Panel Data Analysis on Income Tax Progressivity and Gini Coefficient

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The research explores personal income tax progressivity as a mechanism to reduce income inequality. In the personal income tax progressivity model with data from 1988-2005, the unbalanced panel has up to 103 countries with 1,528 observations. The unbalanced panel uses Driscoll and Kraay standard errors to adjust for nonparametric heteroscedasticity autocorrelation. The researchers test the top, marginal, and average personal income tax rate progressivity. In the full panel, the top, marginal and average rate of personal income tax progressivity are all statistically significant. The models also explore differences in results based on income level. Key findings include the average rate of personal income tax progressivity is statistically significant in the more panels than the marginal rate of income tax progressivity or the top marginal rate. Both the net and market Gini coefficients tend to have similar statistical significance results which may suggest equality promoting policies may cause structural changes in the economy that lead to higher pre-tax incomes for lower-income individuals.

Keywords: income inequality, Gini coefficient, marginal income tax, income tax progressivity, top marginal income tax

INTRODUCTION

Global income inequality has been increasing since the early 1980s (United Nations, 2020). The reduction of income inequality is a sustainable development goal. High income inequality can have negative effects. It can lead to individuals disengaging from society (Karklins, 2005). The disengagement can lead to a loss of Gross Domestic Product since a country's labor assets are not utilized or not utilized to their highest value use. There is a lack of consensus, and mixed findings, on many determinants of income inequality (Sahota, 1978; Sturm & De Haan, 2015; Furceri & Ostry, 2019). Innate abilities, property rights, and market structures affect distribution of income (Acemoglu et al, 2013). Structural and institutional determinants, such as neoliberal government policies, as well as marginal and average tax rates, affect income inequality (Brown & Picket, 2017). Marginal and average tax rates, decided by governments, are institutional determinants. The study explores the personal income tax progressivity's effect on the net and market Gini coefficients, which are the dependent variable. The net Gini coefficient measures income inequality post-tax and post-transfer while the market Gini measure income inequality pre-tax and pre-transfer.

The study examines tax progressivity effect on the Gini coefficient from 1988-2005 and uses an unbalanced panel of 103 countries. The tax progressivity data is from the Andrew Young School World Tax Indicators (2010). The data set was originally assembled for research on global tax reform (Peters & Buttrick, 2009). The data set does not continue beyond 2005. The determinants of focus are the personal income tax rate marginal rate of progressivity, the average rate of progressivity, and the highest marginal income tax rate. The study examines the personal income tax variables and their relationship with income inequality through a full panel as well as panels based on income level. The econometric model includes variables to account for economic development, institutional quality, demographics, structure of the economy, education, and macroeconomic conditions. The study tests both the net Gini (post-tax and post-transfers) and the market Gini (before tax and transfer).

The study begins with a review of the relationship between tax progressivity and income inequality. The design of the panel data analysis is in the methods section. The findings, discussion, and conclusion sections offer insight into the results and reflect on the study's contributions and limitations.

INCOME TAX PROGRESSIVITY

Unlike some determinants of income inequality, e.g. ethnic fractionalization, the tax system is discretionary and changeable relatively quickly. Governments can consider and change the tax system which can affect income distribution (Poterba, 2007). The level of tax progressiveness can influence income distribution. In progressive tax systems, higher-income earners will earn a higher share of income, pay a higher share of income tax, and pay a higher proportion of their income as taxes as their income rises. The expectation is personal income tax is skewed towards higher-income earners. Still, we expect an even greater skewness in the distribution of income tax as income tax progressiveness increases. Thus, the more progressive the taxes, *ceteris paribus* in a homogeneous environment, the higher the marginal tax rates on higher-income earners, leading to a decrease in income inequality (Moyes, 1988; Moyes & Shorrocks 1998; Chakravarty & Moyes, 2002). There are conditions for income distribution to improve through higher income tax progressivity on the net Gini. First, it is dependent on the extent higher personal income tax rates are redistributed to lower-income individuals. Second, if high-income earners are able to avoid the higher marginal tax rates through tax avoidance, fraud, or altering their income source, higher personal income taxes would not be skewed towards higher-income earners. In this case, income inequality might not improve or could potentially worsen. For example, capital gains taxes in the United States are taxed at a lower rate than income gained through employment. Lastly, a country's ability to control corruption and the quality of its institutions and bureaucracy influences a country's ability to obtain the increased tax revenue from higher personal income progressivity as well as redistribute them.

