are the highest ("The Economist" 2012; Green, Riddell and St-Hilaire 2016, 4; Creedy 2001).

In the literature, the increase in income inequality for countries in the Organisation for Economic Co-operation and Development (OECD) is attributed to factors such as technological changes, the globalization of economic activities, and

[1]For more details on measures of low income and other measures of income inequality not considered here, see Green, Riddell and St-Hilaire (2016).

changes in institutional factors such as regulatory environment, minimum wages, and unionization. While advanced information and computer technologies enhance productivity and the wages of skilled workers, they do so at the expense of low-skill workers who end up with either lower wages or unemployment, both of which lead to income inequality.

Shipping of production to countries with cheap labour (foreign direct investment or FDI) results in high earnings for those at the top of income distribution and low earnings for those in the middle and bottom, again enhancing income inequality in developed countries (Green, Riddell and St-Hilaire 2016, 158). Green, Riddell and St-Hilaire 2016 observation agrees with Ha (2012), who argues that globalization increases income inequality, but that it is mitigated by government pro-poor redistributive projects—social transfers.

The economic literature suggests few solutions that can reduce income inequality. Green, Riddell and St-Hilaire (2016) discuss policies such as pre-labour market policies (building human capital to increase wages of low-income individuals), policies that directly affect labour market outcomes (such as minimum wage and union regulation), and post-market redistributive policies (taxing market outcomes and redistributing the resulting revenue through transfer).[2]

In welfare economics—the redistribution of income through the provision of public goods and income transfer—decreasing inequality might not be Pareto optimal. While those at the bottom of the income distribution are made better-off by the redistribution, the top earners might be made worse off. This distortion of top income earners is the negative effect of the post-market redistributive policy. Many studies in the taxation literature have credited Ramsey (1927)—who argued that a government could raise nearly all its revenue from taxing inelastic commodities—as the earliest chief contributor to optimal tax theory.[3]

[2]For further details on the pre-labour market and policies that directly affect labour market outcomes, see Green, Riddell and St-Hilaire (2016).

[3] Ramsey showed that taxing inelastic commodities does not diminish utility no matter the proportions and that taxing commodities should be such as to diminish the production of all com-

The types of income tax systems that are usually applied are progressive, regressive, and proportional tax systems. A tax is progressive if the percentage of income an individual pays in taxes tends to increase with increasing income; it is regressive if the proportion of income paid in taxes tends to decrease as one's income increases; and it is proportional if everyone pays the same tax rate regardless of income earned.[4] Similarly, Rosen, Wen and Snoddon (2012) define the tax rate as progressive if the average tax rate (ratio of income tax paid to income) increases with income, and regressive if the average tax rate decreases with income (276).

A progressive tax system, which is at centre stage of welfare economics, is often attacked for being a hindrance to economic growth. While the proportional tax system encourages economic growth in part because the system allows high-ability individuals to keep nearly all their rewards, it is decried as being socially unjust to low-ability individuals. Likewise, the regressive tax system is deprecated for being socially unjust in that a heavy burden falls on low-income individuals, in addition to diminishing the needed government revenue for public goods.

While there is no consensus on the tax system that is both efficient and equitable, except for lump-sum tax or transfers, Shome (1995, 26) elaborates that the choice of taxable income unit has several implications for economic efficiency. For instance, the choice influences the marginal tax rate of the unit and hence affects the decisions to work, save, and invest. The main argument against the progressive income taxation system is that it distorts top income earners' decisions. High-income earners, for instance, might respond by taking steps to reduce their taxable income by either working less or only reporting a smaller share of true income—tax evasion.[5]

Moreover, progressive income taxes, like high corporate taxes, discourage investment. High-income earners—investors and professionals—for example, can re-

modities in the same proportion.

[4]These are standard definitions of progressive, regressive, and proportional tax systems in public finance literature.

[5]For more details, see Mirrlees (1971). Mirrlees also shows that a zero-marginal tax rate on top earners is optimal.

locate to countries with lower income taxes or incorporate their assets if the corporate tax rate is lower than the personal income tax rate. If this response is widespread, a progressive income tax can fail to reduce income inequality. Various studies in the literature have shown that a progressive income tax has a positive effect on income inequality in developed countries, but mixed results on the efficiency-equity trade-off.

In this paper we attempt to answer the following questions: Do progressive income taxes reduce income inequality in developing economies? Do progressive income taxes negatively affect economic growth? And what effects, if any, do progressive income taxes have on the welfare of the poor in developing economies? To address these questions, we test the following hypotheses. A progressive income tax system alleviates income inequality in developing countries (**H1**). We test this hypothesis by estimating effects of tax progressivity (tax indicators) and other control variables on the net-income based Gini coefficient. There is a negative relationship between a progressive income tax system and economic growth (**H2**). To test this, we estimate the impact of tax progressivity with the same control variable in (**H1**) on economic growth rates (per capita GDP growth). A progressive income tax is welfare improving (alleviates poverty) (**H3**). To examine this hypothesis, we estimate the effect of the tax rates and other control variables on the poverty rate—poverty headcount ratio is the percentage of the total population that lives on less than $3.10 a day.

Moreover, it is often argued in the literature that countries that have well-established democratic institutions—for example, greater access to political rights and civil liberties—have greater success in reducing income inequality when they adopt a progressive tax system. We add interaction terms between the tax rates and democratic institution variables—proxies by political rights and civil libertiestextemdashto hypothesis (**H1**) to examine this statement.

Furthermore, the prevalence of tax evasion in developing countries is likely to diminish the effect of progressive taxation on income inequality. We add interaction terms between the tax indicators and tax avoidance indicators—proxy by law and

order, and corruption—to hypothesis (**H1**) to examine this argument.

In this paper, we focus on thirty-two developing countries selected from Africa, Latin America, and Asia over a period 1985−2005. The selection of countries is constrained by the availability of data. The rest of this paper is structured as follows. Section 2 reviews the literature on tax progressivity and reduction of income inequality, both theoretical and empirical; section 3 describes the data; section 4 presents the empirical methodology and regression specifications; section 5 presents preliminary ordinary least square results and discussion; section 6 presents further results and discussion using instrumental variables; and section 7 concludes the paper.

2 Literature Review

2.1 Theoretical Literature Review

It was not until very recently that great minds in economics started re-examining tax structure and income inequality—questions long thought more appropriate for moral philosophers, whereas economists should restrict themselves to identifying Pareto efficient allocations and showing how to mitigate inefficiencies. Although the concept of income distribution involves value judgments, as many have argued, others (Stiglitz 1988; Rosen, Wen and Snoddon 2012, 86) have asserted that efficiency is not the only concept used to evaluate a given situation. More so, the role of government in the distribution of income has often been questioned.

The Lorenz curve of post-tax income lies between the 45-degree line (perfect equality) and the pre-tax Lorenz curve. The more redistributive the tax structure is, the closer the Lorenz curve is to the diagonal line (Haughton and Khandker 2009, 108; "The Economist" 2012; Green, Riddell and St-Hilaire 2016, 4; Rosen, Wen and Snoddon 2012, 86; Creedy 2001).

Other measures of income inequality are the decile dispersion ratio, general-

ized entropy measure (for example, Theil indexes), and Atkinson's inequality measures (Haughton and Khandker 2009, 108). The Gini coefficient is then defined as twice the area enclosed by the diagonal line and the Lorenz curve. So, the inequality-reducing effect of a tax structure is attained by the extent of reduction in the Gini inequality measure when moving from pre-tax to post-tax incomes. The absolute difference between pre-tax income and post-tax income gives the extent of the reduction in inequality arising from the tax system (Creedy 2001, 25).[6]

With rising inequality, improving the well-being of the individual is the central platform in the policy auditorium. The theory of optimal taxation—second best as it is commonly known—has three main components,[7] one of which starts with the famous work of Ramsey (1927), later advanced by Diamond and Mirrlees (1971a, 1971b) (cited in Auerbach and Hines 2002, 1362). The second strand on which this paper and many other empirical studies are based starts with Mirrlees (1971), who considers a general nonlinear income tax and the role this tax plays in addressing distributional concerns.

The optimal income taxation theory—the fair and efficient distribution of the tax burden across individuals with different earnings—hypothesizes that the tax should maximize a social welfare function subject to a government budget constraint while considering the individual response to taxes and transfers. Social welfare is more effective when resources are fairly distributed, but redistributive taxes and transfers can negatively affect incentives to work and earn income—this creates the classic trade-off between equity and efficiency (Piketty and Saez 2013, 392).[8] Piketty and Saez, in their review of optimal income taxes, show that most advanced economies in the OECD raise between 35 and 50 percent of national income from taxes (395). They assert that, although most individual income tax systems have brackets with

[6]For further details on the measures of inequality, see Haughton and Khandker (2009) and Creedy (2001).

[7]For further details on these and the third strands not discussed here, see Auerbach and Hines (2002).

[8]For further details on the social welfare function and its normative analyses, see Piketty and Saez (2013).

increasing marginal tax rates, the payroll taxes or consumption taxes tend to have flat rates.

Comparatively, Heady(1996), in "The Economics of Tax Policy", considers an optimal income tax starting with Mirrlees's 1971 influential paper. He contends that the main result of Mirrlees's study was that the disincentive effect of taxation is on the labour supplied, and the disparity in wages depends on productivity. He notes that the overall net effect on social welfare hinges on the compensated elasticity of labour supply, the degree of concern for income inequality coupled with the proportion of people above the range of the tax increase (36).[9] Heady concludes that linear income tax incorporates the negative income tax system and that any attempt to increase the tax progression is balanced by the fact there are few taxpayers above such tax brackets (38).

There are several measures of progressivity in the income taxation literature. For example, the Kakwani measure and Reynolds-Smolensky measure are commonly used, with the latter preferred to the former. The Reynolds-Smolensky, which takes the difference of Gini coefficients—on pre-tax income and post-tax income—is positive when the tax is progressive. While the fundamental argument against progressive taxation is the equity-efficiency trade-off, the proponents of progressive taxation argue that social justice requires the most successful to contribute to the economic well-being of the less fortunate. Taxing the rich more to fund means-tested programs for the poor reduces the incentive to work among both the rich and the transfer recipients (Piketty and Saez 2013, 400).

Creedy (2001), reviewing taxation, redistributive and progressive, asserts that "taxation is not only a primary source of revenue for governments in industrialized countries. It is also used, in combination with the transfer, to influence the inequality of outcomes" (22). He argues that post-tax income is likely to be more equal

[9]Heady (1996) also concludes that any attempt to increase the tax progression is balanced by the fact that there are few people to pay those higher taxes. It is often argued that the marginal tax rate for the person with the highest income should be zero. For more details on this and other marginal tax rates, see Heady (1996).

than pre-tax income if more tax is taken from the productive, and more transfers go to the least productive.

The welfare cost of taxation depends on the extent to which individuals' marginal decisions are influenced by taxes, which arguably depends on an income effect—increasing labour supply at the expense of leisure to compensate for the reduction in post-tax income—and a substitution effect—choosing leisure over work when the tax rate increase. The net response hinges on the elasticity of the labour supply. The magnitude of excess burden depends on the extent of the substitution effect. The excess burden can be measured by consumer surplus, compensating variation, or equivalent variation (Creedy 2001, 7−8; Stiglitz 1986, 375).

The normative analysis of optimal tax theory often considers various forms of social welfare functions. The common ones are utilitarian, which is a function of individual utilities, and a maximin, where the social planner is concerned with maximizing the well-being of the person with the minimum utility, both of which might not be Pareto efficient (Rosen, Wen and Snoddon 2012, 94). The optimal tax structure, therefore, balances the trade-off between efficiency and equity by selecting a tax structure that minimizes the deadweight loss while maximizing the social welfare gain. For instance, it may involve a low marginal rate in the lower part of the income distribution with many individuals and a higher average tax rate and low marginal tax rate for upper-income individuals (Stiglitz 1986, 411).

