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Abstract

This paper examines whether income inequality is affected by the structural progressivity of national income tax systems. Using detailed personal income tax schedules for a large panel of countries, we develop and estimate comprehensive, time-varying measures of structural progressivity of national income tax systems over the 1981–2005 period. We find that while progressivity reduces observed inequality in reported gross and net income, it has a significantly smaller impact on true inequality, approximated by consumption-based measures of Gini. We show theoretically and empirically that, under specific conditions, tax progressivity may increase actual inequality, especially in countries with weak law and order and a large informal nontaxable sector. The paper discusses implications of these results for increasingly popular flat tax policies. The Kuznets hypothesis is also supported by the estimates.

Keywords: income inequality, Gini, personal income tax, structural progressivity, tax evasion, redistribution, Kuznets hypothesis, democracy, law and order.

JEL Classification: H2, I3, J3, O1, O2

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1. Introduction

That personal income tax structures contain a trade-off between efficiency and equity is considered conventional wisdom in the public finance literature (Ramsey 1927 and Mirrlees 1971). It is commonly believed that efficiency is best achieved by the use of simple lump sum taxes that do not distort the choices that people make, whereas vertical equity generally requires progressive tax schedules accompanied by individual specific deductions, allowances, and credits, which are distortionary. As such, taxes that are efficient are thought to reduce equity and vice versa.

But are these two objectives always in conflict? Underlying this tradeoff is the presumption that a higher level of tax progressivity reduces income inequality. However, the presence of tax evasion undermines this commonly held view of progressivity. To the extent that tax rates and evasion are positively related, it is possible that both efficiency and equity are reduced as a result of increased progressivity. This possibility follows if progressivity has a differential effect on observed inequality in reported income vs. actual inequality in true income in the presence of tax evasion.

In this paper, we seek to determine, theoretically and empirically, the relationship between structural progressivity of personal income taxes[1] and income inequality, with a special emphasis on the differential effect of progressivity on observed vs. actual inequality. Although a lot of work has been done to assess the impact of tax reforms on equity, this is the first known attempt to differentiate between these two effects. Verification of this possible differential effect is becoming increasingly important given the number of countries that have or are considering the implementation of tax reforms with tax structures much flatter than their predecessors. Sabirianova Peter, Buttrick, and Duncan (2008) shows that personal income tax (PIT) structures

[1] The term *structural progressivity* denotes changes in the average tax rate along the income distribution.

today have fewer tax brackets, lower top statutory marginal tax rates and reduced complexity than 25 years ago. They also identify what appears to be a shift towards flat rate income taxes. By 2008, 21 countries adopted the flat rate PIT schedule and many more countries are seriously considering this policy. If progressivity and income inequality are negatively related, then there are important implications of such policies for the distribution of income. Given the tax evasion argument, however, it is not clear that shifting to flat taxes – or more generally, to income tax structures with lower levels of progressivity – will necessarily lead to greater levels of income inequality.

Another important contribution of this paper is that we use a unique dataset for a large panel of countries that contains time-varying country-specific measures of structural progressivity of national personal income tax systems over the period 1981-2005. We develop and estimate several measures of structural progressivity for over one hundred countries worldwide by using complete national income tax schedules with statutory rates, thresholds, country-specific tax formulas and other information. The measures are based on data definitions that are compatible across countries as well as over time. This dataset allows our analysis to be different than most of the previous work, which has been country-specific incidence studies that rely on micro-simulation exercises or computable general equilibrium models (Gravelle 1992 and Martinez-Vazquez 2008).

We do acknowledge that macro analysis has certain limitations as we are not able to examine within country heterogeneity in individual responses or directly estimate the tax evasion effect on income inequality. We also cannot account for the possible offsetting effects of other taxes.[2] Nevertheless, macro data provide an exceptional opportunity for examining the

[2] It is important to emphasize that we focus on the personal income tax only. As such, any equity offsets that may come from other taxes such as the corporate income tax or sales taxes are not taken into account. In principle,

relationship between structural progressivity and income inequality on a large international scale and for cross-country comparisons in testing several important hypotheses.

The key prediction of our theoretical framework is that progressivity affects observed inequality differently than it does true inequality, and that the difference between the two inequality effects is increasing with the extent of tax evasion and its responsiveness to tax changes. To test this hypothesis, we use a country-level dataset of Gini coefficients calculated separately for gross income, net income, and consumption. We argue that the consumption-based measure of income is closer to true permanent income in comparison to disposable income reported in the household surveys.[3] Our empirical analysis reveals that while progressivity reduces observed inequality in reported gross and net income, it has a significantly smaller impact on inequality in consumption. We theorize that the positive effect of progressivity on true inequality is plausible, especially in the presence of weak legal institutions that can trigger a very large tax evasion response. The evidence provides some support for our hypothesis as we show that weaker law and order produce a positive effect on inequality in consumption. As expected, we find that progressivity has a larger negative effect on net income inequality than on gross income inequality.

This paper also contributes to the testing of two additional hypotheses. One hypothesis is an inverted U-shape relationship between income inequality and growth, known as the Kuznets hypothesis. According to Kuznets (1955), this relationship is driven by changes that take place in the allocation of resources as the economy expands. Our results are consistent with this hypothesis. Another hypothesis, derived from the median voter theorem is that democracy and

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policy makers could achieve the same level of income inequality by substituting reduced progressivity of the personal income tax with increased progressivity of the corporate tax.

[3] The empirical micro literature on developing countries has long pointed out the unreliability of income measures in household budget surveys due to widespread under-reporting and called for the use of consumption-based measures of inequality (e.g., Deaton 1997, Milanovic 1999).

income inequality should be negatively related. While we do not test this hypothesis directly, we do show that progressivity tends to have a larger equalizing effect in societies that are more democratic. We argue that this reinforcing effect works via larger redistribution which is brought about by the median voter in democratic societies.

The paper proceeds as follows. Section 2 provides the theoretical framework. Following that is a description of the data in section 3, the empirical model and results in section 4 and the conclusion in section 5.

2. The Relationship between Tax Progressivity and Income Inequality

Progressive taxes are often designed to collect a greater proportion of income from the rich relative to the poor, thus reducing the inequality of disposable income relative to taxable income. However, as the government increases structural progressivity or tax rates facing the rich, individuals may respond by taking steps to reduce their taxable income. Reducing taxable income is achieved by either working less (productivity response) or simply reporting a smaller share of true income (tax evasion/avoidance response). While both behavioral responses are likely to reduce observed income inequality, they can have a differential effect on true income inequality. That is, though we expect the productivity response from more progressive taxes to reduce true inequality, the evasion response may increase true disposable income of the rich (since no taxes are paid on the hidden income) and thus increase inequality in true net income.

The existing estimates of the productivity response based on the labor supply elasticity with respect to tax changes are rather modest (Eissa and Liebman 1996 and Blundell, Duncan, and Meghir 1998). However, they may well be understated as they do not account for other forms of productivity adjustment such as response in efforts, occupational mobility, job reallocation, etc. Another common measure, the elasticity of taxable income, is not a suitable

statistic to assess the productivity response as it also blends in the tax evasion response (Chetty 2008). Recently, Gorodnichenko, Martinez-Vazquez, and Sabirianova Peter (2008; GMP) propose to use consumption data to measure the productivity response to tax changes; they find a relatively small growth in consumption of wealthier households that faced smaller tax rates after the 2001 Russian flat rate income tax reform. At the same time, they estimate a significant increase in reported income (5 to 10 times larger than the consumption increase net of windfall gains), attributing the difference to improved tax compliance of households in the upper tax brackets. It has also been argued, in earlier studies, that the evasion/avoidance effect is much stronger in the upper tail of the income distribution (Slemrod 1994 and Feldstein 1995). In other words, the rich tend to be more sensitive to changes in the tax rates because they are better able to hide their income.[4]

If the tax evasion response is indeed large, then the negative effect of higher and more progressive taxes on observed income inequality will significantly overstate (in absolute terms) their effect on the true distribution. Below we illustrate these possibilities more formally using the Kuznets ratio as a measure of inequality. We first model the effect of tax progressivity on observed income inequality and then on true income inequality.

2.1. Inequality in Observed Income

In this subsection, we outline a simple theoretical framework that demonstrates the effect of structural progressivity on observed income inequality. Suppose we have two groups of individuals: *r*=rich and *p*=poor. Let I_y^0 be observed income inequality in disposable income between rich and poor, measured as the Kuznets ratio, which is the ratio of income received by

[4] A well documented result in the tax evasion literature is that compliance is highest among individuals whose income is easily verified by tax authorities. For example, wages can be more easily verified due to withholding. It is also generally accepted that wages as a share of total income decline as income increases. In other words, the rich has less verifiable income than the poor, and consequently they have more opportunities to hide their income.

the rich relative to that received by the poor. We can write the Kuznets measure of observed inequality in disposable income as:

$$I_y^0 = \frac{y_r^o}{y_p^o + G} = \frac{Y_r^o(1-\tau_r)}{Y_p^o(1-\tau_p)+\theta(\tau_r Y_r^o)}, \quad (1)$$

where Y^o is observed gross earned income reported for tax purposes, y^0 is observed earned income net of tax, τ is the average tax rate, and G is non-taxable government transfers. For simplicity of exposition, we assume that transfers are exclusively from rich to poor, and that they comprise a fixed portion θ of revenues collected from rich. Equation (1) allows redistribution through transfers to be either pro-poor ($0<\theta<1$) or neutral ($\theta=0$). We also note that observed gross income can be written as the difference between the true income Y^* and unreported, hidden income Y^H, $Y_r^o = Y_r^* - Y_r^H$ for rich and $Y_p^o = Y_p^* - Y_p^H$ for poor.