Some studies suggest an increase in the level of taxation progressiveness leads to lower income equality (Musgrave & Thin, 1948; Fellman, 1976; Kakwani, 1977). In the United States, the tax rates for the highest income bracket ranged from 70 percent to 13 percent between the years 1972-2014 (Tax Foundation, 2015). Tax progressiveness is strongly inversely associated with income inequality in the United States from 1972-2014 (Oishi, Kushlev, & Schimmack, 2018). A 10 percent increase in taxation's progressiveness led to a 1.2 decrease in the Gini coefficient (Oishi, Kushlev, & Schimmack, 2018). This study will examine a panel of countries based on income levels to determine if the results are consistent across incomes.

Data Sources

Data sources are chosen based on the quality, methodology, and availability. The dependent variable for the study is the Gini coefficient from the Standardized World Income Inequality Database (SWIID) (Solt, 2015). The net Gini measures income inequality post-tax and post-transfer while the market Gini measures it pre-tax and pre-transfer. The SWIID measures income inequality on a scale between 0 and 100, with higher values denoting higher income inequality. The SWIID provides the most comprehensive Gini coefficient data (Solt, 2015). The model uses unbalanced panel data from 98 to 103 countries from 1988 to 2005 (see appendix A for full list of countries in the panels).

Much research predicts higher tax progressivity improves income distribution (Musgrave & Thin, 1948; Fellman, 1976; Kakwani, 1977; Moyes, 1988; Moyes & Shorrocks 1998; Chakravarty & Moyes, 2002; Oishi, Kushlev, & Schimmack, 2018). Data on tax progressivity is open source and from the Andrew Young School World Tax Indicators (2010). See appendix B for full list of descriptive statistics on all variables used in the study. The personal income tax (PIT) dataset compiles tax rate information from over 100 distinct references from accounting firms such as Deloitte and PriceWaterhouseCoopers. The data range from 1981 to 2005 and averages 145 countries per year. The data was built and not updated after used for research on global tax reform (Peter & Buttrick, 2009). The data set includes the average rate of progression and the marginal rate of progression. The average rate of personal income tax progression measures national tax schedules' structural progressivity to average income distribution rates. The data point is the slope coefficient from regressing the average tax rate on the natural logarithm of gross income. The marginal rate of progression does the same but measures changes in marginal rates along the income distribution. The average and marginal rates progressivity measurements are taken at two points. First, ARP-all and MRP-all, where the average rate (or marginal rate) of progression up to an income level equivalent to four times the per capita income (y). Second, ARP-mid and MRP-mid, where the average rate (or marginal rate) of progression for the levels of income between y and $3y$. The tax data indicators adjust for allowances/deductions, tax credits, significant local taxes, and other main rules of tax code. They do not adjust for deductions, exemptions, and credits that depend on taxpayer specific characteristics. The top personal income tax rate is also used to test the determinant of tax progressivity.

The study includes variables to account for institutional quality, the natural log of per capita GDP, the dependency ratio, the unemployment rate, employment in industry (manufacturing) as a percentage of total employment, the human capital index, and the GDP deflator (inflation). The research provides a brief overview of data sources and theory on their relationship with income inequality. The variables are listed below; they are obtained either from the International Country Risk Guide (ICRG), World Bank, or the Penn World Tables.

The natural logarithm of per capita GDP accounts for economic development (Heston et al., 2012). Kuznet (1955) and Kaldor (1957) find higher growth rates correlate to higher income inequality at initial economic development stages. They claim individual countries face trade-offs between reducing income inequality and promoting growth during early stages of economic development. Further economic growth during the initial economic development stage increases income inequality. However, as a country develops, it reaches a point where economic growth lowers income inequality. Evidence of Kuznets' theory is mixed. Deininger and Squire (1998) find it does not hold in some Latin American countries. Palma (2011) finds Kuznets' theory fails in many low-income countries.

The research uses the human capital index, which provides a score based on average schooling years and returns to education (Feenstra, Inklaar, & Timmer, 2015). Education and improved access to education may increase the opportunity for low-income individuals to increase income. Neither education nor economic development alone guarantees a reduction in income inequality. Supply and demand factors affect wages based on the market value of skills that influence income inequality.