Gale and Samwick (2017), while acknowledging the increased US federal budget deficit as a result of tax rate cuts, maintain that the tax cut might encourage individuals to work, save, and even invest. They argue that, while the objective of tax cuts is to boost economic growth—which they define as expansion of the supply side of the economy and potential gross domestic product (GDP)—the substitution effect of tax cuts will boost labour supply and saving so that the net effect on economic growth is uncertain given other effects when the tax cuts are not paid for by reduced

government spending.[10]

Tax evasion and tax avoidance are frequently cited as the obstacles to tax progressivity and hence the distribution of tax burden—which in turn affects the redistribution of income. Rosen, Wen and Snoddon (2012) and Slemrod and Yitszhaki (2002) distinguish between tax evasion (illegal) and tax avoidance (legal). Individuals may avoid paying taxes by reorganizing their business to a form not heavily taxed, characterizing ordinary income as a capital gain, or retiming a transaction to alter the tax year it falls under (Slemrod and Yitszhaki 2002, 1428).

Slemrod (2017), reviewing the literature on tax compliance and enforcement in "The Economics of Tax Policy", shows that an increase in either the probability of detection or the penalty if detected will reduce the incentive to evade tax (88).[11] He also discusses other deterrence measures, including third-party information reporting and public disclosure. Additionally, Slemrod and Yitszhaki (2002), surveying the literature on tax evasion, avoidance, and administration in the "Handbook of Public Economics", argue that tax avoidance and evasion are pervasive in many countries, both developed and developing, and that the tax structures are undoubtedly hampered by tax evasion, tax avoidance, and administrative costs (1425).[12] The optimal level of tax progressivity can be accurately assessed only simultaneously with the instruments the government uses to control avoidance and evasion.

Moreover, Besley and Persson (2013), exploring taxation and development in the "Handbook of Public Economics", argue that a well-designed tax system can minimize the efficiency losses imposed by taxes and even raise the growth rate in endogenous-growth models (53). Tax design in developing economies takes into account information about behavioural responses, administration, and compliance issues. The authors show that, as countries collect larger tax revenues, they do so by

[10] Gale and Samwick (2017) elaborate three concepts of economic growth. We use the concept that considers any change in the level of economic activity for periods longer than the business cycle.

[11] For further details on tax evasion and compliance, including a rich literature review, see Slemrod (2017).

[12] For further details on these and other tax evasion models, see Slemrod and Yitszhaki (2002).

moving away from trade taxes to collecting a larger portion of their revenue from income taxes and value-added taxes. These taxes depend on incentives and constraints, which in turn depend on political institutions and the economic environment, respectively (106).[13]

2.2 Empirical Literature Review

Duncan and Sabirianova Peter (2016) present the most relevant study to our paper. They use a dataset for a large panel of countries that contains time-varying, country-specific measures of structural progressivity of national personal income tax systems for the period 1981−2005. They determine the empirical relationship between personal income tax and income inequality, with special emphasis on the differential effect of tax progressivity on observed versus actual income inequality. They hypothesize that structural progressivity is negatively correlated with observed income inequality, and that the structural progressivity coefficient is smaller (more negative) in countries that facilitate pro-poor government transfers (proxy higher civil liberties and political rights). To test these claims, Duncan and Sabirianova Peter use country-level Gini coefficients (both income based and consumption based) as the dependent variables, top personal income tax (PIT) rate, the marginal rate progression (MRP), average rate progression (ARP), ARP-bottom, ARP-top, and ARP-middle as measures of progressivity on the right-hand side of their regression equations.

Furthermore, the authors use multiple control variables: country size (log [population]), cultural background (with religion as a proxy), one-year lag of GDP in quadratic form (to account for Kuznets' curve—nonlinear relationship between per capita GDP and income inequality), and the inflation rate. They also control for financial development by including the ratio of financial deposits to GDP and an interest rate spread as proxies and other auxiliary variables.

[13] Governments can shift these constraints by investing to improve economic efficiency or trying to create a sense of national identity by proposing reforms to political institutions.

To address a possible endogeneity effect, the authors use lagged values of the measures of tax progressivity and other macro variables and exploit the spatial correlation in the tax rate among neighbouring countries to create instrumental variables (IVs), and use the control variables mentioned above to minimize possible bias due to omitted variables. Using the ARP-middle of a neighbour as an IV in estimating the effect of the measures of tax progressivity on country-level Gini coefficients, the authors find that a one-unit increase in either MRP or ARP reduces the Gini coefficient by 4−6 percentage points. Furthermore, the authors find that increasing progressivity at the top of the income scale is a more efficient method of reducing inequality in observed income. This finding, they argue, is consistent under the assumption that the rich have a higher combined productivity and evasion response than the poor.

In examining the second claim, the authors added an indicator of the pro-poor redistribution (civil liberties and political rights—which the authors obtained from Freedom House). These proxies are measured on a one-to-seven scale, with the highest value indicating no liberties or rights. The authors find that progressivity has a greater equalizing effect in countries with greater access to political rights and civil liberties, and hence a progressive tax structure requires democratic institutions that facilitate pro-poor redistribution policies for it to alleviate income inequality.

In sum, Duncan and Sabirianova Peter (2016) find that personal income tax progressivity reduces observed income inequality in reported net income and that this negative effect on observed income inequality is particularly high in countries with more developed democratic institutions. Moreover, they find a significantly smaller negative effect of PIT progressivity on true inequality, approximated by consumption-based measures of the Gini coefficient. They conclude that changing progressivity at the top of the tax schedule is more efficient in reducing observed net income inequality than similar changes at the bottom of the income scale.[14]

Another relevant study reviewed in detail here is by Nantob (2016). Nantob

[14]For further details on the construction of these IVs and the models they estimate, see Duncan and Sabirianova Peter (2016).

uses dynamic panel data of forty-six developing countries observed over the period 2000−2012 to analyze the effects of taxation on income inequality. In contrast to Duncan and Sabirianova Peter (2016), Nantob estimates the effect of tax rates—tax revenue; taxes on goods and services; taxes on income, profits, and capital gains; and taxes on international trade—and a vector of control variables (such as CPI inflation, GDP per capita, political instability, and governance) on the Gini coefficient.

Using a system generalized method of moments (GMM) estimator to address endogeneity issues, Nantob finds that, while tax revenue reduces income inequality, taxes on goods and services, taxes on income, tax on profits and capital gains, and taxes on international trade increase income inequality. Nantob's results suggest a positive relationship between government expenditures and income inequality, and a negative relationship between investment and income inequality. Furthermore, whereas political stability and corruption are positively correlated with income inequality, the rule of law is negatively related to income inequality.[15]

An extensive body of literature has investigated the distribution of income and its effect on economic activities. Gatzia and Woods (2014) use US data to study the tax and transfer systems in the United States. They argue that, by being less progressive than its counterparts in the OECD, the current income tax system in the United States promotes income inequality. Least progressivity, they stress, not only hampers projects that could reduce poverty, but also contributes to higher rates of income inequality. Gatzia and Woods further contend that redesigning a progressive tax system is instrumental in promoting equality of condition and thus the alleviation of poverty. This can be achieved by investing in excellent social services such as education, health care, and public transport.

Furthermore, numerous studies estimate the effect of a progressive income tax on income inequality using data on personal income tax only. This measure, as many studies have shown, is misleading in part because the top earners' income comes

[15]Nantob (2016) also finds that the interactions between government effectiveness and tax revenue, the rule of law, and tax revenue lead to a reduction in income inequality.

from various sources, some of which are taxed less progressively. Iyer, Jimenex and Reckers (2012) compare the top and bottom income earners in the United States using data from a Congressional Budget Office publication on average federal tax rates in 2007. Using Kakwani's progressivity index and quintile income shares, the authors argue that, while the federal income tax system is progressive and the top one percent of taxpayers pay 40 percent of total federal income tax, the payroll tax is regressive.

Iyer, Jimenex and Reckers (2012) finding, while concurring with the consensus conclusion in the literature, maintains that focusing on the federal income tax alone to measure the success of progressive income taxation in reducing income inequality leads to misleading conclusions.[16] They assert, "For taxpayers in the lower income ranges, the payroll tax burden outweighs the income tax burden, while for higher-income taxpayers, incomes from wages are payroll-tax-free." (226). As a consequence, a payroll tax and a progressive tax amplifies and alleviates income inequality, respectively.

Another study that explores the progressive income tax is by Piketty and Qian (2009). Piketty and Qian compare income inequality and progressive income taxation between China and India using annual tabulations from urban household income surveys collected by China's National Statistical Bureau from 1986 to 2003 and Indian tax return tabulations. They find that the proportion of the Chinese population subject to the income tax has increased twenty times since 1986, while that of the population of Indian subject to high income tax has stagnated around 3 percent. Moreover, the authors argue that a fast income growth and an under-indexed tax schedule in China imply that Chinese income tax revenues grow faster in contrast to the stagnant tax revenue growth in India. The authors' projections indicate that Chinese income tax revenues could well exceed 5 percent of GDP by 2015, and might alleviate income inequality compared to India.

[16]The Iyer, Jimenex and Reckers (2012) study is one of the few studies that stress the importance of the payroll tax and show that it is regressive.

Many studies in the income inequality and taxation literature show that a progressive tax, albeit it might cause economic inefficiency, has a profound positive effect on income inequality. Andrienko, Apps, and Rees (2016) use the approach of optimal piecewise linear income taxation to address the issue of the taxation of top incomes. Their results, though they have limitations, suggest that the appropriate response to the significant increase in income is a shift towards a more progressive income tax system implemented by raising the top marginal tax rates and lowering marginal tax rates in the lower half of the distribution.[17]

Additionally, Corneo (2002) hypothesizes that individuals care about their relative position in society in addition to caring about income and consumption, and argues that a progressive income tax system reduces income inequality and is efficient. He contends that introducing a small progressive income tax can yield a Pareto improvement whenever the Gini coefficient of the distribution of pre-tax income is lower than a critical level.[18] His result rests on the assumption that improving one's rank in society implies worsening somebody else's rank, and hence a progressive income tax system may improve efficiency in the same manner as a Pigouvian tax.[19]

Additionally, Gentry and Hubbard (2004), one of the few studies that extensively explore the effects of a progressive income tax system on labour supply, find "that both higher tax rates and increased tax rate progressivity decrease the probability that a head of household will move to a better job during the coming year."(2301). For example, using data from the panel study of income dynamics, over 1979−1993, in the United States, the authors estimate that a five-percentage-point reduction in the marginal rate of a worker's income increases the prospect of moving to a better job by 0.79 percentage points, and a 3.12 percentage point decrease in a measure of tax convexity increases the likelihood of moving to a better job by 0.86

[17]See Andrienko, Apps, and Rees (2016) for more details.

[18]Corneo uses a utility function with consumption, leisure, and ranks. He also shows that an optimal degree of progressivity decreases with the Gini coefficient of the distribution of pre-tax income.

[19]Pigouvian taxes, levied on goods with negative externalities, provide a disincentive to produce or consume that good. Hence a progressive tax can provide a disincentive to improve one's rank.

percentage points.

Whereas the primary concern against high progressivity in developed economies is its distortionary nature, it is often argued that the main obstacles to tax progressivity in developing economies are not only administration costs and the distortionary effects, but also the lost trust in political institutions. Berens and von Schiller (2016) study the tax composition preferences of a cross section of Latin American countries using public opinion data from the Latin America Public Opinion Project, or LAPOP, for 2012. They find that higher levels of trust in political institutions actively mitigate the opposition of the high-income earners towards more progressive taxation. They conclude that the uncertainty that high-income earners associated with the utilization of tax revenue is the biggest obstacle to progressive taxation, and that top income earners' trust in the reliability of government institutions is, therefore, a prerequisite.

In another study, Nantob (2014) uses panel data for eight West-African Economic and Monetary Union (WAEMU) countries, observed over the period 1989−2012, to analyze the impact of taxation on economic growth. Using a system general method of moments estimator, the author finds that economic growth is positively related to the level of taxation. Nantob concludes that high levels of taxation are favourable to economic growth and that WAEMU countries' governments can engage in expansionary fiscal policies with less distortionary apprehension.

Nantob (2014) is one of the few studies that have arrived at this nondistortionary conclusion. Ogbonna and Ebimobowei (2012), examining the impact of tax reform on economic growth in Nigeria using time-series analysis, arrive at a similar conclusion. They find that tax reform is positively and significantly related to economic growth. Tax reform, they argue, increases the revenue needed by government to undertake socially desirable expenditure that will improve the economic growth in the long run.