Holding the tax rate facing the poor constant, τ_r becomes an indicator of structural tax progressivity. Changes in structural progressivity create a likely negative productivity response on the part of the rich, $\frac{\partial Y_r^*}{\partial \tau_r} < 0$. This assumption follows from the earlier discussion and is supported by numerous studies of labor supply elasticities with respect to tax changes (e.g., Kumar 2008 and references therein). Since the average tax rate facing the poor doesn't change, we assume no behavioral response for the poor.[5] If tax rates and hidden income of the rich are positively related, $\frac{\partial Y_r^H}{\partial \tau_r} > 0$,[6] then the partial derivative of I_Y^0 with respect to τ_r is unambiguously negative,

[5] In reality, a small negative productivity effect might exist for the poor because of the positive income effect from government transfers which reduces work incentives.

[6] A majority of empirical studies find evidence of a positive relationship between tax rates and tax evasion (e.g., Clotfelter 1983, Slemrod 1985, GMP 2008). Feinsten (1991) is a notable exception. Although the early expected utility theoretical models produce ambiguous results that depend on assumptions made about risk aversion and the structure of penalties (Allingham and Sandmo 1972, Yitzhaki 1974), more recently, Dhami and al-Nowaihi (2007) argue that prospect theory might be a better alternative to expected utility models and derive an unambiguous positive relationship between tax rates and tax evasion.

$$\frac{\partial I_y^0}{\partial \tau_r} = \frac{\left[y_p^o+G\right]\left[\frac{\partial Y_r^0}{\partial \tau_r}(1-\tau_r)-Y_r^o\right]-\theta Y_r^o(1-\tau_r)\left[\tau_r\frac{\partial Y_r^0}{\partial \tau_r}+Y_r^o\right]}{\left(y_p^o+G\right)^2}$$

$$= \frac{y_p^o\left[-Y_r^o+\frac{\partial Y_r^0}{\partial \tau_r}(1-\tau_r)\right]-\theta(Y_r^o)^2}{\left(y_p^o+G\right)^2}$$

$$= \underbrace{-AY_r^o}_{\substack{direct\\ effect<0}} + \underbrace{A(1-\tau_r)\frac{\partial Y_r^*}{\partial \tau_r}}_{\substack{productivity\\ effect<0}} \underbrace{-A(1-\tau_r)\frac{\partial Y_r^H}{\partial \tau_r}}_{\substack{tax\ evasion\\ effect<0}} \underbrace{-\frac{\theta(Y_r^o)^2}{\left(y_p^o+G\right)^2}}_{\substack{redistribution\\ effect<0}} < 0, \qquad (2)$$

where $A = \frac{y_p^o}{\left(y_p^o+G\right)^2}$. The first term in equation (2) shows the direct effect of tax progressivity on income inequality in the absence of behavioral responses and subsequent redistribution from rich to poor. The negative direct effect arises simply from the fact that a progressive tax structure imposes a higher tax burden on the rich.

Equation (2) hints that the response of true and observed inequality to tax changes is likely to be different. If the rich have greater access to the various means of hiding their income, they are likely to report a relatively smaller share of their income as structural progressivity increases, which will give the false impression that the distribution of income is becoming more equal. As shown below, however, the distribution of true income may not improve.

The last term in equation (2) shows the negative redistribution effect through transfers to poor. If the government succeeds in redistributing the collected revenues in a pro-poor or neutral manner, then the higher tax on the rich is likely to reduce observed income inequality, *ceteris paribus*. On the other hand, if redistribution through transfers is pro-rich, then the effect of structural progressivity on observed income inequality becomes ambiguous.

Thus, the negative direct effect of higher tax progressivity on observed income inequality is reinforced by the negative productivity response, the positive tax evasion response, and pro-

poor redistribution. Consequently, we formulate the first hypothesis that can be tested with macro data:

H1: The statistical relationship between tax progressivity and income inequality as measured by observed, reported income is likely to be negative.

It is clear from equation (2) that redistribution in the form of transfers and other social welfare programs (captured by the last term) plays an important role in determining the redistributive properties of the income tax system. The higher is θ, the more effective will be the income tax system in equalizing income levels. This implies that countries with institutional structures that facilitate redistribution through transfers, such as democratic political systems, should be more effective in reducing inequality via its personal income tax.[7] In other words, any factor that increases θ should reinforce the effect of progressivity on observed income inequality. This effect is captured by the following hypothesis, which we can test in the current framework:

H2: Factors that are positively associated with pro-poor redistribution such as democracy and civil liberties are likely to reinforce the negative effect of structural tax progressivity on observed income inequality.

2.2. Inequality in True Income

We now turn our attention to true income inequality. Using the above notations, we define true income inequality I_y^* as the ratio of actual disposable income received by the rich relative to that received by the poor:

$$I_y^* = \frac{y_r^*}{y_p^* + G} = \frac{Y_r^o(1-\tau_r) + Y_r^H}{Y_p^o(1-\tau_p) + Y_p^H + \theta\tau_r Y_r^o}. \quad (3)$$

[7]This argument relies on the median voter hypothesis which is widely cited in the political economy literature on redistribution (Persson and Tabellini 1999 and Meltzer and Richard 1981). Also see Gradstein et al (2001) and references therein for a discussion of the effect of democracy on income inequality.

We again assume that redistribution through transfers is pro-poor ($0<\theta<1$). Given that true income is the sum of reported, observed income and unreported, hidden income, i.e., $Y_r^* = Y_r^0 + Y_r^H$, we can obtain the following partial effect of structural progressivity on true income inequality, holding tax rates of poor τ_p and redistribution policy θ constant.

$$\frac{\partial I_y^*}{\partial \tau_r} = \frac{\left[\frac{\partial Y_r^0}{\partial \tau_r}(1-\tau_r) - Y_r^o + \frac{\partial Y_r^H}{\partial \tau_r}\right] - \frac{y_r^*}{y_p^* + G}\theta\left[\tau_r \frac{\partial Y_r^0}{\partial \tau_r} + Y_r^o\right]}{y_p^* + G}$$

$$= \frac{\left[\frac{\partial Y_r^*}{\partial \tau_r}\left(1-\tau_r - I_y^*\theta\tau_r\right) - \left(Y_r^* - Y_r^H\right)\left(1 + I_y^*\theta\right) + \frac{\partial Y_r^H}{\partial \tau_r}\tau_r\left(1 + I_y^*\theta\right)\right]}{y_p^* + G}$$

$$= \frac{\frac{\partial Y_r^*}{\partial \tau_r} + \left(1 + I_y^*\theta\right)[Y_r^H(1+\epsilon_{H\tau}) - Y_r^*(1+\epsilon_{*\tau})]}{y_p^* + G} \lessgtr 0, \qquad (4)$$

where $\in_{H\tau}$ and $\in_{*\tau}$ are the elasticity of hidden and true income with respect to tax changes, respectively.

Equation (4) demonstrates that the effect of tax progressivity on true income inequality is ambiguous, when $\in_{H\tau}>0$.[8] Higher taxes on the rich could increase actual income inequality if the share of hidden income among the rich is large while the elasticity of true income/productivity is small relative to the elasticity of hidden income. For example, GMP (2008) find a large positive tax compliance response but small productivity/consumption response of affluent households to Russia's 2001 flat rate personal income tax reform. Thus, in countries like Russia, inequality might possibly decline through lowering tax rates for the upper income groups.

While we do not observe true income in a typical household survey, expenditures or consumption are much closer to true permanent income than is reported income. Individuals may feel more comfortable reporting their consumption levels because there is less association between consumption levels and personal income tax liability (see Lemieux, Fortin, and Fréchette

[8] Even when $\in_{H\tau}<0$, as early theoretical models predict, but $|\in_{H\tau}|<1$, the effect of tax progressivity on true income inequality is still ambiguous.

1994 and GMP 2008 for a similar assumption). In addition, income data tend to suffer from recall bias, seasonality and other issues to a greater extent than consumption data (Deaton 1997). Although consumption data also suffer from seasonality, the ability to smooth consumption over a few months makes consumption data a much better measure of true income. According to Deaton (1997), these problems, which favor the use of consumption data, are more serious in developing countries where a large proportion of the population tends to be self-employed primarily in agriculture.

The testable implication of equation (4) is that in the presence of a positive tax evasion response, an increase in structural progressivity should lead to a more sizeable reduction in observed income inequality than in consumption inequality. Consequently, we can postulate the third testable hypothesis:

H3: The effect of structural progressivity on inequality in consumption is likely to be smaller than the effect of structural progressivity on inequality in observed net income. A positive effect on consumption inequality is also possible.