The study accounts for structural economic development through the type of economy, using the percentage of workforce employment in manufacturing. Structural change from agriculture to industry has been associated with improvements in income distribution for low-income households (Young, 2013).

The political system of a country affects income distribution through laws, institutions, and policies (Acemoglu et al., 2013). The evidence on the effect of political system on income inequality is mixed (Muller, 1988; Persson & Tabellini, 1994; Alesina & Rodrik, 1994; Bénabou, 2000; Bourguignon & Verdier, 2000; Verardi, 2005; Milanovic et al., 2007). The Polity IV data series is used account for effects of regime type. The polity data evaluates the level of democracy based on competitiveness, openness, political participation, and checks on executive authority. The polity indicator ranges from (-10) for strongly autocratic to (+10) for strongly democratic regimes.

The model uses the dependency ratio to account for demographic distribution of a population. The demographic distribution of a country influences age-earnings percentages thus may lead to income

inequality variations among countries (Burtless, 2009). The age dependency ratio is the percentage of the population in the working-age category.

The quality of institutions and bureaucracy affects income equality through property rights, civil liberties, and political rights (Huber, 2002). The study uses an institutional quality proxy from the ICRG. The ICRG measure of institutional strength and quality of bureaucracy is on a scale of (0) low institutional strength and bureaucracy's quality to (4) high bureaucracy quality and institutional strength. The measure is based on the extent the bureaucracy has the strength and expertise to govern and have mechanisms for recruitment and training.

Some countries have high levels of long-run unemployment because of structural unemployment. In addition, some countries can have high levels of long-run inflation (e.g. Zimbabwe) because of mismanagement of currency and money supply. Higher levels of unemployment can lead to higher income inequality since it directly affects the share of labor income (Furceri & Ostry, 2019). Inflation can affect income inequality since higher-income individuals hold more income in interest-bearing accounts than low-income groups. The result is that the low-income group's disposable income is reduced disproportionately by inflation than high-income individuals (Albanesi, 2007).

EMPIRICAL FRAMEWORK

The econometric model design (1) uses a framework from Barro (2000), and Lundberg & Squire (2003), and Dobson & Ramlogan (2009). Barro (2000) and Lundberg & Squire (2003) research both economic growth and the Gini coefficient. Their models use similar dependent and independent variables as this research. The model includes a vector set of the variables found significant and used in much income inequality research. There are many explanatory determinants of income inequality both known, unknown, and known but uncertain (mixed results). The panel data design will control for variables you cannot observe or measure (Bagwati, 2001). Given variable uncertainty, there may be variables omitted or difficult to measure. Panel data analysis can control for omitted variable problems (Bagwati, 2001). See equation (1) for the initial model design used for specification model tests.

$$Gini_{it} = \alpha + X_{it} + \varepsilon_{it} \quad and \ (i = 1, \dots n; t = 1, \dots T) \tag{1}$$

where $Gini_{it}$ is the measure of income inequality for country (*i)* and time (*t)*. X_{it} is the vector set of explanatory variables used in the model that vary across time and countries. The parameter α contains a constant and individual-specific variable that are invariant over time. ε_{it} is the error term.

The Hausman model specification test supports fixed effect. A joint test for the time indicator variables shows time fixed effect. The same test indicates a country fixed effect as well. A Wald test points to heteroscedasticity in the fixed effect regression model. The Pesaran CD test shows cross-sectional dependence in the data. The research finds the presence of autocorrelation in the panel data through the Wooldridge test. The model specification tests suggest a two-way individual effects model.

$$Gini_{it} = \alpha + X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad and \ (i = 1, \dots n; t = 1, \dots T) \tag{2}$$

In the model (2), μ_i captures unobservable individual-specific effects and λ_t captures unobservable time-specific effects.

Statistical software packages provide procedures to correct for correlations and heteroscedasticity. Hoechle (2007) built the Stata routine xtscc that uses the Driscoll and Kraay (1998) standard errors. The Driscoll & Kraay (1998) standard errors use cross-sectional averages of nonparametric standard errors with heteroscedasticity autocorrelation (HAC). The resulting Driscoll & Kraay (1998) standard error is free from heteroscedasticity, cross-sectional dependence, and autocorrelation. The Hoechle xtscc program uses Newey-West corrections to cross-sectional averages in the moment conditions while adjusting the standard error estimates to guarantee the covariance matrix estimators remain consistent and independent of the cross-sectional dimension. The xtscc model also allows for fixed effects within both the entity and time.