In contrast, a growing number of studies—particularly those conducted on developed economies—find a negative relationship between taxation and economic

growth (Padovano and Galli 2001, Dackehag and Hansson 2012, Widmalm 2001, and Macek 2014). Padovano and Galli (2001), examining a cross section time-series panel of twenty-three OECD countries for the 1950s−1980s, show that a high marginal tax rate and tax progressivity are negatively correlated with long-term economic growth. The authors argue that previous findings—positive relationship between progressive taxes and economic growth—were likely due to a misspecification of tax variables, which rely on average rather than marginal measures of financial pressure.

3 Data and Descriptive Statistics

3.1 Measures of Income Inequality and Control Variables

This paper uses a panel data of 32 developing countries—most of which are from Latin America—to study the effect of a progressive tax system on income inequality. The countries and time period covered by this study are presented in Table 1.

Table 1: Country and Time covered by this Study

County	County	County	Country
Argentina	El Salvador	Nigeria	Dominican Republic
Bolivia	Ghana	Pakistan	Ecuador
Botswana	Guatemala	Panama	Malaysia
Brazil	India	Peru	Venezuela
Chile	Indonesia	Philippines	Malawi
China	Iran	Senegal	Thailand
Costa Rica	Jamaica	South Africa	Zimbabwe
Cote d'Ivoire	Kenya	Sri Lanka	Mexico

Table 1 report the countries we cover in this study. Each country covers a period 1985–2005. Although there are misisng values in the specified time frame, each country generally has 21 observations.

The study includes a set of countries often categorized as emerging economies (China, India, Brazil, and South Africa). Although these countries are considered more economically advanced than many developing countries, it is undeniably true that they are unequal in income distribution despite their growing economies. Their inclusion in this study is, therefore, justified.

The country-level Gini coefficient—which is the main dependent variable—come from several sources. The primary source is UNU-WIDER World Income Inequality Database (WIID 3.4). WIID 3.4 is a part of the 2014−18 UNU-WIDER work program on transformation, inclusion, and sustainability, first established in 1997−1999 for the UNU-WIDER-UNDP project: Rising Income Inequality and Poverty Reduction. The Gini coefficient is measured on a zero-to-hundred scale which is equivalent to a zero-to-one scale, where zero implies perfect equality, and one implies perfect income inequality. The Gini coefficient is estimated using net (i.e after income tax) or gross (i.e before income tax) income or consumption.

Graphically, the Gini coefficient is half the area between the diagonal (45 degrees) line, and the Lorenz curve, where the horizontal axis measures the cumulative percentage of the population starting from the poorest to the richest. Additionally, the vertical axis measures the cumulative percentage of income (or expenditure) associated with the units on the horizontal axis (WIID 3.4 Guide).

The WIID 3.4 database source contains 182 countries with over 8,800 observations covering the period 1960−2015. Within the WIID 3.4 database, there are various Gini coefficients from several sources having a different quality rating. For instance, many Latin American country-level Gini coefficient come from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) 2016, and the World Bank 2016, among others. For consistency, the Gini coefficient is assigned a quality rating—high average and low—and whether the welfare definition was income or consumption base. The database also includes specifications on which part of the country was the sample used in the estimate—All, urban and rural area. This pa-

per chooses a net-income Gini coefficient with a high-quality rating, and to maintain consistency the same source is selected every time it is net-income based and has a high-quality rating. However, the consumption based Gini coefficient is selected whenever there is no net-income based Gini index, though it is entirely not used in the current study.

Furthermore, the quintile share, in the WIID 3.4 source, measure the share of total income going to each fifth of the population ordered according to the size of their incomes. These shares are expressed as percentages of total income. The first quintile group includes the poorest 20% of the population, while the fifth quintile includes the richest 20% (WIID3.4).[20] This paper also estimates the effect of progressive taxes on the first and fifth quintile groups, in addition to estimating the impact of the progressive tax on income inequality using the Gini coefficient.

The Gini coefficient from the WIID3.4 database, however, are sparse in the period of study, and are, therefore, supplemented from other sources. These sources include the World Development Indicator (WDI) of the World Bank, the Standardized World Income Inequality Database (SWIID) v.5.1, and the Income Distribution in Latin America (IDLA) Dataset. While the IDLA compares Gini index from various sources including the WIID and the World Bank beginning in 1990, the SWIID v.5.1 have 100 separate imputations of the complete series, where the differences across these imputations capture the uncertainty in the estimates. We fill in the missing values in our Gini coefficients dataset using the first imputation from the SWIID v.5.1 dataset, which we assigned an average quality rating.

While the consumption based Gini coefficient is included in the dataset, we choose to use the net-income based Gini coefficient and quintile shares to analyze the impact of progressive tax system on income inequality. The current study also includes a set of dummy variables for quality of the Gini coefficients (high, average and low) and dummy variables for the national area coverage (all, urban, and rural).

[20]WIID 3.4 also includes decile shares, which divides the population into 100 groups based on income, with the first decile representing the lowest 10% of population.

Although the Gini coefficient is the most widely used measure of income inequality, there is a divided opinion in academics on which is the preferred measure, a net-income or consumption based measure. Several studies advocate for consumption as the better measure of inequality in developing countries in part because a large proportion of the population survive on non-income, and hence using net-income as a base will likely over-identify the inequality. still, others cite the difficulty encounter in collecting consumption data used to estimate Gini coefficient. This paper estimates the effect of tax variables on income inequality using the Gini coefficient, net-income based, and the quintile shares—first and fifth quintile shares. The Gini coefficient is net-income or disposable income based if the income concept used in estimating it corresponds to the one specified by the Canberra Group—total income less direct taxes, compulsory fees and fines, current inter-household transfers paid, employee and employers' social insurance contributions, and current transfers to non-profit institutions (WIID 3.4).The income share unit is primarily the household—people who share a dwelling and resources—and in some cases, individual level.[21]

In addition, the study uses the per capita GDP growth rate, which measures the change in per capita GDP, to estimate the effect of tax rate on economic efficiency. We also use the poverty head count ratio ($3.10)—which is the headcount ratio of individuals who live on less than $3.10 a day, measured in 2011 purchasing power parity (PPP) and expressed as a percentage of population—to estimate the effect of a progressive tax system on the welfare of the poor in developing countries. Both the per capita GDP growth and the poverty head count ratio are obtained from the WDI database of the World Bank.

The WDI database covers about 217 economies and addresses topics ranging from agriculture to poverty. The database also covers major economic regions such as the International Bank for Reconstruction and Development (IBRD), and the International Development Association (IDA), among others. The dataset covers the

[21]For further details, see WIID 3.4 user guide, 2017

1960−2016 time frame. The definitions and sources of these variables are presented in Table 2.

In addition, the current study uses several control variables to analyze the effect of a progressive tax rate on income inequality. The first category of control variables includes the per capita GDP—a quadratic one-year lag of log(per capita GDP) term is used to account for a nonlinear relationship between income inequality and per capita GDP- Kuznets curve; total population—proxy for the size of the economy; and the total tax revenue expressed as a percentage of GDP.

The second category of control variables is the financial and trade development indicators: the interest rate spread—the difference between lending and borrowing rates; exports and imports of goods and services expressed as a percentage of GDP; foreign direct investment (FDI)—the net inflows of investment to acquire a lasting management interest in an enterprise operating in an economy other than that of the investor—expressed as a percentage of GDP; net official development assistance (NODA)—which consists of disbursements of loans and grants by official agencies of the members of the Development Assistance Committee (DAC); and the inflation rate (Consumer Price Index), which reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services in percentage terms.

The third category of variables tested in this paper is the pro-poor redistribution or democratic institutional variables—proxied by civil liberties and political rights—obtained from the Freedom House. These variables are measured on a one-to-seven scale, where seven indicates no political rights or civil liberties, and one indicates more political rights or freedoms. As discussed in Duncan and Sabirianova Peter (2016), democratic institutions variables positively correlate with redistribution of income that favour the bottom share of the income distribution. Through voting system, the poor can influence the redistribution of income by electing into office those parties that favour redistribution.

The fourth category of variables used in this paper is the political risk index

proxied by the rule of law (law-and-order), and control of corruption (corruption). These variables are available from the Political Risk Services International Country Risk Guide or ICRG, for the 1984 to 2011 period. While corruption is measured on a zero-to-six scale, where zero represents the worst case of corruption, the law-and-order variables are measured separately on a zero-to-three scale each and then added together to get the lowest scale of zero, which represents the absence of law and order. It is argued that the prevalence of corruption and the absence of the rule of law hinder the efforts to redistribute income in developing countries. These variables and their sources are discussed more extensively in Table 2.

Table 2: Definitions and Sources of Variables

Variables	Definitions and Sources
Gini index	The main measure of income inequality is the Gini coefficients, net-income based. It is measured on a zero-to-hundred scale. Sources: WIID, SWIID and IDLA.
Quintile shares	The first and fifth quintile shares are the shares of income going to the poorest and richest 20% of the population, respectively Sources: WIID.
PCGDPGrowth	The per capita Gross Domestic Product growth rate measures the change in per capita GDP. Source: World Development Indicators (WDI), World Banks.
Poverty Rate	The headcount ratio of individuals who on less than $3.10 a day measured in 2011 PPP, and expressed as a percentage of the population. Source: WDI.
Tax Revenue	Is a compulsory transfers to the central government for for public purposes, expressed as a % GDP. From WDI.

Continuation of Table 2

Variables	Definitions and Sources
Panel B: Measures of Tax Progressivity (Tax Variables)	
Source: Andrew Young School of Policy Studies (AYS)	
Top PIT rate	Legally determined marginal tax rate applicable to the top bracket personal income tax rate.
MRP-all	Marginal rate progression obtained from regressing marginal tax rate on the log of gross income for the income scale up to 4y, where y is a GDP.
ARP-All	Characterizes the structural progressivity of national tax schedules with respect to the changes in average rate along the income distribution. It is the coefficient from regressing actual average tax rates on the log of gross income for the income scale up to 4y income.
ARP-bottom	Average rate progression for the income scale up to 2y income. Obtained from Professor Duncan.
ARP-middle	Average rate progression for the income scale between y and 3y income.
ARP-Midn	Is the ARP-middle of the country's neighbour and is used as an instrumental variable (IV).
ARP-Top	Average rate progression for the income scale between 2y and 4y income. Source: Professor Duncan.
Panel C: Control Variables, All Obtained from WDI, World Banks	
Population	Is based on the de facto definition(mid-year), which counts all residents regardless of legal status.
PercapitaGDP	Per capita is the Gross Domestic Product divided by midyear population in constant 2010 U.S. dollars.

Continuation of Table 2

Variables	Definitions and Sources
LagLogpcgdpsq	Is used to account for the existence of nonlinear relationship between income inequality and per capita GDP (Kuznets curve).
Exports	The value of all goods and services provided to the rest of the world, expressed as percentage of GDP.
Imports	The value of all goods and services received from the rest of the world, expressed as percentage of GDP.
ForeignDI	FDI are the net inflows of investment to acquire a lasting management interest in an enterprise operating in a foreign economy, expressed as percentage of GDP
NetOffDevAid	Net official development assistance and official aid received consists of disbursements of loans made on concessional terms and grants by official agencies of the members of the Development Assistance Committee (DAC) to promote economic development and welfare in countries expressed in term of millions of U.S. dollars.
InflationRate	Inflation as measured by the Consumer Price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed.
IntRteSpread	Interest rate spread (lending rate minus deposit rate) is the interest rate charged by banks on loans to customers minus the interest rate paid by commercial banks to customers for savings or deposits. Source: WDI, World Bank

Continuation of Table 2

Variables	Definitions and Sources
Panel D: Pro Poor Redistribution and Tax Evasion Indicators	
Political Rights	This index give indication of the degree to which citizens participate in democratic processes, such as voting and contesting political office. They are measured on a one-to-seven scale, where one is the highest degree of freedom. Source: Freedom House.
Civil Liberties	Civil liberties index gives an indication of the degree to to which individuals are allowed freedoms of expression and belief among others. It is measured on a one-to-seven scale, where one is the most free. Source: Freedom House.
Law and Order	Law and order are assessed separately, each scored from zero to three points. For law, the strength and impartiality of the legal system are considered, while for the order, the popular observance of the law is considered. Law and order is measured on a zero-to-six scale, where zero being the worst case. Source: International Country Risk Guide (ICRG).
Corruption	Corruption is manifested in several forms, demands for special payments and bribes connected with import and export licenses among others. It is measured on a zero-to-six scale. Source: ICRG
Panel D: Auxiliary Variables (Quality and Areacovered dummy variables)	
Quality=High	Observations where the quality of income underlying concepts of estimating Gini coefficients are known. Most observations have high quality ratings.