Another important implication of equation (4) is that the difference between the effect of tax changes on consumption inequality and their effect on observed income inequality is expected to increase with the extent of tax evasion. In other words, the positive effect of structural progressivity on consumption inequality is more likely to be found in countries with higher Y_r^H/Y_r^* or larger informal sector. Since the extent of tax evasion is not observable in our data, we cannot test this hypothesis directly. However, we can see whether observable factors that increase the share of the informal sector Y_r^H/Y_r^* attenuate the effect of structural progressivity on consumption inequality (or make the effect less negative or even positive). The weakness of legal institutions could be one of such factor as it is likely to be positively correlated

with the size of the informal sector. To the extent we can measure the strength of legal institutions, one may anticipate that a positive effect of structural progressivity on consumption inequality is more likely to be found in countries with weaker legal institutions. This will be our fourth testable hypothesis.

H4: The positive effect of structural progressivity on consumption inequality is more likely to be found in countries with weaker legal institutions.

3. Measuring Inequality and Structural Progressivity

3.1. Income Inequality Measure

We test the hypotheses developed in the previous section using country-level Gini coefficients obtained from the World Institute for Development Research (WIDER v.2b), the International Labor Office LABORSTA, and European Commission EUROSTAT. Altogether these sources provide us with 3512 Gini estimates from 1981 to 2005. For the purpose of our analysis, we selected all Gini coefficients that are based on one of the three income definitions: gross income, disposable (net) income, and expenditures or consumption. The selected Ginis were grouped into 3 categories of area coverage (national, urban or national with exclusions, and other), 4 categories of income adjustment (equivalence scale, per capita adjustment, no adjustment, and unknown), and 4 categories of data quality rating.[9] We then averaged multiple Gini measures by country, year, income base, area coverage, income adjustment, and quality rating. Finally, for a given country, year, and income base, we selected one average measure using the following set of preferences: national estimates are preferred to urban, rural and other

[9] The data quality rating is designed by the WIDER. It ranges from 1 to 4, where 1 denotes observations with a sufficient quality of the income concept and the survey. As to other data sources, we assigned 1 to Eurostat data and 2 to ILO estimates.

area coverage estimates, equivalence scales or per capita adjustment are chosen over no or unknown adjustment, higher quality ranking is preferred to lower quality ranking.

This selection process left us with 1683 Gini estimates for 143 countries from 1981 to 2005.[10] The majority of the estimates meet the best practices as set out by the WIDER. Appendix Table A1 shows that 93% of the Gini estimates have national coverage, 75% have been adjusted for the household size, and 71% have a good quality rating, 1 or 2. Also, the distribution across income base is suited for the type of analysis that we carry out in the paper. More specifically, of the total sample of Gini estimates, 20% are based on consumption, 34% on gross income, and 46% on net income. To control for differences in Gini measurement, our estimates include dummy variables for income base, area coverage and income adjustment categories. While we recognize that the use of dummy variables does not eliminate all of the biases resulting from comparability issues (Atkinson and Brandolini 2001), we are constrained by existing inequality estimates. This is especially restricting in cross-country panel studies due to variations in the quality of primary data sources, differences in definition of variables and other procedures followed by individual countries.

In an effort to identify the trend in income inequality over time, we regress the Gini coefficients on a quadratic time trend, controlling for income base, area coverage, income adjustment, and country classification.[11] The coefficients on the time terms are then used to plot the average Gini trend in Figure 1. The results indicate that income inequality increased throughout the 80s and 90s before declining during the 2000–2005 period. Figure 1 also reports

[10] The sample includes only countries that were independent in a corresponding year. To avoid double counting, we excluded GINIs for the parts of the former unified countries like USSR or Yugoslavia prior to their breakup.

[11] A similar, though not identical, procedure is used by Easterly (2007) to address the consistency problem inherent in the GINI data. Country categories are defined using the World Bank country classification based on historical (time-varying) income thresholds. For example, the income thresholds used for the 2005 classification are as follows: low income, $875 or less, lower middle income, $876-$3465, upper middle income, $3466-$10725, and high income, $10725 or more.

the time trend weighted by a country's GDP in constant U.S. dollars and population.[12] While the GDP–weighted trend follows that of the unweighted, the population–weighted trend shows income inequality increasing throughout the sample period, which is consistent with rising inequality in China, India, and other developing countries with large populations.

Table 1 provides additional summary statistics on the Gini coefficient by income definition across time. However, one has to be careful in interpreting these numbers because of comparability issues. In particular, the income–based and expenditure–based measures cannot be compared without a regression framework because the latter oversamples low and lower middle income countries while the former oversamples high and upper middle income countries (see Figure A1). Bearing in mind this important caveat, the table shows that the consumption–based Gini follows the unweighted trend in Figure 1; increasing from a low of 36 in the early 1980s to a high of 41 in the early 1990s before declining to a low of 35 in the last period of the sample. From Figure A1, we can conclude that this pattern of change is driven primarily by low and lower middle income countries. Based on the income measures, we observe that gross (net) income inequality increased from 37(30) in the early 1980s to 43(36) in mid 1990s before falling back to 40(31) in the last period. We also observe that gross income is most unequally distributed followed by consumption and net income. These patterns are consistent with the literature (e.g., Easterly 2007).

3.2. Tax Progressivity Measures

In contrast to income inequality, the measures of tax progressivity are not readily available for cross-country comparison. The existing measures implemented in the literature fall into one of three groups: 1) the top statutory PIT rate, 2) effective inequality-based measures of

[12] We suspect that population may be the better of the two weights since inequality is essentially an individual concept.

progressivity, and 3) structural progressivity measures. In their original form, none of these measures are perfectly suitable for our analysis.

The top statutory PIT rate is a legally determined marginal tax rate applicable to the top bracket of the income tax schedule. Although this tax rate has occasionally been used in empirical cross-country research as a proxy variable for tax progressivity, it might be a misleading indicator of progressivity since both proportional and highly progressive tax systems may, in principle, have the same top statutory rate. In reality, however, there is a high (about 0.5) correlation between the top rate and other progressivity measures that will be introduced below. For that reason, we do not discard this variable and will employ it in some specifications.[13]

The effective progressivity is based on some indicator of income inequality. In its simplest form, effective progressivity is the ratio of after-tax Gini to before-tax Gini and "measures the extent to which a given tax structure results in a shift in the distribution of income toward equality" (Musgrave and Thin 1948). More sophisticated measures have been proposed by Kakwani (1977), Suit (1977), and others. The inequality-based measures generally require information on pre- and post-tax inequality and the distribution of the tax burden. Information on these variables is either not available or not comparable across countries. The more serious problem, though, is the issue of simultaneity in determination of income inequality and inequality-based progressivity, which inhibits the identification of the direct effect of tax progressivity on inequality.

[13] As an alternative to the top statutory PIT rate, some studies employ the income-weighted average marginal tax rate (Easterly and Rebelo 1993). While this approach can capture the average marginal rate, it does not measure the PIT progressivity. This approach also imposes strong distributional assumptions on the marginal tax schedule which we are able to avoid due to the information that we have on each country's personal income tax schedule.

From this perspective, the measures of structural progressivity are more suitable for the purpose of our analysis. The term "structural progressivity" was introduced by Musgrave and Thin (1948) to denote changes in average and marginal rates along the income distribution. These changes can be identified without knowing after-tax inequality, making the endogeneity problem less severe. However, the calculations require information on gross income distribution, which is difficult to gather in a comparable way at the cross-country level. Another issue is which value to choose since structural progressivity changes along the income distribution.

Ideally we need a single, comprehensive measure of PIT progressivity, which is comparable across countries, available for a large representative sample of countries, and vary over time. We propose the following procedure to derive such a measure.

The first step in calculating structural progressivity is to obtain average and marginal tax rates at different points of the income distribution. Instead of actual income distribution, we use a country's GDP per capita and its multiples as a comparable income base. The GDP figures are rescaled to get 100 units of pre-tax income for each country and year, ranging from 4% to 400% of a country's GDP per capita. We then apply the tax schedule information to these units of income to obtain tax liability and average and marginal tax rates. The data on national tax schedules is collected for 189 countries from 1981 to 2005 and described in detail in Sabirianova Peter, Buttrick, and Duncan (2008). Here we just note that our average and marginal tax rates take into account standard deductions, basic personal allowances, tax credits, local taxes, major national surtaxes, multiple schedules, non-standard tax formulas, and other provisions in addition to statutory rates and thresholds.

The progressivity measures are obtained by regressing marginal (or average) rates on gross income using 100 data points that are formed around a country's GDP per capita in a given year. The slope coefficient on the income variable measures the percentage point change in the tax rate resulting from a one percentage point change in pre-tax income[14] and is our measure of structural progressivity. The PIT structure is interpreted as progressive, proportional or regressive if the slope coefficient is positive, zero or negative, respectively. This procedure gives us marginal rate progression (MRP1) and average rate progression (ARP1) for each country and year in our dataset. Figure 2 illustrates how the MRP1 is obtained for a hypothetical case with no allowances and other provisions.

It should be noted that structural progressivity can deviate significantly from the nominal progressivity of the legal tax scale. This is especially pertinent to low income countries, where taxable income of the majority of population is often below the first tax threshold. Based on our procedure, countries for which a significant proportion of the population does not pay taxes will have progressivity measures of zero or close to zero. This makes sense, since the tax structure is effectively proportional when no one is paying taxes, even if the statutory rate schedule is highly graduated.