The xtscc program permits unbalanced panel dynamics. The study uses panel regressions with Driscoll-Kraay standard errors and fixed effect for the entity and time based on test results, the goodness of fit, and the model and program requirements. There is a maximum lag of up two years in the model. Missing data are omitted from the regressions. The researchers test for variance inflation factors and find a low mean score of 2.15 with no individual factor above 4. Unit root tests were also performed with no issues detected.

RESULTS – HIGHEST MARGINAL INCOME TAX RATE

The econometric model uses variables for institutional quality, the natural log of per capita GDP, the dependency ratio, polity, the unemployment rate, employment in industry (manufacturing) as a percentage of total employment, the human capital index, and the GDP deflator (inflation). See appendix B for descriptive statistics. Based on tests in the methods section, the base model uses fixed effects for both entity and time.

In the top marginal income tax rate model, with data from 1988-2005, the unbalanced panel has 103 countries with 1,528 observations. See Table 1. The top personal income tax rates range from 0 to 75 percent. With both the net and market Gini as the dependent variables, the top personal income tax rate is statistically significant in the full, low income, and lower middle income panels. The negative coefficients suggest higher marginal income tax rate correlates to smaller Gini coefficients in the full, low income, and lower middle income panels.

In the average rate of personal income tax model, the unbalanced panel has 99 countries with 1,392 observations. See table 2. The study tests the personal income tax rate (PIT) average rate of progressivity at the midpoint (ARP-mid) where the average rate of progression for the levels of income between y and $3y$ and (ARP-all) where the average rate of progression up to an income level equivalent to four times y (i.e., $0y$ to $4y$; where y is a country's per capita GDP). The average rate of personal income tax progressivity is statistically significant for both the net Gini and market Gini at both the "mid" and "all" points for every panel except the upper middle-income panel. The negative coefficients suggest higher average personal income tax progressivity correlate to smaller Gini coefficients in all panels except for the upper middle-income panel.

TABLE 1
TOP MARGINAL TAX RATE (GINI NET FIRST, GINI MARKET SECOND)

	Full Panel	High Income	Low Income	Lower Middle Income	Upper Middle Income
No. in Group	103	38	12	26	27
Obs.	1528	609	117	385	417
F	1515159*** 1107349***	4707*** 11547***	127814*** 91417***	3299261*** 94319***	86021*** 31754***
R^2	.278 .432	.358 .587	.600 .635	.356 .374	.478 .453
Top Marginal Tax Rate	-.013*** (.004) -.027* (.005)	.008 (.011) -.001 (.017)	-.056** (.025) -.073** (.032)	-.015*** (.005) -.022*** (.005)	-.007 (.012) -.010 (.013)
Other Explanatory Variables					
GDP Per Cap (log)	2.56*** (.684) 3.44*** (.893)	-.254 (.900) .837 (1.52)	4.69*** (.983) 6.49*** (1.12)	4.27*** (.905) 3.52*** (.680)	4.22** (1.48) 3.95 (1.42)
Polity	-.010 (.008) -.027*** (.007)	.013 (.031) -.010 (.027)	-.063 (.045) -.060 (.052)	.003 (.019) -.004 (.015)	.070** (.032) .074** (.030)
Quality of Bureaucracy	-.121** (.054) -210*** (.070)	-.355*** (.113) -.619*** (.169)	.076 (.247) -.053 (.281)	-.128 (.085) -.130 (.075)	-.050 (.098) -.168 (.117)
Dependency Ratio	.039*** (.003) .072*** (.008)	.004 (.021) .033 (.026)	-.253*** (.050) -.295*** (.052)	.107*** (.023) .077*** (.017)	.100*** (.030) .113*** (.029)
Unemployment	.098*** (.013) .121*** (.014)	.104*** (.019) .165*** (.020)	.005 (.186) .038 (.247)	.038 (.041) .065** (.026)	.051** (.023) .050* (.026)
Human Capital Index	-.580 (.588) -1.51 (.906)	1.21** (.466) .149 (.456)	9.78** (4.52) 14.29** (5.30)	1.72 (1.75) 1.11 (1.22)	-2.68 (1.86) -1.52 (2.17)
% Industry	-.107*** (.031) -.158*** (.033)	.020 (.017) .024 (.026)	-.144** (.069) -.186** (.079)	.030 (.061) .050 (.041)	-.364*** (.034) -.325*** (.035)
Inflation	.001*** (.000) .001*** (.000)	-.007 (.007) .010 (.010)	.001 (.002) .003 (.002)	.005*** (.001) .003*** (.001)	.001*** (.001) .001*** (.001)