Continuation of Table 2

Variables	Definitions and Sources
Average	Observations where the quality of either the income concept or the survey is problematic or unknown.
Low	Observations where both the income concept and the survey are problematic or unknown.
Areacov=All	When the land include in the original sample survey is nationwide.
Urban	When the land included is urban.
Rural	When the included is Rural.

Table 2 presents the variables used in this study and their sources. The sources are discussed in detail in the data section.

3.2 Measures of Tax Progressivity

While the measures of income inequality and other explanatory variables are readily available from the WDI of the World Bank, the main independent variables of the current study—the measures of tax progressivity or tax indicators—need modification. Structural progressivity, as defined by Musgrave and Thin (1948), is the change in average and marginal tax rates along the income distribution. The measures of tax progressivity implemented in the current study include: the top statutory personal income tax (PIT) rate, the average rate progression (ARP), the marginal rate progression (MRP), and the ARP (bottom, middle and top). These tax variables are obtained from the Andrew Young School of Policy Studies (AYS), World Tax Indicators V.1.

A team of economists, Denvil Duncan (Indiana University), Jorge Martinez Vazquez (Andrew Young School of Policy Studies at Georgia State University), and Klara Sabirianova Peter (University of North Carolina), have compiled a panel data portal containing these various measures of taxes progressivity and tax rates.

They constructed structural progressivity by rescaling the country per capita GDP to 100 units of pre-tax income for each country and year ranging from 4% to 400% of the country's per capita GDP. They then applied tax schedules to obtain tax liability and average and marginal tax rates on a scale ranging from 0.4y to 4y, where y represent the country per capita GDP.[22]

The key variables of interest, average rate progression(ARP), characterizes the structural progressivity of national tax schedules with respect to the changes in average rates along the income distribution. It is the slope coefficient obtained from regressing actual average tax rates on the log of gross income. For example, ARP-all is the average rate progression up to an income level equivalent to four times y (that is, from 0y to 4y, where y is a country's per capita GDP), while ARP-middle is the average rate progression for the levels of income between y and 3y (AYS world tax indicators).[23] The slope coefficient on the income variable measures the percentage point change in the tax rate resulting from a one percent point change in gross income and is a measure of structural progressivity. The personal income tax structure is interpreted as progressive, proportional, or regressive if the slope coefficient is positive, zero, or negative, respectively (Duncan and Sabirianova Peter 2016). All the variables and their sources are discussed at length in Table 2 above.

3.3 Descriptive Statistics

This study uses a panel data of 32 developing countries, covering a 1985–2005 period. Although some countries are missing a value or two in a particular year in at least one of the four dependent variables, each country covers a period 1985– 2005.

The summary statistics of the main dependent variables—Gini coefficients (net-income and consumption based),quintile shares, per capita GDP growth rate,

[22]For more information on the construction of these tax rates, see Duncan and Sabirianova Peter (2016) and Andrew Young School of Policy Studies (AYS), World Tax Indicators V.1.

[23]For further information on the average and marginal rate construction, see AYS world tax indicators.

and the poverty head count ratio ($3.10), all weighted by the population—are presented in Table 3, panel A. Panel B of the same table presents summary statistics for the measures of tax progressivty. While the variation in the mean income inequality, as manifested by the standard deviation is wide, the variation between countries (7.258222) is larger than the variation over years for a given country (4.367957).[24] This observation is consistent with findings in the literature that have consistently shown that within country income inequality has decreased, while the between countries inequality has increased. Additionally, the measures of tax progressivity follow a similar trend: large variability between countries compare to variation over years.

For inference and comparability purpose, we calculate summary statistics by period and weighted by the population. In Table 10, in the appendix of this study, the weighted mean of the Gini coefficient (both consumption and net-income based) increases over the period: 1985-1989, 1990-1995, 1996-2000, and 2001-2005. For example, the mean of Gini coefficient increased from 35.25 points in 1985−1989 to 44.03 ppoints in 2001−2005. The overall variability, however, declines in the same periods. Whereas the mean of the net-income based Gini coefficients increases over the period—36 in 1986−1989 to 46 in 2001−2005)—the mean of the consumption based Gini coefficient increases in the first three period, but declines in the last period.

Additionally, the poverty head counts ratio ($ 3.10)—measured as percentage of population—decreases from 65% in 1985−1989 to 48% in 2001−2005 period. This observation confirms an earlier argument that an income inequality can increase even if the poverty rate is declining. Moreover, the mean of per capita GDP growth rate increases from 4.5 percent in 1985–1989 to 5.6 percent in 2001−2005. The variability in all the dependent variables declined in the entire period.

The mean of most measures of tax progressivity increased in the entire periods. For instance, the mean of MRP-all increased from 1.012 points in 1985−1989 to about 2.6 points in 2001−2005. However, the mean of the tax revenue, as a percent-

[24]The summary statistics for between countries and within country variation, minimum and maximum values are omitted in Table 3. We only report the overall statistics.

age of gross domestic product, for instance, decreases from 26.9 percent in 1985–1989 to 10.5 points in 2001–2005, while the mean of top PIT rate decreases from 47.36 percent in 1985–1989 to 36.09 percent in 2001–2005 period as shown in Table 10

Table 3: Descriptive Statistics; Weighted

Variables	Obs	Mean	Std. Dev	Minimum	Maximum
Panel A: Dependent Variables					
Gini (consumption/income)	627	39.17	8.55	20.20	66.30
Gini (net-income)	521	41.51	8.66	20.20	66.30
Gini(consumption)	106	33.41	4.68	23.90	65.76
Percapitagdppcgrowth	672	4.90	4.45	-17.53	30.34
Poverty rate ($3.10)	247	57.19	25.31	0.00	91.58
1st Quintile	328	6.56	2.33	0.90	11.33
2nd Quintile	327	10.60	2.43	4.50	15.70
3rd Quintile	327	14.76	2.16	7.81	18.89
4th quintile	327	21.91	2.70	11.75	31.25
5th Quintile	328	46.11	8.18	31.48	70.27
Panel B: Measures of Tax Progressivity					
Tax Rev	420	16.90	34.50	0.91	648.18
Top Rate	665	40.54	8.78	10.00	90.00
ARP-all	629	0.26	1.07	-0.00	12.51
ARP-mid	629	0.24	1.02	-0.00	13.15
ARP-midn	522	1.80	1.99	-0.00	11.07
ARP-bottom	629	1.07	1.90	-0.00	15.93
ARP-top	629	1.75	1.84	-0.00	13.95
MRP-all	629	0.36	1.68	-0.00	27.12

Continuation of Table 3

Variables	Obs	Mean	Std. Dev	Minimum	Maximum
Panel C: Explanatory Variables					
LagLogpcgdpsq	640	52.55	12.85	33.21	89.98
Exports(%GDP)	668	19.30	11.96	3.73	121.31
Imports(%GDP)	668	18.66	10.98	4.63	100.60
Foreign D.Investment	670	1.87	1.87	-10.08	12.20
NetOffDevAid (in million)	664	1455.29	902.37	-941.59	6401.79
Log(population)	672	19.85	1.42	13.98	20.99
Inflation rate	670	42.27	293.58	-4.14	11749.64
Interest rate spread	471	7.00	56.33	-11.00	2334.96
Panel D: Pro Poor Redistribution and Tax Avoidance Indicators					
Political Rights	672	4.49	2.18	1.00	7.00
Civil Liberties	672	4.68	1.57	1.00	7.00
Corruption	672	2.63	1.00	0.00	6.00
Law and Order	672	3.45	1.13	0.00	5.00
Panel E: Auxiliary Variables					
Quality=High	624	0.14	0.35	0.00	1.00
Quality=Average	624	0.73	0.44	0.00	1.00
Quality=Low	624	0.13	0.33	0.00	1.00
AreaCov=All	603	0.72	0.45	0.00	1.00
Areacov=Rural	603	0.11	0.32	0.00	1.00
Areacov=Urban	603	0.17	0.38	0.00	1.00

Table 3 presents summary statistics, weighted by the population.

4 Empirical Methodology and Regression Specifications

This paper sets out to estimate the effect of a progressive income tax on income inequality. The software application package we use to analyze data and estimate the models specified below is the STATA software. The first hypothesis examined (**H1**) say that a progressive income tax system alleviates income inequality in developing countries. We test this claim by regressing the country-level Gini coefficients on the measures of tax progressivity and a vector of explanatory variables as:

$$Gn_{itx} = \beta_0 + \lambda \mathbf{P}_{itx} + \beta_1 \mathbf{X}_{itx} + \beta_2 \mathbf{W}_{itx} + \xi_{tx} + \epsilon_{itx} \quad \forall x \in (y, c) \tag{1}$$

where Gn is the Gini coefficient of country i in time t, and x is a Gini welfare definition (net-income (y) or consumption (c) based). **P** is a vector of the measures of tax progressivity: ARP(all), ARP(bottom), ARP(middle), ARP(top), MRP(all), Top PIT rate, and the tax revenue variables, which are discussed in details in Table 2. **X** is a vector of further explanatory variables: the squared of lag(log(per capita GDP)), the total population (used as a proxy for economy size), exports and imports of goods and services (to control the effect of international trade on income inequality, expressed as a percentage of GDP), foreign direct investment (FDI) and net official development assistance (to control for the effect of globalization and foreign aid on the country-level income inequality), inflation rate (CPI) and interest rate spread (to control for the effect of financial market development on the country-level income inequality).These variables are also discussed in details in Table 2. **W** is a vector of auxiliary variables: dummy variables for the quality of Gini coefficient (high, average and low), and dummy variables for the national area covered (all, urban and rural area), ξ captures time effects and ϵ is the error term.

The study also looks at the effects of the measures of tax progressivity on

quintile shares:

$$Q_{itx} = \beta_0 + \lambda \mathbf{P}_{it} + \beta_1 \mathbf{X}_{it} + \beta_2 \mathbf{W}_{it} + \xi_t + \epsilon_{it} \quad \forall x \in \ (q1, q5) \tag{2}$$

where Q is the share of total income going to each fifth of the population, q1 is a share of income going to the poorest 20%, and q5 is the one going to the richest 20%. We expect the increase in the tax progressivity to increase the share of total income going to the first quintile, and decrease the one going to the fifth quintile. All the other variables are as defined in equation (1).

The third equation we considered in this study is

$$Percapitagdpgrowth_{it} = \beta_0 + \lambda \mathbf{P}_{it} + \beta_1 \mathbf{X}_{it} + \xi_t + \epsilon_{it} \tag{3}$$

where the per capita GDP growth rate—the change in per capita GDP—estimates the effect of progressive tax rates on economic efficiency. All the right hand side variables are as defined in equation (1), except for the ($\mathbf{W}$), vector of auxiliary variables. We hypothesize that there is a negative relationship between progressive tax system and economic growth, and are expecting the coefficients of the measures of tax progressivity (λ) to be negative **(H2)**.

We also look at the effect of tax indicators on the poverty head count ratio ($ 3.10), to estimate the possible effect of tax progressivity on the welfare of the poor:

$$PovertyRate_{it} = \beta_0 + \lambda_1 \mathbf{P}_{itx} + \beta_1 \mathbf{X}_{itx} + \xi_{tx} + \epsilon_{itx} \ \ \forall x \in \ (y, c) \tag{4}$$

where PovertyRate is the poverty headcount ratio of individuals who live under $ 3.10 a day. We hypothesize that progressive taxation is welfare improving (alleviating of poverty). All the other variables are as defined in equation (3).

Moreover, it is often argued that countries with the greatest access to political rights and civil liberties have a higher chance of reducing the income inequality

when they raise the tax rate on the top earning individuals. To test this claim, we include the interaction term between the tax indicators and democratic institutions or pro poor redistribution indicators variables (political rights and civil liberties, all obtained from the Freedom House) to equation (1). We model the effects of this interaction as:

$$Gn_{itx} = \beta_0 + \lambda_0 \mathbf{G}_{itx} + \lambda_1 \mathbf{P}_{itx} + \lambda_2 \mathbf{P}_{itx} * \mathbf{G}_{itx} + \beta_1 \mathbf{X}_{itx} + \beta_2 \mathbf{W}_{itx} + \xi_{tx} + \epsilon_{itx} \ \ \forall x \in (y, c) \quad (5)$$

where G is a proxy for democratic institutions (pro poor redistribution indicators): political rights or civil liberties. All the explanatory variables, the measure of tax progressivity, and dependent variable are as defined in equation (1). The civil liberties and the political rights are measured on a one-to-seven scale, with one representing the highest degree of freedom or the most free society.