To obtain a single, comprehensive measure we had to impose a linearity restriction on the relationship between rates and income levels. Given that the nominal tax schedule has a top statutory marginal rate, both the average and marginal rate progression measures, as defined by Musgrave and Thin (1948), decline as one moves up the income distribution. In other words, the tax schedule is less progressive at the top of the income scale. In an effort to capture this nonlinearity, we also calculated MRP2 and ARP2 for the bottom portion of the income scale up to 200% of a country's GDP per capita. Figure 2 illustrates MRP2 for a hypothetical case.

[14] Pre-tax income is measured in percentage points relative to a country's GDP per capita.

Table 2 reports summary statistics on the four progressivity measures across time. To infer the global trend, mean values are weighted by a country's share in world GDP and world population. The pattern that stands out is that all of the measures declined throughout the 1980s and early 1990s and then remained stable during the latter period, with the exception of ARP2 that declined steadily over the whole period. In concordance with the non-linear properties of progressivity (Musgrave and Thin 1948), our measures calculated for the bottom portion of the income scale tend to be larger than those for the full income scale, and the ARP measures are smaller than their corresponding MRP measures. Table 2 also reports summary statistics on the top statutory PIT rate. The top marginal tax rate has declined steadily from a high of 56% in the 1981–1985 period to a low of 37% in the 2001–2005 period. Since these global trends follow closely those reported in Sabirianova Peter, Buttrick, and Duncan (2008), we refer the reader to that paper for a more detailed description of the changes that have taken place over the last 25 years.

4. Empirical Methodology

4.1. The OLS Model for Observed Income Inequality

Following the theoretical framework discussed above, we write observed income inequality as a function of structural progressivity and other control variables:

$$I_{it} = \zeta_t + \beta P_{it} + \mu D_{g,it} + \delta Z_{it} + \phi W_{it} + \varepsilon_{it} \quad (5)$$

where I_{it} is observed inequality measured by income-based Gini coefficients (either net or gross income[15]) in country i and year t, ζ_t captures year effects, P_{it} is the relevant measure of PIT progressivity, $D_{g,it}$ is a dummy equal one if Gini is based of gross income and zero if Gini is based on net income, Z_{it} is a vector of control variables, W_{it} is a vector of auxiliary variables that

[15] Following the theoretical framework in Section 2, progressivity may affect gross income distribution through productivity and tax evasion responses.

are included to control for consistency of the Gini coefficients (a dummy for national area coverage and a set of dummies for the type of income adjustment), and ε_{it} is the error term. The Z vector includes the one-year lagged log of GDP per capita in quadratic form, the rate of inflation, the share of services in GDP, and the share of industry in GDP (see Appendix Table A2 for variable definitions). The quadratic form of GDP per capita is used to account for the existence of the Kuznets Curve which postulates that there is a non-linear (inverted U) relationship between income inequality and per capita GDP. If it exists, we expect a positive coefficient on the linear term and a negative coefficient on the quadratic term. The share of services and industry in GDP are included to control for the effect of GDP composition on the distribution of income. For example, an expanding service sector may benefit the rich relative to the poor thus leading to higher levels of income inequality. Inflation is included to account for the possible equalizing effect of price stability on the distribution of income (Minarik 1979 and Bulir 2001). The β captures the effect of progressivity on inequality in observed income, and according to our first hypothesis it is expected to be negative.

The OLS results reported in Tables 3 and 4 by and large confirm these expectations. A one percentage point increase in the top statutory PIT rate reduces the Gini by 0.08 points, ceteris paribus.[16] Inequality in gross income is predictably higher than inequality in net income. The sign of the coefficients on both GDP terms is consistent with the Kuznets hypothesis. Table 4 includes the same set of covariates as in Table 3, except for the top statutory PIT rate, which is replaced with one of the measures of structural progressivity. All of the progressivity measures have a statistically significant negative effect on income inequality. The magnitude of the marginal effects is, however, small. A 100% increase in any progressivity measure reduces the

[16] The GINI is measured on a scale from 0 to 100.

Gini coefficient by less than 20% at the mean. For example, a twofold increase in the MRP1 slope from 0.062 (mean) to 0.124 is estimated to reduce the Gini coefficient by 1.57 (=25.317*0.062); not such a large effect given that the sample mean of Gini coefficients for net and gross income is 37.

4.2. The IV Model for Observed Income Inequality

Despite the promising start, there are several reasons to believe that the OLS results reported in the previous section might be biased and inconsistent. For example, the ideal estimating procedure would be to use country fixed effects to account for heterogeneity among countries. However, the use of fixed effects is problematic given the limited within variation in the dependent variable for some countries. The Gini data are mostly sparse for a number of the countries in our sample.[17] To the extent that constant country characteristics are correlated with the error term, omitted fixed effects create an endogeneity bias.

Another form of endogeneity bias stems from the fact that structural progressivity by itself is an estimated parameter with associated standard errors. This can lead to an attenuation bias in the estimated effects, assuming that standard errors follow the properties of the classical error-in-variables problem.

Finally, an endogeneity bias may arise from reverse causality. The political economy literature has long established a reverse relationship between income inequality and taxes (Meltzer and Richard 1981, Persson and Tabellini 1999). Also, much of the empirical work that examines the effect of income inequality on economic growth argues that inequality affects growth through its effect on taxes and redistribution, (Perotti 1992, Persson and Tabellini 1994, Barro 2000, Milanovic 2000, among others). The general argument, based on the median voter

[17] Some countries either have one income base or they have both but only for some years. Furthermore, there are a number of countries for which GINI data is only available for few years.

hypothesis, is that as the ratio of median income to mean income falls (i.e., inequality increases), the median voter will vote for higher taxes and greater redistribution. Therefore, greater income inequality should lead to greater progressivity. This reverse causality implies that the OLS estimates of β are likely to be biased upwards.

Therefore, all three sources of endogeneity (omitted variables, measurement error, and reverse causality) could bias the estimated effects of progressivity on observed income inequality. To account for the endogeneity of our progressivity measures, we rely on the tax competition models to create instrumental variables using the corresponding tax variables from neighboring countries. Theoretically, we expect that tax variables in country A will be correlated with tax variables in bordering country B, as countries compete for the tax base, but will only affect country B's level of inequality via this correlation. As such, we create instruments for each progressivity measure using distance-population weighted averages of tax/progressivity measures in neighboring countries (Sabirianova Peter 2008). The choice of weights used is driven by the need to account for both the ease with which individuals can travel from country A to country B (distance from A's capital to B's capital) and the volume of the potential flow (population). Since the tax rates in country A do not have an independent effect on income inequality in country B, we expect that our instruments will be uncorrelated with the error term in equation (5).

Columns 2 and 3 of Table 3 report 2SLS estimates of β using average top PIT rate in bordering countries, IV(a), and average MRP1 and marginal rate at the level of income equivalent to four times GDP per capita in bordering countries, IV(b); all instrumental variables are weighted by distance and population. The *F*-statistic for excluded instruments rejects the null that the instruments have no explanatory power in the first stage. Since we used two

instruments in column 3, we are able to implement the Sargan-Hansen overidentification test. The large *p*-values reported in Table 3 means that we cannot reject the null that the orthogonality conditions for the instruments are satisfied.

Both IV results are qualitatively similar to the OLS results presented in column 1. The most obvious difference, though, is that the IV estimates are much larger, indicating that endogeneity is a serious problem. An increase in the top PIT rate by one percentage point now reduces the Gini coefficient by 0.64 points, when one instrument is used and by 1.61 points when two instrumental variables are used. Also interesting is the significance of the Kuznets curve in both IV specifications.

A similar pattern of results is observed in Table 4 where the results of our primary progressivity measures are reported. The instrument used in IV(a) is the average top statutory PIT rate in bordering countries. In IV(b), MRP1 is instrumented by weighted MRP1 and marginal tax rate at income equivalent to 4·GDP per capita; other progressivity measures are instrumented similarly using one progressivity slope and one tax rate from neighboring countries. All instruments are weighted by distance and population. The choice of instruments is supported by the statistical validity tests, including the Sargan-Hansen test of overidentification.

All progressivity measures are estimated to have a negative and statistically significant effect on observed income inequality. Furthermore, unlike the OLS results, the effect on income inequality is large in magnitude. Increasing ARP1 by 0.01 (or 20% increase at the mean), for example, reduces the Gini coefficient by 3.9 points or about 10%. These results all point to the significant role played by progressive taxes in the redistribution of observed, reported income. The effect of progressivity on true income inequality remains undetermined.

4.3. The Role of Democratic Institutions in Observed Income Inequality

The effect of progressivity on observed income inequality, though shown to be unambiguously negative, may be affected by the redistribution policy of the government. Pro-rich redistribution in the presence of rising progressivity may cause the estimated effect of progressivity to be smaller than it actually is (in absolute value). We therefore expect that environments that are conducive to pro-poor redistribution will have a greater progressivity effect. In particular, pro-poor policies are more likely to be implemented in countries with stronger democratic institutions that give people a voice in their political and economic governance to ensure liberty and equality. Theoretical arguments for a positive relationship between democracy and pro-poor redistribution come from the median voter hypothesis. According to this hypothesis, the median voter votes for higher tax progressivity and greater redistribution to the poor as income inequality rises (Meltzer and Richard 1981, Persson and Tabellini 1999). Since the ability to vote requires some kind of democratic process, the median voter hypothesis implies that there is a positive link between democracy and pro-poor redistribution. In other words, the more democratic the political process, the more likely it is that the median voter will have some influence over policy making. In particular, to the extent that income is distributed unequally, having a more democratic political process should be positively correlated with pro-poor redistribution (Gradstein, Milanovic and Ying 2001).