Note: ***p<0.01, **p<0.05, *p<0.10. Dependent variable is net Gini coefficient first, market Gini coefficient second. Standard deviation in parenthesis.

TABLE 2
AVERAGE RATE OF PERSONAL INCOME TAX RATE PROGRESSIVITY (GINI NET FIRST, GINI MARKET SECOND)

	Full Panel	High Income	Low Income	Lower Middle Income	Upper Middle Income
No. in Group	99	38	10	26	25
Obs.	1392	600	91	347	354
F	18401***	257635***	443851***	7072***	29149***
	352465***	184286***	4659***	42393***	60734***
R^2	.282	.383	.792	.371	.505
	.457	.597	.792	.376	.465
ARP-mid	-5.52*** (1.76)	-14.8*** (2.76)	-5.35*** (1.24)	-4.17** (2.07)	-.4.57 (3.84)
	-7.86*** (1.98)	-14.3*** (4.29)	-8.32*** (1.90)	-4.27** (1.81)	-5.75 (4.51)
ARP-all	-6.08*** (2.05)	-13.78*** (4.42)	-8.62** (3.24)	-7.88** (3.75)	-2.82 (5.54)
	-6.89** (2.52)	-14.3*** (4.29)	-11.2** (4.66)	-6.28** (3.21)	-3.27 (6.14)
Other Explanatory Variables (For ARP-Mid)					
GDP Per Cap	2.87*** (.671)	.096 (.734)	4.84*** (1.07)	4.01*** (.858)	6.07*** (1.37)
(log)	3.89*** (.828)	1.07 (1.12)	6.88*** (1.32)	3.57*** (.750)	5.63*** (1.31)
Polity	-.014* (.008)	.025 (.038)	.016 (.024)	-.011 (.016)	.059** (.027)
	-.027*** (.009)	.003 (.030)	.027 (.030)	-.008 (.014)	.063** (.024)
Quality of	-.153** (.066)	-.303** (.111)	.720*** (.236)	-.250*** (.086)	.107 (.120)
Bureaucracy	-.223*** (.068)	-.569*** (.171)	.678** (.268)	-.224*** (.076)	-.014 (.120)
Dependency	.045*** (.006)	.017 (.025)	-.468*** (.032)	.132*** (.025)	.074*** (.024)
Ratio	.079*** (.009)	.053 (.031)	-.510*** (.036)	.103*** (.021)	.085*** (.024)
Unemployment	.115*** (.015)	.119*** (.016)	.389*** (.129)	.036 (.046)	.144*** (.045)
	.155*** (.015)	.183*** (.018)	.469*** (.155)	.080** (.030)	.134** (.047)
Human Capital	-.252 (.627)	1.73*** (.485)	7.58** (2.69)	2.77 (2.30)	-6.84** (2.38)
Index	-1.76* (.985)	.727 (1.07)	12.5*** (3.07)	1.76 (1.72)	-4.99* (2.89)
% Industry	-.045 (.041)	.061* (.033)	-.105 (.075)	.063 (.060)	-.398*** (.048)
	-.101** (.044)	.077 (.048)	-.177** (.082)	.060 (.045)	-.346*** (.041)
Inflation	.001 (.000)	-.003 (.007)	-.002 (.002)	.003** (.001)	.001 (.000)
	.001 (.000)	-.006 (.012)	-.001 (.002)	.002** (.001)	.001 (.000)

Note: ***p<0.01, **p<0.05, *p<0.10. Dependent variable is net Gini coefficient first, market Gini coefficient second. Standard deviation in parenthesis.