Moreover, in the literature (Gentry and Hubbard, 2004; Slemrod and Yitszhaki, 2002, p.1428; Slemrod 2017; Besley and Persson, 2013), it is often argued that the prevalence of tax avoidance or tax evasion in developing economies diminishes the effort of a progressive income tax to alleviate the income inequality. We test this claim by modelling equation (1) with the interaction of rule of law (law and order) and corruption variables with the measures of tax progressivity as follow:

$$Gn_{itx} = \beta_0 + \lambda_0 \mathbf{D}_{itx} + \lambda_1 \mathbf{P}_{itx} + \lambda_2 \mathbf{P}_{itx} * \mathbf{D}_{itx} + \beta_1 \mathbf{X}_{itx} + \beta_2 \mathbf{W}_{itx} + \xi_{tx} + \epsilon_{itx} \ \ \forall x \in (y, c) \quad (6)$$

where $\mathbf{D}$ is a proxy for a tax evasion indicators—that is, the degree of the rule of law or control of corruption. Both law and order, and corruption are measured on a zero-to-six scale, with zero being the worst level of law and order or corruption. All the other variables are as defined in equation (1).

5 Preliminary OLS Regression Results and Discussion

We commence by estimating equations (1), (2), (3), and (4) initially using ordinary least square (OLS) regressions (using Stata statistical software). Table 5 summarizes the estimates from OLS, weighted by the log of population with robust standard errors reported. While the economic growth model has a very low measure of goodness of fit, the other four specifications have a substantial goodness-of fit. For instance, 66% of the variation in a country-level Gini coefficient in equation (1) is explained by the measures of tax progressivity and other control variables, while 81% of the variation in the poverty rate is explained by the same variables.

We expect a priori an increase in tax revenue, top PIT rate, ARP-top, ARP-all, MRP-all, exports of goods and services, foreign direct investment (FDI), and net official development assistance (NODA) to decrease the Gini coefficient. We also expect an increase in the ARP-bottom, ARP-mid, inflation rate, interest rate spread, and imports of goods and services to increase the Gini coefficient.

However, the estimates in Table 4 column (1) show that only the tax revenue, ARP-all, ARP-mid, MRP-all, ARP-bottom, and exports of goods and services have the predicted signs, while the FDI, NODA, top PIT rate, ARP-top, and MRP-all do not have the expected signs in equation (1). An increase in the ARP-all, tax revenue, inflation rate, and size of the economy, which are significantly different from zero, reduce the Gini coefficient, while an increase in the top PIT rate, ARP-mid, MRP-all, ARP-top, and interest rate spread—which are also significantly different from zero—are estimated to increase the Gini index. For example, a one-unit increase in the ARP-all—which is significantly different from zero at the 1% significance level—decreases a country-level Gini coefficient by 20 percentage points, whereas a similar increase in either ARP-top or ARP-middle, both significantly different from zero at 5% or 1%, increase the Gini coefficient by $0.91-9.7$ percentage points.

Table 4: Preliminary OLS Regression Results.

	Dependent Variables				
Variables	Gini Index	1st Quintile	5th Quintile	GDPGrowth	Poverty310
	(1)	(2)		(3)	(4)
TaxRev	-0.2372**	0.0256**	-0.2052**	-0.0358	-1.0742**
	(0.1282)	(0.0324)	(0.1379)	(0.060)	(0.4492)
TopRate	0.2697***	-0.0176*	0.2035***	0.0701**	-0.3059 *
	(0.0612)	(0.0110)	(0.0602)	(0.0339)	(0.1787)
ARP-all	-20.5026***	6.5900**	-30.4804***	7.0644	-67.4800***
	(3.0423)	(2.5943)	(11.4386)	(7.4006)	(23.2312)
ARP-mid	9.6621***	-4.9917**	23.3851**	-4.3771	66.829***
	(1.6235)	(2.0893)	(9.2327)	(4.3797)	(19.6580)
MRP-all	6.4272***	-1.3710**	6.3471**	-2.1622	12.7875**
	(0.8516)	(0.5947)	(2.6368)	(2.0883)	(4.9802)
ARP-bottom	0.2923	-0.0222	-0.0396	0.15134	.30606
	(0.3296)	(0.0671)	(0.3205)	(0.1401)	(0.5463)
ARP-top	0.9089**	-0.1753**	0.9176**	-0.0279	-.46433*
	(0.4715)	(0.0943)	(0.4350)	(0.2145)	(0.8804)
Exports	-0.0324	0.0056	0.0005	0.0194	-.06040
	(0.0707)	(0.0265)	(0.09475)	(0.0660)	(0.2255)
Imports	-0.0989	0.0329	-0.1270	-0.0157	-.23086
	(0.0918)	(0.0261)	(0.0978)	(0.0761)	(0.2766)
ForeignDI	0.2356	-0.0680*	0.2230	0.0952	-.26617
	(0.1683)	(0.0391)	(0.1934)	(0.1323)	(0.4145)
NetOffDevAid	0.0002	0.0012**	-0.0037*	-0.0007	.01091**
	(0.0008)	(0.0005)	(0.0020)	(0.0007)	(0.0058)

Continuation of Table 4

	Dependent Variables				
Variables	Gini Index	1st Quintile	5th Quintile	GDPGrowth	Poverty310
	(1)		(2)	(3)	(4)
InterestRSpread	0.1233***	0.0010	0.0701	0.0257	-.15624*
	(0.0449)	(0.0115)	(0.0514)	(0.0303)	(0.1333)
Inflation Rate	-0.1843***	0.0154	-0.0487	-0.0990**	.44059***
	(0.0535)	(0.0110)	(0.0516)	(0.0489)	(0.1088)
Log(population)	-3.2936***	0.0896	-0.2763	-0.0282	5.9073***
	(0.5967)	(0.1528)	(0.6742)	(0.3812)	(1.9584)
LagLogpcgdpsq	0.1099**	0.05709***	-0.20119**	-0.0836	-.81102***
	(0.0558)	(0.0173)	(0.0825)	(0.0407)	(0.2002)
Constant	98.7476***	-1.6883	68.2277***	8.3286	-30.1333
	(10.1576)	(2.6170)	(10.5228)	(5.5667)	(28.8944)
Observations	206	126	127	245	108
R^2	0.565	0.700	0.614	0.116	0.845
Adjusted R^2	0.539	0.663	0.571	0.059	0.812

Table 4 reports the estimates for equation (1), (2), (3), and (4), weighted by the log of population. The dependent variables are specified by column heading. The robust standard errors, reported by Stata, are in parentheses. $*$ significant at 10%, $**$ significant at 5% and $***$ significant at 1% significance level. The estimates for auxiliary variables are omitted.

The first finding is consistent with Duncan and Sabirianova Peter (2016), who find that an increase in ARP-all, among others, decreases income inequality. Also, the finding that an increase in the tax revenue decreases income inequality is consistent with Nantob (2016), who finds a similar result in a study of the tax rate on income inequality in developing countries.

Additionally, we forecast that the variables that reduce the Gini coefficients in equation (1) will invariably increase the share of income that goes to the bottom

fifth of the population and decrease the share that goes to the top quintile as modelled in (2). The estimated coefficients in Table 4, columns (2) and (3), however, show that the ARP-all, tax revenue, and NODA are the only variables that have the expected signs. For instance, a one-unit increase in ARP-all increases the share of income going to the poorest 20% by 6.6 percentage points, and decreases the share of income going to the fifth quintile by 30.5 percentage points, whereas a similar increase in ARP-middle or MRP-all decreases the share of income going to the first quintile by 1.4−5 percentage points and increases the fifth quintile share by 6−23.4 percentage points.

What is striking is that an increase in ARP-top or the top PIT rate tend to decrease the percentage share of income going to the bottom fifth and increase the share to the top fifth as opposed to the reverse. This finding is consistent with the argument that the high-income individuals are more likely to avoid paying income tax when there are tax rate increases in developing countries. The reduction in the first quintile share is likely due to reduced productivity at the top or fewer transfers when the top earners avoid paying income tax.

Furthermore, we expect a priori an increase in tax revenue, the top PIT rate, ARP-bottom, MRP-all, ARP-mid, ARP-top, ARP-all, and MRP-all to decrease the incentives to work, among other behavioural responses, and hence reduce economic growth. However, Table 4, column (4) shows a 1% increase in the top PIT rate—which is significantly different from zero at 5% significance level—increases the per capita GDP growth rate by 0.07 points. This finding is consistent with many studies in the literature (for example, Nantob 2014; Ogbonna and Ebimobowei 2012), which find that increasing the tax rate on the top improves economic growth, but also contradicts many more studies in the literature (for example, Padovano and Galli 2001; Dackehag and Hansson 2012; Widmalm 2001; Macek 2014), which find that increasing the tax rate on the top decreases economic growth.

In equation (4), we argue that the variables that decrease income inequality in equation (1) can also decrease the percentage of population that lives on less than

$3.10 a day, and those that increase income inequality increase the percentage of population living on less than $3.10 a day. In Table 4, column (5), the tax revenue, the top PIT rate, ARP-all, ARP-top, FDI, ARP-bottom, ARP-mid, MRP-all, inflation rate, and exports and imports of goods and services all have the expected signs. A one-unit increase in ARP-all—which is statistically different from zero at the 1% significance level—reduces the percentage of the population that lives on less than $3.10 a day by 67.5 points. Moreover, a one-unit increase in either ARP-middle or MRP-all, which are both significantly different from zero at 5% level based on OLS estimates, increases the poverty rate by 12.8−66.8 points. The poverty rate is more sensitive to increased progressivity in the middle, and hence an increasing progressivity at the top can reduces it.

6 Further Estimation Results and Discussion

In the estimates discussed above, and the ones that follow, the estimators in Stata ignores the missing values. The presence of missing values, coupled with the use of many instrumental variables, reduces the number of observations in each of the models estimated. In addition, the two-stage least square IV discussed in Baum et al. (2009) and Schaffer (2010) have a built-in mechanism that bypasses the first-stage regression and hence solve the issue of large standard errors associated with usual 2SLS results. A preliminary estimation (not reported here), however, showed that the possibly endogeneous variables (top PIT rate, ARP-all ARP-bottom ARP-middle, ARP-top, MRP-all, and tax revenue) are highly correlated with their one-year lag and ARP-mid of the country neighbour(instrumental variables). This correlation is also confirmed by the test of endogeneity in all the models.

6.1 Adjusting for Potential Endogeneity

The preliminary OLS estimates presented in Table (4) are likely to suffer from a potential endogeneity problem and could lead to a misleading conclusion. This likely bias is due to many possible causes. First, the income inequality literature has since established the reverse causality effect between the tax rate and income inequality. Second, the measures of tax progressivity are estimates—obtained by regressing the average tax rate on the country's GDP and its multiples—and hence are likely to correlate with the error term as argued by Duncan and Sabirianova Peter (2016). In addition, the OLS-based estimates are likely to suffer from a multicollinearity problem—the tax indicators are obtained from regressing the similar tax rates on GDP and its multiples and are likely to correlate with each other.[25]

Third, although we made efforts to include as many control variables as possible, the models might still suffer from an omitted variables effect. Therefore, more appropriate estimators should address such a potential problem of endogeneity. We address the first and third potential causes of endogeneity by using a two-stage least square IVs estimator and a DPD one-step system GMM estimator as discussed in Davidson and Mackinnon (1993, 313−338). Also see Baum et al. 2007, Schaffer 2010, and Roodman 2009. These two estimators use instrumental variables to address the pontential problem of endogeniety that the OLS estimator could not address. To address the possible multicollinearity issue, we estimate the equations defined above with each of the seven tax indicators and a vector of control variables. **P** is, therefore, no longer a vector of tax variables as defined earlier, but a particular measure of tax progressivity.