Given the theoretical result in equation (2) and our second hypothesis (H2), we expect that stronger democratic institutions, indicating greater likelihood of pro-poor redistribution, should reinforce the negative inequality effect of progressivity. In order to test this hypothesis, we extend the baseline equation (5) to include an interaction term between the progressivity

measures and democratic indicators. Given the above discussion, we expect the coefficient on the interaction term to be negative.

The democratic indicators include two Freedom House 7-point country ratings of civil liberties and political rights and a composite democracy score, which is a revised combined POLITY IV score from the Center for International Development and Conflict Management. The original Freedom House ratings are reversed on a scale from 1 to 7, with the lowest value indicating no liberty or rights. The POLITY IV democracy score is measured on a scale from -10 to 10, with 10 indicating strong democracy and -10 indicating strong autocracy.

The results with democratic institutions are shown in Table 5 for each of the four measures of structural progressivity. We report only estimated coefficients on progressivity, democratic institutions, and their interaction. Other covariates have similar effects as in Table 3 and thus not reported. It is interesting that in countries with zero structural progressivity, the direct effect of democratic institutions on income inequality is inconsistent across specifications and varies from zero to positive. What stays consistent across all specifications and all measures of democracy and structural progressivity is that the negative effect of progressivity on observed income inequality is reinforced by democratic institutions. Civil and political liberties are estimated to improve the effectiveness of the progressivity measures.

The results show that using progressivity as a means of equalizing income may not be the best policy to implement in environments that offer little in the way of pro-poor redistribution. This further implies that equalizing the distribution of income via personal income taxes require not only progressive tax structures, but also active pro-poor redistribution policies on the expenditure side of the budget.

4.4. The Effect of Progressivity on Inequality in Consumption

One of the main predictions of the theoretical framework is that changes in progressivity may affect true and observed income inequality differently. This theoretical result is very important since it suggests that policies that are often thought to reduce income inequality may actually be worsening the distribution of income. Likewise, policies that appear to be worsening the distribution of income may, in reality, be improving equality. For example, one argument against implementing a flat rate personal income tax is that it is grossly unfair and will lead to high levels of inequality. However, if tax evasion is widespread and the evasion response to tax changes is large relative to the productivity response among the rich, then what would appear to be increased inequality would in fact be a more equal distribution of true (reported and hidden) after-tax income. According to our theoretical framework, the difference between true and observed inequality effects of tax changes is increasing with the share of unreported income in the economy.

The difficulty in testing this hypothesis is to obtain a measure of true income inequality. Such a measure requires that individuals report their true disposable income to surveyors. This, it is well known, is not the case. Individuals often underreport their income to tax authorities. Also, possibly out of fear that they will be caught and penalized, they tend to underreport their income on surveys as well. In an effort to measure true income inequality, we therefore rely on expenditures/consumption-based Ginis as a proxy for true income inequality. The logic behind this choice is that, individuals generally do not associate consumption with personal income tax liability and are therefore more likely to report their true level of consumption. That is, we assume that the consumption levels people report on surveys is closer to true income than the income they report; both of which are assumed to be larger than income reported for taxation

purposes. Given this assumption, the estimated effect of progressivity on consumption-based Ginis will represent a lower bound on the effect on true income inequality.

A more serious problem, however, is the limited number of countries for which consumption-based Ginis are calculated. Furthermore, as is evident from Figure A2, there is a systematic difference in the type of countries that use a given income base for Gini calculation. We observe, for example, that rich and upper middle income countries are underrepresented in consumption-based Ginis while low and lower middle income countries are overrepresented. This implies that any differential effect in progressivity obtained without considering this selection issue may be purely spurious. To correct for this sample selection problem, we develop sample probability weights using the following procedure.

First, we divide the whole universe of independent countries in a given year into 3 equal groups by population and 4 equal groups by GDP per capita (in 1990 USD). This gives us a total of 12 population-GDP cells (3 x 4) for which we calculate the number of countries in the general population in a given year (NP_t). Then, for each income base separately (gross income, net income, and consumption), we calculate the number of countries in our estimation sample that is in each population-GDP cell in a given year (NS_t). The ratio of NS_t to NP_t is the probability that a given country observation (for a given income base) is included in the estimation sample. For example, a ratio of 1/5 means that only 20% of the world countries from a specific cell are included in the estimation sample in a given year. We use the inverse of this probability, which varies from 1 to 24 with a mean of 3.75, as the probability sample weight in our subsequent estimations.

To capture the differential effect of progressivity on inequality in observed income vs. consumption, we re-estimate the baseline model with interaction terms for different income bases. The estimated model is specified as follows:

$$I_{it} = \alpha + \zeta_t + \beta P_{it} + \mu_1 D_{g,it} + \mu_2 D_{n,it} + \lambda_1 P_{it} \cdot D_{g,it} + \lambda_2 P_{it} \cdot D_{n,it} + \delta Z_{it} + \phi W_{it} + \varepsilon_{it} \quad (6)$$

where D_g and D_n are dummy variables which are equal to one if the Gini base is gross or net income, respectively. Consumption-based Gini is the omitted base category. The Z and W vectors contain the same set of covariates as in equation (5). From hypothesis H3, we expect both λs to be negative. The sign of β, however, is not clear as it depends on the spread of evasion and its responsiveness to tax changes and may or may not be positive.

The model is estimated separately for each measure of progressivity; the OLS results with and without the probability sample weights are reported in Table 6. Since the OLS results maybe biased, we also implement estimation with instrumental variables – the distance-population weighted average of the corresponding progressivity measure in bordering countries and its interactions with the Gini income base. The large Shea's partial R-squared indicate that the chosen instruments are not weak. Examinations of the interaction terms reveal strong support for our hypothesis that progressivity has a differential effect on inequality in consumption vs. inequality in observed income. The estimated coefficients on interaction terms (λs) are negative and statistically significant across all specifications and all measures of progressivity. What is also interesting is the increase in the size and significance of λ as we move from gross to net income-based measures of income inequality. At the same time, the sign of the OLS-estimated β coefficients (both weighted and unweighted) is not consistent across specifications and shifts from negative to positive. In this regard, the IV estimates provide more consistent results and point to the negative effect of structural progressivity on inequality in

consumption. The effect is statistically significant in 3 of 4 specifications. These results indicate that for a typical country in the sample, while progressivity reduces inequality in both observed income and consumption, it appears to have much greater influence on net income-based Ginis.

In section 2.2, we argued that tax evasion can explain the difference between the effect of progressivity on observed net income and its effect on true income approximated by consumption. Hence, we expect that the difference between these two effects is likely to increase with the share of hidden income in the economy. In other words, country A, with identical progressivity but lower incidence of tax evasion than country B, will be more effective in reducing inequality via its progressive tax structure.

Although we cannot measure the extent of tax evasion, we can reasonably assume that weak legal institutions and ineffective law enforcement are highly correlated with tax evasion (Allingham and Sandmo 1972, Alm 1999, Alm and McKee 2006, and Slemrod 2007). Thus, we can anticipate that countries with stronger law and order will experience a greater impact of progressivity on reduction in consumption inequality. This last hypothesis (H4) is tested by using consumption-based Ginis as the dependent variable and including interaction terms between progressivity and the law and order index obtained from the International Country Risk Guide (ICRG).

Table 7 reports the estimates of the following model:

$$I_{it} = \alpha + \zeta_t + \beta P_{it} + \sigma L_{it} + \pi P_{it} * L_{it} + \delta Z_{it} + \phi W_{it} + \varepsilon_{it}, \quad (7)$$

where L_{it} is law and order index for country i in year t. The model is estimated by OLS and IV methods using the distance-population weighted average of the corresponding progressivity measure in bordering countries and its interaction with the law and order index as instrumental variables.

The results reported in Table 7 are largely consistent with our expectations despite a relatively small sample size of consumption-based Ginis (N=220). We note, for example, that for countries with worse law and order (index=0), the estimated βs are positive and statistically significant for all progressivity measures; they are also large in magnitude. This result suggests that a positive relationship between progressivity and consumption-based inequality might exist, especially in countries with poor institutions. The coefficients on the interaction terms are all negative and thus support the hypothesis that progressivity has the most equalizing effect in economic environments less conducive to tax evasion.

5. Conclusions

In this paper we develop a theoretical framework that yields four testable hypotheses about the relationship between tax progressivity and income inequality. Firstly, we show that increased structural progressivity of the PIT structure reduces observed income inequality (H1), and that this effect depends on the type of redistributive environment (H2). We also derive that structural progressivity has a differential effect on observed vs. actual income inequality (H3), and that the difference between two effects is positively related to the spread of tax evasion in the economy (H4).