In the marginal personal income tax model, the unbalanced panel has 99 countries with 1,392 observations. See table 3. The study tests the personal income tax rate (PIT) marginal rate of progressivity at the midpoint (MRP-mid) where the marginal rate of progression for the levels of income between *y* and 3*y* and (MRP-all) where the marginal rate of progression up to an income level equivalent to four times *y* (i.e., 0*y* to 4*y*; where *y* is a country's per capita GDP). With the dependent variable as the net Gini, the marginal rate of personal income tax progressivity at the "mid" point is statistically significant in the full and upper middle income panels. The negative coefficients suggest higher marginal personal income tax progressivity correlates to smaller Gini coefficients in the full and upper middle income panels. With the dependent variable as the market Gini, the marginal rate of personal income tax progressivity at the "all" point is statistically significant in the full and lower middle income panels. The negative coefficients suggest higher marginal personal income tax progressivity correlates to smaller Gini coefficients in the full and lower middle income panels.

TABLE 3
MARGINAL RATE OF PERSONAL INCOME TAX RATE PROGRESSIVITY
(GINI NET FIRST, GINI MARKET SECOND)

	Full Panel	**High Income**	**Low Income**	**Lower Middle Income**	**Upper Middle Income**
No. in Group	99	38	10	26	25
Obs.	1392	600	91	347	354
F	407349***	88781***	64931***	33579***	46190***
	90337***	4588558***	376722***	109315***	7781***
R^2	.284	.360	.771	.374	.574
	.455	.589	.756	.378	.545
MRP-mid	-.038** (.017)	.010 (.013)	-.011 (.041)	-.038 (.021)	-.132*** (.033)
	-.042** (.018)	.012 (.023)	-.012 (.042)	-.037** (.016)	-.142*** (.033)
MRP-all	-2.80** (.992)	-5.55*** (1.04)	-2.28** (.982)	-2.26** (.969)	-2.04 (2.51)
	-2.88*** (.786)	-1.37 (1.96)	-3.92** (1.61)	-3.13*** (.771)	-1.96 (2.84)
Other Explanatory Variables (For MRP-Mid)					
GDP Per Cap	2.98*** (.671)	.314 (.717)	4.14*** (1.06)	3.97*** (.823)	7.08*** (.950)
(log)	4.01*** (.789)	1.49 (1.12)	5.78*** (1.26)	3.53*** (.717)	6.71*** (.884)
Polity	-.014* (.007)	.015 (.036)	-.009 (.023)	-.006 (.015)	.061** (.025)
	-.027*** (.007)	-.007 (.027)	-.012 (.029)	-.003 (.014)	.066*** (.022)
Quality of	-.161** (.067)	-.363*** (.119)	.768*** (.180)	-.245*** (.083)	.132 (.132)
Bureaucracy	-.238*** (.069)	-.654*** (.176)	.755*** (.209)	-.220*** (.074)	.077 (.125)
Dependency	.044*** (.005)	.023 (.025)	-.495*** (.041)	.126*** (.024)	.042** (.019)
Ratio	.078*** (.008)	.059* (.032)	-.554*** (.053)	.097*** (.018)	.051** (.021)
Unemployment	.112*** (.014)	.122*** (.016)	.429*** (.131)	.029 (.042)	.144*** (.031)
	.151*** (.014)	.186*** (.018)	.526*** (.162)	.072** (.027)	.133** (.029)
Human Capital	-.148 (.478)	1.73*** (.490)	7.97*** (2.46)	2.98 (2.31)	-7.36*** (1.80)
Index	-1.61* (.839)	.722 (.900)	13.2*** (2.84)	1.98 (1.74)	-5.51** (2.24)
% Industry	-.047 (.036)	.060* (.033)	-.061 (.051)	.070 (.058)	-.402*** (.041)
	-.101** (.001)	.075 (.050)	-.107* (.054)	.066 (.044)	-.351*** (.032)
Inflation	.001 (.000)	-.003 (.008)	-.002 (.002)	.004** (.002)	.001 (.000)
	.001 (.000)	-.006 (.013)	-.001 (.002)	.003** (.001)	.001 (.000)

Note: ***p<0.01, **p<0.05, *p<0.10. Dependent variable is net Gini coefficient first, market Gini coefficient second. Standard deviation in parenthesis.