We estimate equations (1) and (2) using a two-stage least square IV (2SLS IV), and equations (3) and (4) using a dynamic panel data (DPD) one-step system GMM estimator. Both the 2SLS IV and DPD one-step system estimators use the

[25]Tax indicators measure the percentage point change in the tax rate resulting from a one percent change in gross income as elaborated in Duncan and Sabirianova Peter (2016).

one-year lag of the measures of tax progressivity—ARP-all$_{t-1}$, ARP-bottom$_{t-1}$, ARP-middle$_{t-1}$, ARP-top$_{t-1}$, MRP-all$_{t-1}$, top PIT rate$_{t-1}$, and tax revenue$_{t-1}$—and ARP-midn, which is the ARP-middle of a country's neighbour, as instrumental variables. In some models, the DPD GMM estimator uses up to 4-year lags in both difference and levels equations. This reduces the number of observations in some estimations.We construct the ARP-middle by assigning each country the ARP-middle of the country bordering it.[26]

To address the multicollinearity issue, we estimate equation (1) with each measure of tax progressivity, instrumented by its lag and ARP-midn and weighted by the log of the total population with robust standard errors reported, as shown in Table 5. The estimated coefficients of the measures of tax progressivity is shown by the column heading and the tax indicators row. All the 2SLS IV models in Table 5 pass the under-identification test (Kleibergen-Paap LM statistic), weak identification test (Cragg-Donald Wald F statistic), Hansen J statistic (over-identification test), and the endogeneity test discussed in Davidson and Mackinnon (1993, 313−338) and also in Baum, Schaffer and Stillman (2007) and Schaffer (2010).

The seven models have a good measure of goodness of fit, evident from the R-squares—range from 43% for the model with the ARP-top as a measure of tax progressivity to 56% for the model with ARP-all—and an F-statistic, which is significantly different from zero at the 1% significance level in each model. Hence the variation in the Gini coefficient explained by the explanatory variables is fairly substantial. The predictions of the coefficients' signs in the models are as discussed in the preliminary OLS results section above.

In Table 5, we see that tax revenue, top PIT rate, ARP-all, ARP-top, ARP-all, and ARP-mid all have the a priori expected signs and are statistically different from zero at the 1% to 5% significance levels. This implies a 1 percent increase in either the top PIT rate (%) or tax revenue (%GDP) decreases the Gini coefficient

[26]Some of the neighbouring countries whose ARP-middle we used are not included in the dataset used in this study.

by 0.29−0.51 percentage points. Moreover, a one-unit increase in either ARP-top or ARP-all increases the Gini coefficient by 1.17−3.70 percentage points. However, a one-unit increase in the ARP-bottom, which is significantly different from zero at the 5% level, is estimated to increase the income inequality in developing countries by 0.51 percentage points.

Table 5: IV 2SLS Results: Weighted by log(Population). Dependent Variable: Gini Coefficient Net-income Based (1). Estimates Adjusted for Possible Endogeneity of Tax Indicators

			ARP				
Variables	TopRate	ARP	Top	Middle	Bottom	MRP	TaxRev
Taxindicator	-0.287 **	-1.171 ***	-3.695**	-0.673***	0.511**	-0.497**	-0.509**
	(0.114)	(0.215)	(1.530)	(0.198)	(0.253)	(0.221)	(0.290)
Observations	274	146	256	320	197	146	155
R^2	0.54	0.56	0.44	0.48	0.49	0.51	0.49
Adjusted R^2	0.51	0.51	0.40	0.42	0.45	0.46	0.46

Table 5 reports estimates for equation (1) with each of the seven tax indicators (instrumented by its lag and ARP-middle of a neighbour) shown by the column heading. All the models pass the under-identification test (Kleibergen-Paap rk LM statistic), weak identification test (Cragg-Donald Wald F statistic), Hansen J statistic (over-identification test), and endogeneity test. All the models include control and auxiliary variables discussed in equation (1). The robust standard errors are in parentheses. $*$ significant at 10%, $**$ significant at 5% and $***$ significant at 1% significance level. The estimated coefficient of tax indicators is given by the column heading and tax indicators row.

The overall increase in the progressivity is significant in reducing income inequality. We can, therefore, infer that the penalty for increasing the progressivity at the top is minimal and is a worthy reform in developing countries. The results are consistent with our hypothesis (**H1**) that a progressive income tax alleviates income inequality in developing countries. The finding is also consistent with Duncan and Sabirianova Peter (2016), who find that an increase in average rate progression decreases the Gini coefficients, and Nantob (2016), who finds that an increase in tax

revenue decreases income inequality in developing countries.

We also examined hypothesis (**H1**) by estimating equation (2), both first quintile and fifth quintile share, using the two-stage least square IVs estimator. The estimated coefficients—weighted by the log of population, with robust standard errors reported—are reported in Table (6), where the column heading indicates the tax indicator used in the model.

Table 6: IV Two-stage Least Square Results, Weighted by Log of Population: Estimates Adjusted for Possible Endogeneity of Tax Indicators

					ARP		
Variables	TopRate	ARP	MRP	TaxRev	Bottom	Middle	Top
Panel A: Dependent Variable (First Quintile Share) (2)							
TaxIndicators	0.018**	0.369*	0.045	-0.072**	0.148***	0.539**	-0.262*
	(0.010)	(0.284)	(0.102)	(0.030)	(0.046)	(0.302)	(0.179)
Observations	156	154	204	88	204	151	125*
R^2	0.410	0.420	0.451	0.394	0.463	0.376	0.470
Adjusted R^2	0.374	0.383	0.426	0.325	0.438	0.337	0.429
Panel B: Dependent Variable (Fifth Quintile Share) (2)							
Tax Indicators	-0.006	-3.547**	-1.631**	1.179**	0.702**	-4.540***	1.985***
	(0.047)	(1.594)	(0.804)	(0.618)	(0.371)	(1.771)	(0.704)
Observations	157	155	152	101	142	152	126
R^2	0.325	0.284	0.275	0.456	0.461	0.236	0.297
Adjusted R^2	0.286	0.233	0.229	0.402	0.424	0.209	0.243

Table 6 reports estimates for equation (2) with each of the seven tax indicators (instrumented by its lag and ARP-middle of a neighbour) shown by the column heading. All the models include control variables defined in equation (1). The robust standard errors are in parentheses. $*$ significant at 10%, $**$ significant at 5% and $***$ significant at 1% significance level. The estimated coefficient of tax variables is given by the column heading and dependent tax indicators.

We predict that an increase in the tax indicators increases the share of income going to the first quintile and decreases the share going to fifth quintile, ceteris paribus.

In the quintile equation (2), the centred R-square measure of goodness of fit in the seven models ranges from 38% to 44% for the first quintile equations, and from 24% to 42% for the fifth quintile share, which implies that the variation in the dependent variables explained by the explanatory variables is fairly substantial. All the 2SLS IV models in Table 6 pass the under-identification test (Kleibergen-Paap LM statistic), weak identification test (Cragg-Donald Wald F statistic), Hansen J statistic (over-identification test), and the endogeneity test as discussed in the literature cited above.

In Table (6), panel A, the top PIT rate, ARP-all, and ARP-mid, have the expected signs, while the tax revenue and ARP-top do not. In panel B, the top PIT rate, ARP-all, MRP-all, and ARP-middle have the predicted signs, while the tax revenue, ARP-bottom, and ARP-top do not. For instance, a one-unit increase in either ARP-all (significant at 10% level) or ARP middle (significant at % level) increases the share of income going to the first quintile by $0.37-0.54$ percentage points. A similar increase in ARP-all (significant at 5% level) or ARP-middle (also significant at the 1% level) in panel B, however, decreases the share of income going to the fifth quintile by $3.55-4.54$ percentage points.

What is striking is that a 1% increase in the tax revenue decreases the share of income going to the first quintile by 0.08 percentage points and increases the share of income going to the fifth quintile by 1.18 points. This result is true under the assumption that the prevalence of tax evasion or tax avoidance in developing countries makes it expensive to reduce income inequality by increasing the tax revenue through higher tax rates, even in the possible presence of high transfers. The high-income individuals, for instance, are more likely to not report their total income or to devise ways to avoid paying taxes altogether when the tax rate increases.

However, the overall findings in equation (2) are generally consistent with those obtained in equation (1), using the Gini coefficient as a dependent variable. This implies that projects that are directed at alleviating income inequality also generally increase the share of income going to the poorest 20% of the population.

To test hypothesis (**H2**) that there is a negative relationship between a progressive income tax and economic growth, we estimate the equation (3) using the DPD one-step system GMM with each of the seven tax indicators (instrumented by the up to four-year lag of specific tax indicator, and the ARP-midn discussed above). Table 7, panel A presents the estimated coefficients of the measure of tax progressivity only. The estimated coefficients of the vector of control variables specified in equation(3) are omitted. The Wald test statistic—which tests the hypothesis that the estimated coefficients are jointly equal to zero—in all seven models is significantly different from zero at the 1% level. All the models pass the Sargan test of over-identification, difference in difference test of exogeneity, and Arellano−Bond test for AR(1) and AR(2) as discussed in (Davidson and Mackinnon (1993, 313−338). Also see Baum, Schaffer and Stillman (2007), Schaffer (2010), and Roodman (2009)

We expect a priori the estimated coefficients of the tax indicators to be negative. In panel A, the tax revenue, ARP-all, MRP-all, ARP-bottom, and ARP-top have the predicted signs, while the top PIT rate and ARP-middle do not have the expected signs. For instance, a one-unit increase in ARP-all, which is significantly different from zero at the 1% level, reduces the per capita GDP growth rate by 1.34 percentage points, whereas a similar increase in ARP-middle (significantly different from zero at the 1% level) increases the growth rate by 0.3 percentage points. Moreover, a 1 percent increase in the top PIT rate, which is also significantly different from zero at the 5% level, increases economic growth by 0.17 points.

The first finding is consistent with Padovano and Galli (2001), Dackehag and Hansson (2012), Widmalm (2001), and Macek (2014), who find a negative relationship between taxation and economic growth. Padovano and Galli (2001), for example,

argue that high marginal tax rates and tax progressivity are negatively correlated with long-term economic growth.

Table 7: DPD One Step System GMM Results, Weighted by Log of Population: Estimates Adjusted for Possible Endogeneity of Tax Indicators

					ARP		
Variables	TopRate	ARP	MRP	TaxRev	Bottom	Middle	Top
Panel B: Dependent Variable (Per Capita GDP Growth) (3)							
Taxindicator	0.173**	-1.338***	-0.169	-0.013***	-0.380*	0.298***	-0.331
	(0.075)	(0.419)	(0.199)	(0.003)	(0.236)	(0.100)	(0.366)
Observations	437	414	306	194	306	175	175
Wald Statistic	102***	78***	680***	3555***	351***	132***	44***
Panel B: Dependent Variable (Poverty Head Count($3.10)) (4)							
Tax indicator	0.515**	-3.359**	-1.690**	-1.135	2.247*	4.758***	3.687***
	(0.278)	(1.958)	(0.863)	(0.985)	(1.367)	(1.691)	(1.425)
Observations	126	108	108	80	121	121	121
Wald Statistic	442***	1287***	802***	182***	307***	917***	1779***

Table 7 reports estimates (weighted by the log of population) for equations (3) and (4, with each of the seven tax indicators (instrumented by its lag and ARP-middle of a neighbour). All the models include control variables defined in equation (3), but their results are omitted. The robust standard errors are in parentheses. $*$ significant at 10%, $**$ significant at 5% and $***$ significant at 1% significance level. The estimated coefficients of tax indicators is given by the column heading and tax indicator.

The second finding, that an increase in the top rate and ARP-middle increases economic growth, is consistent with Nantob (2014) and Ogbonna and Ebimobowei (2012), who find the increased level of taxation in developing countries to improve economic efficiency. While there are tax variables with positive estimated coefficients (top PIT rate and ARP-middle), the general conclusion concurs with our

hypothesis (**H2**) and general argument in the literature, that there is a negative correlation between taxation and economic growth. This negative correlation is possibly due to the disincentive to work that high tax rates may cause.

To examine hypothesis (**H3**) that a progressive income tax is welfare improving (alleviating poverty), we estimate equation (4) using the DPD one-step system GMM with each of the seven tax indicators (instrumented by a lag of tax indicator, and the ARP-midn discussed above).[27] Table 7, panel B presents the estimated coefficients of the measure of tax progressivity. The Wald test statistic in all seven models is significantly different from zero at the 1% level. All the models pass the test specified above. We predict that the variables that decrease the Gini coefficient will also decrease the percentage of the population that live on less than $ 3.10 a day.