We develop and estimate comprehensive, time-varying measures of structural progressivity of national income tax systems. We then use these progressivity measures and the Gini coefficients to test the above four hypotheses. As predicted, we find that PIT progressivity reduces observed inequality in reported gross and net income and show that this negative effect on observed income inequality is particularly strong in countries with more developed democratic institutions. At the same time, we find a significantly smaller negative effect of PIT progressivity on true inequality, approximated by consumption-based measures of Gini. We also

establish that the effect of tax progressivity on consumption inequality can be positive, especially in countries with weak law and order that increase the likelihood of tax evasion.

Our empirical analysis implies that the tradeoff between equity and efficiency does in fact exist. This follows from the negative relationship that we identify between progressivity and income inequality. The result suggests that as taxes become more efficient, via lower progressivity, income inequality tends to increase. This result by itself points to the importance of taking into account the equity effects of shifts in tax policy towards greater efficiency.

What we find particularly interesting, though, is that the cost of efficiency differs across country groups. Because tax evasion is so pervasive in developing countries, our results lead us to speculate that developing countries face much lower equity costs of efficiency. That is, to the extent that efficiency is achieved by lowering the progressivity of taxes, developing countries with their higher levels of tax evasion, lose a lot less in terms of equity than developed countries. If flatter taxes can reduce the size of the underground economy, then they may actually improve the distribution of income via the direct compliance response and via pro-poor redistribution of increased tax revenues from higher levels of compliance. Developed countries on the other hand, may not benefit much from this evasion effect due to higher tax compliance rates to begin with. This may possibly explain why flat taxes are relatively more popular in developing countries than developed countries.

These results have important policy implications, especially given the debate surrounding the implementation of flat taxes. The common argument is to say that flat taxes, while efficient, will lead to greater levels of income inequality. We are arguing that this need not be the case for all countries. While observed income inequality will likely increase following the

implementation of a flat tax, actual income inequality may not change and may even improve in countries that suffer from high levels of tax evasion.

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Table 1: Average Gini by Income Base and Period

Income Base	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
Consumption	36.250	37.180	41.390	37.606	34.954
	(6.137)	(8.994)	(10.795)	(8.132)	(6.837)
	[21]	[54]	[98]	[124]	[40]
Gross income	37.469	39.420	42.934	42.327	40.150
	(11.132)	(12.074)	(12.484)	(10.151)	(8.082)
	[96]	[109]	[162]	[150]	[62]
Net income	29.889	33.664	34.824	35.713	30.979
	(8.604)	(11.245)	(10.406)	(10.922)	(6.285)
	[84]	[113]	[169]	[242]	[159]
Total	34.174	36.625	39.387	38.090	33.766
	(10.331)	(11.450)	(11.892)	(10.458)	(7.812)
	[201]	[276]	[429]	[516]	[261]

Notes: Number of Gini observations is 1683; number of country-year observations is 1229. Standard deviation is in parentheses and number of Gini observations is in brackets.

Table 2: Structural PIT Progressivity by Period

Progressivity measure	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	Total
Top PIT Rate	56.144	48.294	42.085	39.984	36.772	44.479
	(12.717)	(13.153)	(11.053)	(9.959)	(9.482)	(13.216)
	[553]	[585]	[702]	[793]	[826]	[3459]
MRP1	0.069	0.059	0.058	0.058	0.059	0.061
	(0.052)	(0.046)	(0.038)	(0.030)	(0.028)	(0.040)
MRP2	0.114	0.105	0.089	0.092	0.091	0.098
	(0.094)	(0.083)	(0.072)	(0.070)	(0.067)	(0.078)
ARP1	0.054	0.048	0.042	0.042	0.041	0.045
	(0.043)	(0.037)	(0.032)	(0.029)	(0.027)	(0.034)
ARP2	0.083	0.076	0.064	0.063	0.058	0.068
	(0.073)	(0.061)	(0.055)	(0.054)	(0.050)	(0.059)
	[449]	[502]	[603]	[711]	[715]	[2980]

Notes: Standard deviation is in parentheses and number of country-year observations is in brackets. MRP1 and ARP1 is marginal and average tax rate progressions up to an income level equivalent to four times a country's GDP per capita; MRP2 and ARP2 is marginal and average tax rate progressions for the levels of income up to $2 \cdot y$, where y is a country's GDP per capita. .

Table 3: Base Specification for Inequality in Observed Income

	OLS	IV (a)	IV (b)	Mean (Std.dev.)
Top PIT Rate	-0.080***	-0.639***	-1.613***	39.666
	(0.017)	(0.102)	(0.226)	(14.160)
Log (GDP per capita)$_{t-1}$	6.017*	16.251***	29.664***	8.480
	(3.354)	(4.648)	(8.361)	(1.453)
Log (GDP per capita)$_{t-1}$ squared	-0.531***	-1.081***	-1.794***	74.013
	(0.187)	(0.261)	(0.477)	(24.075)
Service, % GDP	0.193***	-0.058	-0.412***	57.437
	(0.061)	(0.083)	(0.155)	(12.428)
Industry, % GDP	-0.244***	-0.335***	-0.339**	32.921
	(0.068)	(0.088)	(0.158)	(7.705)
Inflation	0.001	0.001	-0.001	60.815
	(0.001)	(0.001)	(0.002)	(316.894)
Gini based on gross income (dummy)	7.041***	6.904***	6.985***	0.414
	(0.634)	(0.909)	(1.667)	
National coverage (dummy)	-0.526	3.006*	9.348***	0.926
	(0.899)	(1.568)	(3.311)	
Income adjustment				
Equivalence scale	-0.993	2.869**	9.894***	0.318
	(0.674)	(1.335)	(2.910)	
Per capita adjustment	6.286***	7.304***	8.051***	0.388
	(0.684)	(0.995)	(1.923)	
Unknown adjustment	-0.891	0.967	2.739	0.024
	(1.278)	(1.936)	(3.342)	
N (observations)	1252	1116	1100	1252
R-squared	0.44	…	…	…
Wild chi^2	…	533.040***	174.070***	…
Sargan-Hansen *J* statistic	…	just identified	1.053	…
Sargan-Hansen *p*-value	…	…	0.305	…
F-test of excluded IVs	…	72.750***	27.580***	…
Partial R^2 of excluded IVs	…	0.074	0.044	…

Notes: Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is Gini in gross or net income. Year dummies are included in all three models but not shown here. Instrument in (a) is the distance-population weighted top PIT rate in bordering countries. Instruments in (b) are distance-population weighted MRP1 and marginal rate at income $4 \cdot y$ in neighboring countries, where y is a country's GDP per capita. The omitted category for income adjustment is "no adjustment".

Table 4: Structural Progressivity and Inequality in Observed Income

	Progressivity Measures			
	MRP1	**MRP2**	**ARP1**	**ARP2**
Mean (std.dev.)	0.062	0.122	0.055	0.093
	(0.035)	(0.082)	(0.033)	(0.065)
OLS				
Progressivity	-25.317**	-35.219***	-113.219***	-61.466***
	(10.004)	(4.489)	(11.281)	(5.015)
N (observations)	1117	1117	1117	1120
R-squared	0.46	0.49	0.51	0.53
IV (a): IV = Weighted top PIT rate in bordering countries				
Progressivity	-368.334***	-266.514***	-394.222***	-183.006***
	(54.700)	(53.099)	(52.352)	(25.252)
N (observations)	983	983	983	986
F-test of excluded IV	74.876***	23.925***	74.222***	64.133***
Partial R^2 of excluded IV	0.065	0.026	0.074	0.062
IV (b)				
Progressivity	-579.635***	-212.371***	-392.518***	-173.406***
	(68.177)	(19.870)	(27.781)	(11.958)
N (observations)	970	970	970	973
IVs	W_MRP1 & W_MR at 4*y*	W_ARP2 & W_MR at 2*y*	W_ARP1 & W_AR at 4*y*	W_ARP2 & W_AR at 3*y*
F-test of excluded IVs	41.419***	61.930***	148.927***	170.325***
Partial R^2 of excluded IVs	0.089	0.139	0.286	0.277
Sargan-Hansen *J* statistic	1.120	1.841	0.905	0.689
Sargan-Hansen *p*-value	0.290	0.175	0.342	0.407

Notes: Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is Gini in gross or net income. Estimation is done for each progressivity measure separately. Each specification includes the same set of covariates as in Table 3, however, only the variable of interest is reported above. Prefix "W_" denotes distance-population weighted average of the corresponding measure in bordering countries. MRP1 and ARP1 is marginal and average tax rate progressions for income up to $4 \cdot y$; MRP2 and ARP2 is marginal and average tax rate progressions for income up to $2 \cdot y$, where y is a country's GDP per capita.