DISCUSSION AND CONCLUSION

In the full panels, the study finds countries with a higher top marginal personal income tax rate, and higher levels of marginal and average rate of progressivity, correlate to smaller Gini coefficients for both the net Gini and market Gini. The research findings are consistent with the literature (Musgrave & Thin, 1948; Fellsman, 1976; Kakwani, 1977; Oshi, Kushlev, & Shimmack, 2018). The researchers note some insightful findings from the research.

One, the top marginal tax rate is not statistically significant in the higher income panels (high income and upper middle income panels). One possible explanation is the top marginal income tax rate may not extend to the overall progressivity across a larger range of incomes. The claim does not explain the difference among the different income levels. It is possible the higher-income earning individuals in the higher income countries are better able or have more mechanisms to avoid the higher marginal tax rates. Alternatively, the increased tax revenue is not distributed to lower-income earners.

Two, the average rate of progressivity is statistically significant in more panels than the marginal rate of progressivity or top marginal tax rate. As with the top marginal income tax rate in a country, the explanation may be that the progressivity of the marginal income tax rate does not extend across a larger range of incomes which is captured by the average rate of progressivity.

Three, although there are some exceptions, the net Gini and market Gini tend to have similar results for statistical significance. The outcome may suggest that equality promoting policies (higher tax progressivity) promote structural changes in the economy that lead to labor markets that promote higher pre-tax incomes (especially for lower-income individuals).

Four, in the high income panel for the marginal rate of progressivity at the "all" point, we find net Gini is statistically significant while the market Gini is not. It could be the case government redistribution of the higher marginal personal income tax leads to this outcome.

Five, in multiple cases, the result of the upper middle income panel is atypical to the results of other groups. For example, it is the only panel where the average rate of personal income tax rate progressiveness is not statistically significant. We find the quality of bureaucracy is not statistically significant in *any* of upper middle income panels while it is statistically significant in nearly all the other panels across all tax determinants. Although possible explanations include earlier claims that higher-income earning have more mechanisms to avoid the higher marginal tax rates and the increased tax revenue is not distributed to lower-income earners, additional research on this panel is warranted.

The tax system is discretionary. Furthermore, tax policy changes can be implemented relatively quickly for goals of a more equal income distribution. A country that increases its tax system progressiveness, *ceteris paribus*, should lower its Gini coefficient if the income taxes is redistributed to lower income individuals. Tax avoidance, fraud, corruption, and the inability of government bureaucracy to collect the higher tax rates would limit its effectiveness. The quality of bureaucracy is statistically significant in all the upper middle income panels in both the average and marginal rate of personal income tax rate progressivity models. In another study from the researchers, we find improvements in institutional quality correlate to lower income inequality. However, policymakers may find it may take years to improve institutional quality, thus may lead to little short-run improvements. Therefore, the tax system is a variable countries may want to consider to influence income distribution sooner. An additional policy consideration is the extent a higher tax system progressivity lowers the incentive for higher-income individuals to earn higher incomes. Also, the extent higher top income tax rates as well as marginal and average rates of progressivity incentivize tax avoidance, fraud, and corruption. If increasing a tax system's progressiveness leads to less gross domestic product or less tax revenue (Laffer curve), policy makers should consider the tradeoffs (Agell & Persson, 2001). A limitation of the dataset is missing data; the data range is from 1988 to 2005. Future research should extend data and look at additional personal income sources.