Panel B of Table 7 shows that the estimated coefficients of ARP-all, MRP-all, and tax revenue have the predicted signs while the rest do not. A one-unit increase in an ARP-all or MRP-all (both significantly different from zero at the 5% level), for instance, decreases the poverty head count ratio ($3.10) by 1.7−3.4 percentage points and improves the welfare of the poor in developing economies, while a similar increase in the ARP-middle or ARP-top (both significantly different from zero at the 1% level) increases the poverty head count ratio by 3.7−4.8 points. The effect of top PIT rate, ARP-middle, and ARP-top on the poverty rate is consistent with the observation in (**H1**), which infers that the prevalence of tax evasion or tax avoidance diminishes the impact of higher tax rates on the welfare of the poor. While these findings are not entirely equivalent to those in (**H1**), they highlight a common observation in the literature that income inequality and poverty rate are two different concepts; income inequality, for example, might increase even if the poverty rate is declining.

[27] We choose to use the DPD system GMM estimator in estimating equation (3) and (4) instead of 2SLS IV because the dependent variables, especially the poverty head count ratio($3.10), are sparse in the period of study.

6.2 Possible Effects of Democratic Institutions and Governance Indicators

6.2.1 Effects of Democratic Institutions

It is often argued that countries with greater access to political rights and civil liberties (pro poor redistribution indicators) have a higher chance of reducing income inequality when they raise the tax rates at the top of the income distribution. To test this claim, we modified equation (1) to include the interaction term between the tax indicators and democratic institutional variables—political rights and civil liberties, both obtained from the Freedom House—as shown in equation (5) of section 4 above. Political rights and civil liberties are measured on a one-to-seven scale, with one representing the highest degree of freedom or the freest society. We expect the estimated coefficients of the interaction term to be positive in the model where the estimated coefficients of tax indicators are negative. This would imply that the effect of tax indicators is significant in the presence of higher pro poor redistribution indicators (small value in a one-to-seven scale).

The estimated coefficients of equation (5), obtained using the 2SLS IVs, are presented in Table 8. All the models pass the IVs tests discussed in Table 5 results The centered R-square for both models, in panels A and B, shows that the variation in the dependent variables explained by the explanatory variables is fairly substantial. A one-unit increase in civil liberties (that is, a one-unit decrease in the one-to-seven scale) decreases the Gini coefficient by $0.88-4.29$ percentage points from the linear term. The estimated coefficient of the interaction, civil liberties$*$ARP-all, civil liberties$*$MRP-all, and civil liberties$*$tax revenue have positive coefficients, which implies that the higher tax rates are more effective in countries that have higher civil liberties.

Table 8: Interaction of Tax Indicators with Democratic Institutions Indicators. Dependent Variable: Gini Coefficient (Net Income Based), Weighted by Log(pop)

					ARP		
Variables	TopRate	ARP	MRP	TaxRev	Bottom	Middle	Top
Panel A: Civil Liberties (5)							
TaxIndicators	0.215*	-3.077***	-1.008***	-1.033**	5.294***	-3.454*	1.366**
	(0.129)	(0.906)	(0.324)	(0.5217)	(0.888)	(2.527)	(0.705)
CivilLiberty*R	-0.059*	0.4077**	0.143**	0.259**	-1.535***	0.648	-0.405**
	(0.034)	(0.195)	(0.075)	(0.130)	(0.250)	(0.559)	(0.172)
CivilLiberties	2.095	-0.376	-0.655	-4.287**	2.379***	-0.879*	0.876
	(1.332)	(0.488)	(0.528)	(2.157)	(0.640)	(0.540)	(0.593)
Observations	352	146	146	172	197	320	243
R^2	0.41	0.57	0.52	0.18	0.62	0.43	0.48
Panel B: Political Rights (5)							
TaxIndicators	0.136**	-2.515***	-0.901***	0.146	2.625***	-0.111	1.326***
	(0.080)	(0.743)	(0.244)	(0.119)	(0.488)	(0.696)	(0.459)
PolRights*R	-0.032*	0.284 **	0.127**	-0.076	-0.852***	-0.132	-0.395***
	(0.020)	(0.156)	(0.052)	(0.059)	(0.125)	(0.152)	(0.112)
PolRights	0.783	-0.486	-0.816**	0.622	1.284***	-0.017	0.879 **
	(0.798)	(0.322)	(0.334)	(1.075)	(0.377)	0.306	(0.415)
Observations	352	146	146	224	197	243	243
R^2	0.40	0.57	0.53	0.41	0.61	0.46	0.49

Table 8 reports estimated coefficients for equation (6). IVs are lag of tax indicators, lag of interaction terms, and ARP-midn. The robust standard errors are in parentheses. $*$ significant at 10%, $**$ significant at 5% and $***$ significant at 1% significance level. The coefficient of tax indicator is given by the column heading and taxindicators row. The interaction term is given by variable*R and the column heading.

In panel B of the same table, a one-unit increase in political rights (that is, a one-unit decrease along the one-to-seven scale) decreases the Gini coefficient by 0.49−0.82 percentage points from the linear term. Furthermore, the interaction terms (political rights∗ARP-all and political rights∗MRP-all) are positive, which implies that higher measures of tax progressivity are more effective in the presence of higher political rights. However, the negative estimated coefficients of the interaction term (ARP-bottom∗political rights and ARP-top∗political rights, among others) imply that an increase in the tax indicators is ineffective in the presence of higher political rights. These findings are consistent with the median voter theory, which argues that when the median voter has lower income than the mean, the voter will vote for tax structure that favours the redistribution of income (Borge and Ratto 2004 and Meltzer and Richard 1981). In developing countries, a high percentage of the population has an income lower than the mean and hence would advocate and vote into office those with a redistribution agenda if there are greater access to civil liberties or political rights.

6.2.2 Effects of Governance Indicators

Moreover, in the literature (Gentry and Hubbard 2004; Slemrod and Yitszhaki 2002, 1428; Slemrod 2017; Besley and Persson 2013), it is argued that the prevalence of tax avoidance or tax evasion attenuates the effort of a progressive income tax on alleviating income inequality in developing countries. We investigate this claim by modifying equation (1) in section 4 above to include the interaction between the rule of law (law-and-order) and the control of corruption (obtained from the International Country Risk Guide) as proxies for tax evasion or tax avoidance indicators. Both law and order and control of corruption are measured on a zero-to-six scale, with zero being the worst law and order or control of corruption. We expect the estimated coefficients of the tax indicators to be more negative in countries that have high law

Table 9: Interaction of Tax Indicators with Governance Indicators. Dependent Variable: Gini (Coefficient Net-income Based), Weighted by Log(pop).

					ARP		
Variables	TopRate	ARP	MRP	TaxRev	Bottom	Middle	Top
Panel A: Law and Order (6)							
TaxIndicators	-.470***	-2.202***	-0.573**	-0.070	-0.619	-2.721***	-1.248*
	(.1497)	(.594)	(0.274)	(0.074)	(0.948)	(0.989)	(0.766)
LawOrder*R	.156***	0.408**	0.098	0.050	0.347	0.628**	0.322
	(.0462)	(0.195)	(0.112)	(0.068)	(0.332)	(0.290)	(0.232)
LawOrder	-7.354***	-1.263***	-1.304***	-2.119*	-1.367*	-1.626***	-2.098***
	(1.738)	(0.435)	(0.462)	(1.214)	(0.733)	(0.412)	(0.692)
Observations	271	146	146	172	197	320	243
R^2	0.44	0.58	0.54	0.41	0.50	0.48	0.46
Panel B: Control Of Corruption (6)							
TaxIndicators	-0.330***	-1.566***	-0.284	1.145**	-2.317***	-1.233*	-1.640**
	(0.116)	(0.609)	(0.280)	(0.540)	(0.782)	(0.908)	(0.831)
Corruption*R	0.109***	0.163	-0.028	-0.387**	0.974***	0.156	0.467*
	(0.035)	(0.195)	(0.122)	(0.181)	(0.257)	(0.258)	(0.264)
Corruption	-5.154***	-1.160**	-1.194**	4.298*	-2.493**	-1.198**	-2.172***
	(1.146)	(0.517)	(0.562)	(2.552)	(0.726)	(0.546)	(0.736)
Observations	271	146	146	172	197	243	243
R^2	0.42	0.58	0.53	0.33	0.53	0.47	0.45

Table 9 reports estimated coefficients for equation (6). IVs are lag of tax indicators, lag of interaction terms, and ARP-middle of country's neighbour. The robust standard errors are in parentheses. $*$ significant at 10%, $**$ significant at 5% and $***$ significant at 1% significance level. The estimated coefficient of tax indicators is given by the column heading and tax indicators. The interaction term is given by variable*R and the column heading.

and order and high control of corruption. Also, we expect a priori the interaction terms to be positive.

The estimated coefficients of equation (6), obtained using the 2SLS IV, are presented in Table 9, panel A for the law and order variable, and panel B for the corruption variable. All the models pass the IVs tests discussed in Table 5 results. The centred R-squares in both models range from 33% to 58%, which implies the variation in the Gini coefficient explained by the explanatory variables is fairly substantial. A one-unit improvement in the law-and-order indicator—that is, an increase in a zero-to-six scale (zero being the worst case of law-and-order)—decreases the Gini coefficient by at least 1.3 points (from the linear term), in all the models in panel A. Moreover, the estimated coefficients of the interaction terms (for example, law-and-order∗top PIT rate, law-and-order∗ARP-all, and ARP-middle∗law-and-order, all significantly different from zero at the 5% level) are positive, which implies that high tax rates are more effective in the presence of good law and order, and the converse is also true.

Moreover, a one-unit improvement in the control of corruption variable—that is, a one-unit increase on a zero-to-six scale (zero being the worst control of corruption)—decreases the Gini coefficient by 5.15 percentage points (from the linear term) in the model with the top PIT rate and its interaction. The positive estimated coefficients of interaction terms (for instance, corruption∗top PIT rate, corruption∗ARP-all, and ARP-top∗corruption) imply that an increase in tax rates is effective in the presence of low corruption. The converse is also true: a high tax rate is ineffective in the presence of worse corruption. These findings are consistent with Gupta, Davoodi and Alonso-Terme (2002), in addition to the literature cited above. Gupta, Davoodi and Alonso-Terme (2002) show that a high corruption level increases income inequality.

7 Conclusion

In this paper, we use panel data of thirty-two developing countries to estimate the effect of a progressive income tax on income inequality. We examine the first hypothesis (**H1**) that a progressive income tax reduces income inequality in developing countries. Using the country-level Gini coefficient, seven tax indicators, and a vector of control variables, we find that, while an overall increase in progressivity is significant in generally reducing income inequality, the penalty for increasing the progressivity at the top is minimal and is, therefore, a worthy undertaking in developing countries. Furthermore, we test (**H1**) using quintile shares and find that an increase in the measures of tax progressivity generally increases the share of income going to the first quintile and decreases the share of income going to the fifth quintile.

In addition, we test a second hypothesis (**H2**) that there is a negative relationship between a progressive income tax and economic growth. Using per capita GDP growth, seven tax variables and other control variables, we find that, while the estimated coefficients of the top personal income tax rate and ARP-middle are positively correlated with the GDP growth, the general conclusion is that there is a negative correlation between economic growth and the measures of tax progressivity.

We also investigate hypothesis (**H3**) that a progressive income tax is welfare improving (alleviating poverty). Using a poverty head count ratio ($3.10) and each of the seven tax variables with control variables, we find that an increase in overall average rate progression and overall marginal rate progression generally decreases the percentage of the population that live on less than $3.10 a day, while a similar increase in ARP-middle and ARP-top increases the poverty head count ratio. This finding highlights a common observation in the literature that income inequality and poverty rate are two different concepts; income inequality, for example, might increase even if the poverty rate is declining. The increase in the poverty rate following an increase in the tax rate could also be due to the disincentive to work that high tax rates may likely cause.