Table 5: Structural Progressivity, Gini in Observed Income, and the Role of Democratic Institutions

	Progressivity Measures			
	MRP1	**MRP2**	**ARP1**	**ARP2**
Progressivity	143.289***	17.483	41.347	-18.921
	(43.616)	(21.216)	(54.228)	(28.964)
Civil liberties	0.264	-0.145	0.354	0.069
	(0.458)	(0.368)	(0.395)	(0.343)
Progressivity*Civil liberties	-28.422***	-8.136**	-24.881***	-6.792
	(6.966)	(3.273)	(8.410)	(4.497)
N (observations)	1100	1100	1100	1103
R-squared	0.48	0.50	0.52	0.53
Progressivity	143.519***	55.826**	162.981***	56.634*
	(42.603)	(21.975)	(56.260)	(30.688)
Political rights	0.062	0.030	0.617*	0.283
	(0.368)	(0.295)	(0.318)	(0.293)
Progressivity*Political rights	-26.745***	-13.851***	-42.972***	-18.159***
	(6.471)	(3.287)	(8.413)	(4.577)
N (observations)	1100	1100	1100	1103
R-squared	0.48	0.51	0.53	0.54
Progressivity	88.655***	11.095	21.740	-8.226
	(20.845)	(10.763)	(28.264)	(13.592)
Democracy score	0.571***	0.358***	0.582***	0.355***
	(0.134)	(0.105)	(0.116)	(0.098)
Progressivity*Democracy score	-15.398***	-5.912***	-17.989***	-7.118***
	(2.270)	(1.112)	(2.901)	(1.420)
N (observations)	1030	1030	1030	1033
R-squared	0.48	0.50	0.53	0.54

Notes: Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is Gini in gross/net income. All specifications include the same set of covariates as in Table 3 except for democratic institutions and their interaction with progressivity measures reported above. Original Freedom House 7-point ratings for civil liberties and political rights are on the reverse scale from 1 to 7, where 1 is no freedom. Democracy score is a revised combined POLITY v.4 score that ranges from -10 (strongly autocratic) to +10 (strongly democratic).

Table 6: The Differential Effect of Progressivity on Inequality in Consumption and Observed Income

	Progressivity Measures			
	MRP1	**MRP2**	**ARP1**	**ARP2**
Panel A: OLS unweighted estimates				
Progressivity	52.420***	2.278	-21.417	-32.085***
	(18.976)	(9.102)	(23.044)	(10.111)
Progressivity*Gross income	-46.211**	-20.789**	-52.302**	-15.303
	(21.585)	(9.803)	(24.275)	(11.293)
Progressivity*Net income	-93.205***	-46.963***	-111.808***	-38.373***
	(20.327)	(9.839)	(24.592)	(11.240)
Gini income base				
Gross income	10.840***	10.128***	10.317***	9.818***
	(1.242)	(1.066)	(1.133)	(1.041)
Net income	6.819***	6.163***	6.521***	4.861***
	(1.149)	(1.061)	(1.163)	(1.062)
N (observations)	1376	1376	1376	1379
R-squared	0.42	0.45	0.46	0.48
Panel B: OLS estimates with probability sample weights				
Progressivity	49.275**	5.560	-8.220	-25.498**
	(20.163)	(9.957)	(25.568)	(12.037)
Progressivity*Gross income	-39.183*	-23.367**	-59.689**	-22.050*
	(23.001)	(10.780)	(27.240)	(13.131)
Progressivity*Net income	-92.633***	-47.627***	-115.739***	-39.597***
	(21.337)	(10.623)	(26.914)	(12.798)
Gini income base				
Gross income	11.364***	11.153***	11.302***	10.910***
	(1.297)	(1.090)	(1.179)	(1.078)
Net income	7.596***	6.733***	7.111***	5.407***
	(1.213)	(1.094)	(1.196)	(1.105)
N (observations)	1376	1376	1376	1379
R-squared	0.48	0.50	0.51	0.52

Notes: Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is Gini in either gross/net income or expenditures/consumption. Gini in consumption is the omitted category for the income base. All specifications include the same set of covariates as in Table 3.

Table 6 cont'd: The Differential Effect of Progressivity on Inequality in Consumption and Observed Income

	Progressivity Measures			
	MRP1	**MRP2**	**ARP1**	**ARP2**
Panel C: IV estimates with probability sample weights				
Progressivity	-94.247	-166.785***	-205.317***	-118.846***
	(70.899)	(53.589)	(55.481)	(24.950)
Progressivity*Gross income	-239.419***	-26.673	-76.053	-14.721
	(69.731)	(38.380)	(52.369)	(24.647)
Progressivity*Net income	-309.775***	-129.858***	-182.409***	-70.702***
	(72.892)	(41.670)	(51.152)	(23.236)
Gini income base				
Gross income	18.585***	8.403***	10.542***	9.471***
	(3.287)	(3.234)	(2.104)	(1.780)
Net income	15.737***	13.163***	9.978***	8.457***
	(3.112)	(3.252)	(1.963)	(1.676)
N (observations)	1191	1191	1191	1194
Shea's partial R^2 (first stage)				
Progressivity	0.169	0.113	0.275	0.276
Progressivity*Gross income	0.251	0.265	0.400	0.378
Progressivity*Net income	0.203	0.225	0.380	0.357

Notes: Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is Gini in either gross/net income or expenditures/consumption. Gini in consumption is the omitted category for the income base. All specifications include the same set of covariates as in Table 3. IVs are the distance-population weighted average of the corresponding progressivity measure in bordering countries and its interactions with the Gini income base. The models are just identified.

Table 7: The Effect of Progressivity and Law and Order on Inequality in Consumption

	Progressivity Measures			
	MRP1	**MRP2**	**ARP1**	**ARP2**
Panel A: OLS estimates with probability sample weights				
Progressivity	123.257**	69.882**	220.034***	93.332**
	(55.926)	(27.892)	(72.221)	(40.170)
Law and order	-0.078	0.025	0.572	0.010
	(1.017)	(0.847)	(0.971)	(0.855)
Progressivity *Law and order	-21.586	-17.505*	-57.483***	-28.477***
	(16.580)	(8.909)	(20.908)	(9.821)
N (observations)	220	220	220	220
R-squared	0.30	0.29	0.30	0.29
Panel B: IV estimates with probability sample weights				
Progressivity	373.247***	349.689***	664.509***	402.991*
	(96.584)	(97.715)	(179.011)	(214.568)
Law and order	1.094	2.227	2.560**	2.025*
	(1.479)	(1.625)	(1.306)	(1.177)
Progressivity *Law and order	-55.935**	-64.909***	-143.961***	-95.026***
	(25.233)	(21.152)	(37.964)	(36.336)
N (observations)	185	185	185	185
Shea's partial R^2 (first stage)				
Progressivity	0.281	0.173	0.274	0.116
Progressivity *Law and order	0.291	0.213	0.333	0.258

Notes: Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is Gini in consumption. All specifications include the same set of covariates as in Table 3. The law and order index is measured on a scale from 0 to 6, with 0 representing the worst law and order. IVs are the distance-population weighted average of the corresponding progressivity measure in bordering countries and its interaction with the law and order index. The models are just identified.