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APPENDIX A – COUNTRIES

Full Panel, N=103	High Income, N=38	Low Income, N=12	Lower Middle Income, N=26	Upper Middle Income, N=28
Albania	Australia	Burkina Faso	Angola	Albania
Algeria	Austria	Ethiopia	Bangladesh	Algeria
Angola	Belgium	Gambia	Bolivia	Argentina
Argentina	Canada	Madagascar	Cameroon	Armenia
Armenia	Chile	Malawi	Cote d'Ivoire	Botswana
Australia	Croatia	Mozambique	Egypt	Brazil
Austria	Cyprus	Niger	El Salvador	Bulgaria
Bangladesh	Czech Republic	Sierra Leone	Ghana	China
Belgium	Denmark	Tanzania	Honduras	Colombia
Bolivia	Estonia	Uganda	India	Costa Rica
Botswana	Finland	Yemen	Indonesia	Dominican Republic
Brazil	France	Zimbabwe	Kenya	Ecuador
Bulgaria	Germany		Moldova	Iran
Burkina Faso	Greece		Mongolia	Jamaica
Cameroon	Hungary		Morocco	Jordan
Canada	Ireland		Nicaragua	Kazakhstan
Chile	Israel		Nigeria	Malaysia
China	Italy		Pakistan	Mexico
Columbia	Japan		Philippines	Namibia
Costa Rica	Latvia		Senegal	Paraguay
Cote d'Ivoire	Lithuania		Sri Lanka	Peru
Croatia	Luxembourg		Sudan	Romania
Cyprus	Netherlands		Tunisia	Russia
Czech Republic	New Zealand		Ukraine	Serbia
Denmark	Norway		Vietnam	South Africa
Dominican Republic	Panama		Zambia	Thailand
Ecuador	Poland			Turkey
Egypt	Portugal			Venezuela
El Salvador	Singapore			
Estonia	Slovakia			
Ethiopia	Slovenia			
Finland	South Korea			
France	Spain			
Gambia	Sweden			
Germany	Switzerland			
Ghana	United Kingdom			

Greece Honduras Hungary India Indonesia Iran Ireland Israel Italy Jamaica Japan Jordan Kazakhstan Kenya Latvia Lithuania Luxembourg Madagascar Malawi Malaysia Mexico Moldova Mongolia Morocco Mozambique Namibia Netherlands New Zealand Nicaragua Niger Nigeria Norway Pakistan Panama Paraguay Peru Philippines Poland Portugal Romania Russia Senegal Serbia Sierra Leone Singapore Slovakia Slovenia South Africa South Korea Spain Sri Lanka Sudan Sweden Switzerland Tanzania Thailand	United States Uruguay			

Tunisia Turkey Uganda Ukraine United Kingdom United States Uruguay Venezuela Vietnam Yemen Zambia Zimbabwe				

APPENDIX B – DESCRIPTIVE STATISTICS

Variable	Description	Observations	Mean	St. Dev.	Min	Max
GiniNet	Dependent Variable – net Gini (pre-tax and transfer	1,584	38.22	9.32	19.5	66.5
GiniMkt	Dependent Variable – gross Gini (post tax and transfers)	1,584	46.26	6.53	23.6	70.4
TopTaxRate	Highest personal income tax (PIT) rate	1,584	36.96	13.06	0	75
MRP-mid	(PIT) marginal rate of progressivity at the midpoint (MRP-mid) where the marginal rate of progression for the levels of income between *y* and 3*y*	1,428	8.40	9.51	0	45.55
MRP-all	(PIT) marginal rate of progressivity at the midpoint (MRP-all) where the marginal rate of progression up to an income level equivalent to four times *y* (i.e., 0*y* to 4*y*; where *y* is a country's per capita GDP).	1,428	.05	.04	-.01	.23
ARP-mid	(PIT) average rate of progressivity at the midpoint (ARP-mid) where the average rate of progression for the levels of income between *y* and 3*y*	1,428	.06	.04	-4.23e-09	.16
ARP-all	(PIT) average rate of progressivity at the midpoint (ARP-all) where the average rate of progression up to an income level equivalent to four times *y* (i.e., 0*y* to 4*y*; where *y* is a country's per capita GDP).	1,428	.04	.03	-1.08e-09	.13
DependRatio	percentage of the population in the working-age category	1,584	63.60	17.69	32.28	109.47
Unemp	percentage of the population unemployed	1,584	8.22	5.52	.58	33.47

EmpIndPrc	percentage of workforce employment in manufacturing	1,584	22.56	8.07	2.54	45.42
InfGDPDfr	GDP Deflator	1,583	42.03	278.31	-27.05	6261.24
Polity	The polity data evaluates the level of democracy based on competitiveness, openness, political participation, and checks on executive authority. The polity indicator ranges from (-10) for strongly autocratic to (+10) for strongly democratic regimes.	1,577	5.28	5.80	-9	10
lnGDPPerCap	natural logarithm of per capita GDP	1,584	8.62	1.48	5.21	11.53
HumCapInd	average schooling years and returns to education	1,584	2.43	.66	1.05	3.63