We also examine the effects of the interaction of democratic institutions—political rights and civil liberties—and tax indicators and find that more-free societies generally have a higher chance of alleviating income inequality when they increase their tax rates. We also estimate the effect of the interaction of governance variables—law and order and control of corruption—and tax indicators and find that countries with better law and order and lower corruption (high control of corruption index and high law and order index on a zero-to-six scale) are generally more likely to reduce income inequality when they raise their tax rates than those with worse law and order or control of corruption. What is striking is that increases in the tax indicators is more significant in reducing an income inequality in the presence of good governance variables than greater access to democratic institutions.

Like many studies that use macro-data, we acknowledge the limitations such data might have on the conclusions arrived at in this study. Different or improved results might be attained when the quality of data used here is improved.

References

Andrew Young School of Policy Studies. Andrew Young School World tax indicators. Atlanta, GA: International studies program, 2010 `http://aysps.gsu.edu/isp/wti.html` accessed: June, 4, 2017.

Andrienko, Y., P. Apps, and R. Rees. 2016. "Optimal taxation and top incomes". *International Tax and Public Finance* 23 (6): 981-1003.

Auerbach, Alan J. and James R. Hines. 2002. "Taxation and economic efficiency" In the *Handbook of Public Economics*, Volume 3, 347-1421, ISSN 1573-4420, doi.org/10.1016/S1573-4420(02)80025-8.

Baum, C.F, M.E Schaffer, and S. Stillman. 2007. "Enhanced routines for instrumental variables/generalized method of moments estimation and testing." *Stata Journal* 7 (4): 465-506.

Berens, Sarah, and Armin von Schiller. 2016. "Taxing higher incomes: What makes the high-income earners consent to more progressive taxation in Latin America?" *Political Behavior.* p.1-27, 1573-6687, 10.1007/s11109-016-9376-2

Besley, Timothy and Torsten Persson. 2013. "Taxation and development" In: Alan J. Auerbach, Raj Chetty, Martin Feldstein and Emmanuel Saez, Editor(s), *Handbook of Public Economics*, Elsevier, 2013, Volume 5, 51-110, ISSN 1573-4420. doi.org/10.1016/B978-0-444-53759-1.00002-9.

Borge, Lars-Erik and Jrn Ratts. 2004."Income distribution and tax structure: Empirical test of the Meltzer−Richard hypothesis." *European Economic Review*, Volume 48, Issue 4, 805-826. doi.org/10.1016/j.euroecorev.2003.09.003.

Corneo, Giacomo. 2002. "The efficient side of progressive income taxation." *European Economic Review* 46 (7): 1359-68.

Creedy, John. 2001. *Taxation and economic behaviour.* Northampton, MA; Cheltenham, UK; Edward Elgar.

Dackehag, Margareta, and Asa Hansson. 2012. "Taxation of income and economic growth: An empirical analysis of 25 rich OECD countries." Lund: Dep. of Economics, Lund University.

Davidson, Russell, and James G. MacKinnon. 1993. *Estimation and inference in econometrics.* New York, NY: Oxford Univ. Press.

Diamond, Peter A., and James A. Mirrlees. 1971a. "Optimal taxation and public production I: Production efficiency". *The American Economic Review* 61 (1): 8-27.

Diamond, Peter A., and James A. Mirrlees. 1971b. "Optimal taxation and public production II: Tax rules." *The American Economic Review* 61 (3): 261-78

Duncan, D. and K. Sabirianova Peter. 2016. "Unequal inequalities: Do progressive taxes reduce income inequality?" *International Tax and Public Finance*, 23(4), 762-783. doi: 10.1007/s10797-016-9412-5.

Gale, William G., and Andrew A. Samwick. 2017. "Effects of income tax Changes on economic Growth." In the *Economics of Tax Policy*, edited by Alan J. Auerbach, and Kent Smetters. New York: Oxford University Press, 2017. Oxford Scholarship Online. doi: 10.1093/acprof:oso/9780190619725.003.0002.

Gatzia, Dimitria E., and Douglas Woods. 2014. "Progressive taxation as a means to equality of condition and poverty alleviation." *Economics, Management and Financial Markets* 9 (4): 29.

Gentry, William M., and R. Glenn Hubbard. 2004. "The effects of progressive income taxation on job turnover." *Journal of Public Economics* 88 (11): 2301-22.

Green, David A., W. Craig Riddell and France St-Hilaire. 2016. *Income inequality: The Canadian story.* Vol. 5. Montreal, Quebec: Institute for Research on Public Policy.

Gupta, Sanjeev, Hamid Davoodi, and Rosa Alonso-Terme. 2002. "Does corruption affect income inequality and poverty?" *Economics of Governance* 3 (1): 23-45.

Ha, Eunyoung. 2012. "Globalization, government ideology, and income inequality in developing countries." *The Journal of Politics* 74 (2): 541-57.

Haughton, Jonathan and Shahidur R. Khadker. 2009. *Handbook on Poverty and Inequality.* The World Bank. Washington, DC, The World Bank. `http://openknowledge.worldbank.org/handle/10986/11985.`

Heady, Christopher, 1996. *The economics of tax policy.* ed. Devereux, M. P. Oxford; New York; Oxford University Press.

Iyer, G.S, P. Jimenez, and P.M.J Reckers. 2012. "Comparing the top and the bottom income earners: Distribution of income and taxes in the United States." *Journal of Accounting and Public Policy* 31 (2): 226-34.

Macek, Rudolf. 2014. "The impact of taxation on economic Growth: Case study of OECD countries." *Review of Economic Perspectives* 14 (4): 309-328. doi.org/10.1515/revecp-2015-0002

Meltzer, Allan H., and Scott F. Richard. 1981. "A rational theory of the size of government." *Journal of Political Economy* 89, no. 5: 914-27. `http://www.jstor.org/stable/1830813`.

Mirrlees, James A. 1971. "An exploration of the theory of optimum income taxation." *Review of Economic Studies* 38 (114): 175-208.

Musgrave, R. A. and Tun Thin.1948. "Income tax progression", 1929-48, *Journal of Political Economy*, 56, issue, `http://EconPapers.repec.org/RePEc:ucp:jpolec:v:56:y:1948:p:498`.

Nantob, N'Yilimon. 2016. "Taxation and income inequality in developing countries: An empirical investigation." *Economics Bulletin* 36 (3): 1508-22.

Nantob, N'Yilimon. 2014."Taxation and economic growth: An empirical analysis on Dynamic Panel Data of WAEMU" MPRA Paper 61370, University Library of Munich, Germany, revised 30 Jan 2015. `https://ideas.repec.org/p/pra/mprapa/61370.html`.

Ogbonna, G.N., and Appah Ebimobowei. 2012. "Impact of tax reforms and economic growth of Nigeria: A time series analysis." *Current Research Journal of Social Sciences* 4, no.1 (2012): 62-68.

Padovano, F. and E. Galli. 2001. "Tax rates and economic growth in the OECD countries." *Economic Inquiry* 39 (1): 44-57.

Piketty, Thomas and Nancy Qian. 2009. "Income inequality and progressive income taxation in China and India, 1986-2015." *American Economic Journal: Applied Economics*, 1(2): 53-63.

Piketty, Thomas and Emmanuel Saez. 2013."Optimal labor income taxation", *Handbook of Public Economics*, Volume 5, 391-474, ISSN 1573-4420. doi.org/10.1016/B978-0-444-53759-1.00007-8.

Ramsey, F.P. 1927 "A contribution to the theory of taxation," *Economic Journal*, vol. 37(145), pp. 47-61.

Roodman, D. 2009. "How to do xtabond2: An introduction to difference and system GMM in Stata." *Stata Journal* 9 (1): 86-136.

Rosen, Harvey S., Jean-Francois Wen, and Tracy Snoddon. 2012. *Public finance in Canada*. 4th Canadian ed. Toronto: McGraw-Hill Ryerson.

Schaffer, M.E. 2010. "xtivreg2: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel datamodels". `http://ideas.repec.org/c/boc/bocode/s456501.html`

Shome, Parthasarathi, and International Monetary Fund bureau of language services. 1995. *Tax Policy Handbook.* Washington, D.C: IMF.

Slemrod, Joel. 2017. "Tax compliance and enforcement: An overview of new research and its policy implications." In the *Economics of Tax Policy*, edited by Alan J. Auerbach, and Kent Smetters.

New York: Oxford University Press. Oxford Scholarship Online. doi: 10.1093/acprof:oso/9780190619725.003.0006.

Slemrod, joel and Shlomo Yitzhaki. 2002. "Tax avoidance, evasion, and administration" In the *Handbook of Public Economics*,Elsevier, Volume 3,1423-1470, ISSN 1573-4420, doi.org/10.1016/S1573-4420 (02)80026-X.

Solt, Frederick. 2016. "The Standardized World Income Inequality Database (SWIID)." *Social Science Quarterly* 97. SWIID Version 5.1.

Stiglitz, Joseph E and Rosengard, Jay K. 2015. *Economics of the public sector* (Fourth edition). New York W. W. Norton and Company, Inc.

Stiglitz, Joseph E. 1988. "Pareto efficient and optimal taxation and the new new welfare economics." w2189.

The Economist, October 13, 2012, "For richer, for poorer." 4(US). Academic OneFile (accessed June 4,2017). http://www.economist.com/node/21564414

UNU-WIDER, "World Income Inequality Database (WIID3.4)." https://www.wider.unu.edu/database/world-income-inequality-database-wiid34. https://www.wider.unu.edu/sites/default/files/Data/WIID3.4%20User%20guide.pdf.

UNU-WIDER. 2015."World Income Inequality Database (WIID3.4): The income distribution in Latin America (IDLA) Dataset". https://www.wider.unu.edu/income-distribution-latin-america-idla-dataset.

Widmalm, Frida. 2001."Tax structure and growth: Are some taxes better than others?" *Public Choice* 107, no. 3/4: 199-219. http://www.jstor.org/stable/30026199.

World Bank. "World Development Indicators". WDI Online. Washington DC: World Bank. http://data.worldbank.org/data-catalog/world-development-indicators.

Appendix

Table 10: Descriptive Statistics by separate Time Period; Weighted

Variables	1985-1889	1990-1995	1996-2000	2001-2005
Panel A: Measures of Tax Progressivity				
Tax Revenue	26.86	21.99	11.91	10.47
	(58.70)	(43.94)	5.69	(3.71)
	[69]	[128]	[110]	[113]
Top PIT Rate	47.36	42.62	37.42	36.09
	(7.68)	(7.86)	(7.79)	(7.36)
	[158]	[192]	[158]	[157]
ARP-all	0.22	0.28	0.25	0.27
	(1.17)	(1.15)	(1.01)	(0.97)
	[143]	[185]	[150]	[151]
ARP-mid	0.22	0.26	0.23	0.25
	(1.16)	(1.08)	(0.98)	0.88
	[143]	[185]	[150]	[151]
MRP-all	0.27	0.39	0.35	0.42
	(1.85)	(1.76)	1.54	(1.58)
	[143]	[185]	[150]	[151]
ARP-bottom	1.12	0.95	0.93	1.26
	(2.26)	(2.02)	(1.74)	1.57
	[143]	[185]	[150]	[151]
ARP-top	1.01	1.30	1.95	2.58
	(2.02)	(1.99)	(1.58)	(1.35)
	[143]	[185]	[150]	[151]

Table 10: Descriptive Statistics by separate Time Period; Weighted

Variables	1985-1889	1990-1995	1996-2000	2001-2005
Panel B: Gini Indexes and other Dependent Variables				
Gini (All)	(35.27)	37.52	38.64	44.03
	(8.57)	(7.85)	(8.63)	6.87
	[118]	[190]	[160]	[159]
Gini (net-income)	36.26	40.76	41.00	45.06
	(9.93)	8.20	(9.01)	(6.13)
	[90]	[155]	[136]	[140]
Gini (consumption)	33.19	32.78	34.21	33.90
	(3.91)	(3.99)	(5.31)	(5.31)
	[28]	[35]	[24]	[19]
Percapitagdpgrowth	4.46	5.14	4.21	5.64
	(4.77)	(4.82)	(3.84)	(4.23)
	[160]	[192]	[160]	[160]
Poverty ($3.10)	65.56	66.40	54.89	48.34
	(27.44)	(27.28)	24.06	(20.13)
	[41]	[60]	[68]	[78]

Table 4 report summary statistics for the mean, standard deviation (in parentheses), and the number of observations (in square bracket) of the dependent variables and the measures of tax progressivity by periods. The statistics are weighted by population.