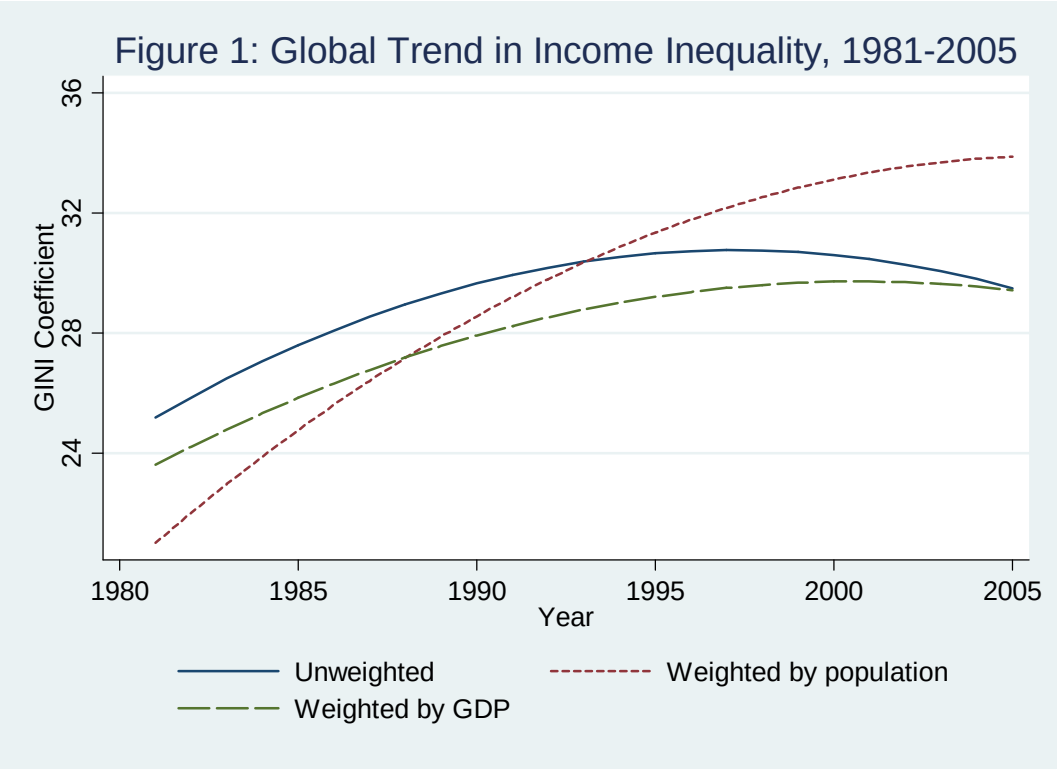
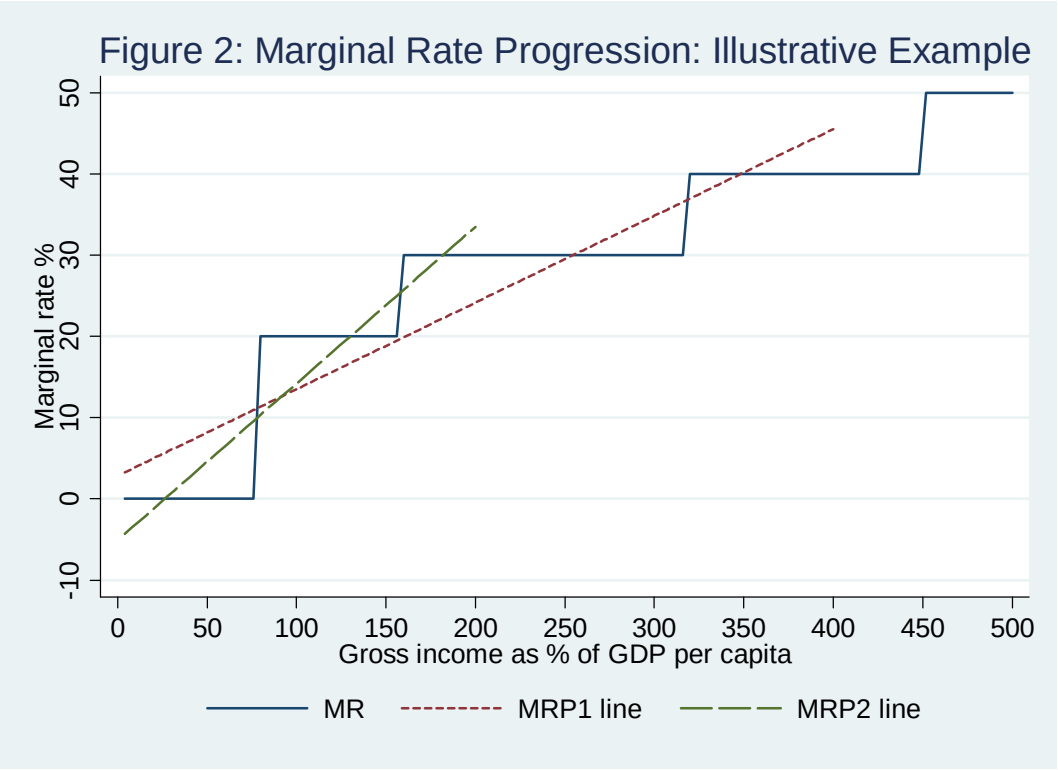
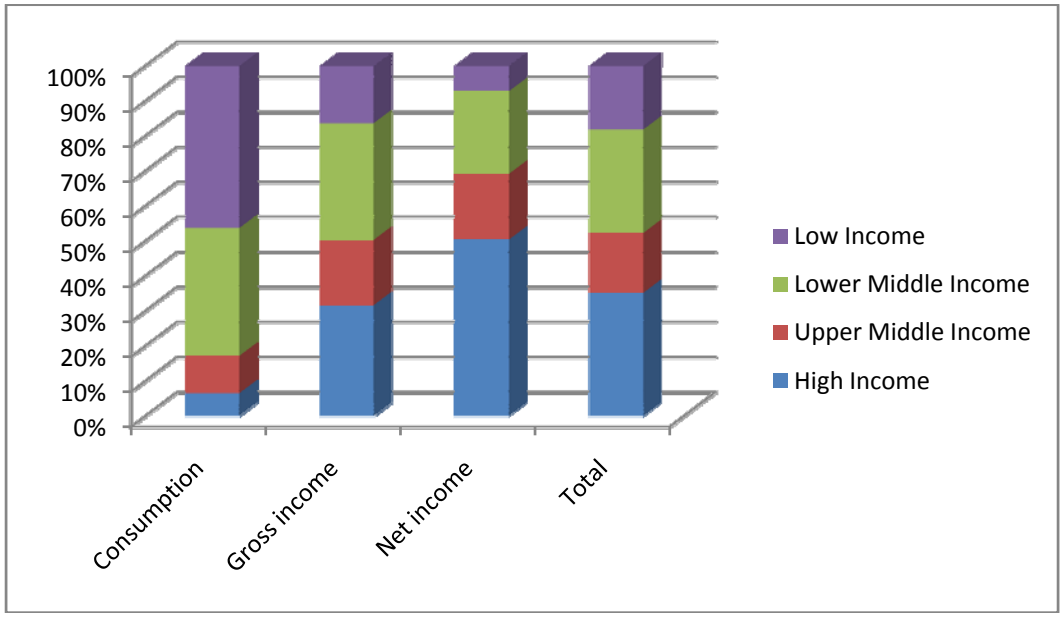


Figure 1: Global Trend in Income Inequality, 1981-2005
GINI Coefficient
24
28
32
36
1980
1985
1990
1995
2000
2005
Year
Unweighted
Weighted by population
Weighted by GDP



Notes: Figure 2 depicts a hypothetical schedule of marginal rates (MR), with top statutory PIT rate 50% and no deductions and tax credits. Marginal rate progression (MRP) is the estimated slope coefficient from regressing marginal rates on gross income (as percent of GDP per capita). MRP1 is calculated for gross income from 4% to 400% of *y*, MRP2 is calculated for gross income from 4% to 200% of *y*, where *y* is a country's GDP per capita.

Figure 3: Sample Composition by Income Base



Appendix

Table A1: Sample Composition

Categories	Selected Sample	Estimation Sample
Income base		
Consumption	0.200	0.186
Gross income	0.344	0.337
Net income	0.456	0.477
Income adjustment		
Equivalence scale	0.259	0.278
Per capita adjustment	0.490	0.465
No adjustment	0.221	0.230
Unknown	0.030	0.027
Area coverage		
National	0.931	0.927
Urban or national with exclusions	0.042	0.043
Other	0.027	0.030
Data quality		
1 – underlying concepts known and judged sufficient	0.393	0.418
2 - income concept or survey is problematic or unknown or estimates not verified	0.315	0.317
3 - income concept and survey are problematic or unknown	0.292	0.265
N (Gini observations)	1683	1538

Table A2: Description of Variables

Variable Name	Description of Variables and Data Sources
Gini coefficient	The measure of income inequality used is the Gini Coefficient reported by WIIDER, WDI, ILO and EUROSTAT.
	Tax variables
The source for all tax variables is World Tax Indicators v.1 (Sabirianova Peter, Buttrick, and Duncan 2008).	
Top statutory PIT rate (%)	Legally determined marginal tax rate applicable to the top bracket of the personal income tax schedule.
ARP1	ARP1 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 from regressing actual average tax rates on the log of gross income for the income distribution up to $4 \cdot y$ income, where y is a country's GDP per capita.
ARP2	Average rate progression for the income distribution up to $2 \cdot y$ income.
MRP1	MRP1 characterizes the structural progressivity of national tax schedules with respect to the changes in marginal rates along the income distribution. It is the slope coefficient from regressing actual marginal tax rates on the log of gross income for the income distribution up to $4 \cdot y$ income.
MRP2	Marginal rate progression for the income distribution up to $2 \cdot y$ income.
	Institutional variables
Law and order	The law and order index is an assessment of the strength and impartiality of the legal system as well as an assessment of popular observance of the law. The index is on the scale from 0 to 6, with 0 representing the worst law and order. Source: International Country Risk Guide (ICRG).
Civil liberties	The civil liberties index gives an indication of the extent to which individuals are allowed "… freedoms of expression and belief, associational and organizational rights, rule of law, and personal autonomy without interference from the state." The original index is reversed on the scale from 1-7, with 1 representing no freedom. Source: Freedom House
Political rights	The political rights index gives an indication of the extent to which individuals are allowed "… to participate freely in the political process, including the right to vote freely for distinct alternatives in legitimate elections, compete for public office, join political parties and organizations, and elect representatives who have a decisive impact on public policies and are accountable to the electorate." The original index is reversed on the scale from 1-7, with 1 representing no freedom. Source: Freedom House
Democracy score	This is the revised POLITY IV score constructed from two other indices; autocracy (AUTOC) and democracy (DEMOC). Democracy indicates the general openness of political institutions, while autocracy indicates the general closeness of political institutions. The POLITY IV score is measured on a scale from -10 (strongly autocratic) to 10 (strongly democratic). Source: Center for International Development and Conflict Management (CIDCM)

	Other control variables
GDP per capita (log)	Log of GDP per capita. Gross Domestic Product per capita is calculated using GDP (in US$ at 1990 prices) divided by country population. Sources: United Nations Common Database (UNCD).
Inflation rate (%)	Percentage change in annual CPI. Sources: IMF IFS (2006), IMF WEO (2006), ILO Laborsta (2006), EIU (2005), and IMF WEO annual reports
Services (% of GDP)	Service sector's value added as a share of GDP. Services include wholesale and retail trade and restaurants and hotels; transport, storage and communication; financing, insurance, real estate and business services; public administration and defense; community, social and personal services. This sector is derived as a residual (from GDP less agriculture and industry). Sources: WB WDI (2007) supplemented by EIU (2005), UNECE (2007), ECLAC (2005) and publications of national statistical offices.
Industry (% of GDP)	Industry sector's value added as a share of GDP. Industry includes mining, manufacturing, construction, electricity, water, and gas. Sources: WB WDI (2007) supplemented by EIU (2005), UNECE (2007), ECLAC (2005) and publications of national statistical offices.