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Essays on Personal Income Taxation and Income Inequality

Denvil R. Duncan
Georgia State University

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Denvil R. Duncan
3200 Lenox Road NE
Apartment D309
Atlanta, GA. 30324

The director of this dissertation is:
Dr. James R. Alm
Economics
Andrew Young School of Policy Studies
Georgia State University
P. O. Box 3992
Atlanta, GA 30302-3992

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Essays on Personal Income Taxation and Income Inequality

By

Denvil R. Duncan

A Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree

of

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ACCEPTANCE

This dissertation was prepared under the direction of the candidates Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Andrew Young School of Policy Studies of Georgia State University.

Dissertation Chair: Dr. James R. Alm
Committee: Dr. Klara Sabirianova Peter
Dr. Jorge L. Martinez-Vazquez
Dr. Barry T. Hirsch
Dr. Yuriy Gorodnichenko

Electronic Version Approved:
Mary Beth Walker, Dean
Andrew Young School of Policy Studies
Georgia State University
August 2010

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To my parents, Etta Samuels and Everald Duncan

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ABSTRACT

ESSAYS ON PERSONAL INCOME TAXATION AND INCOME INEQUALITY

By

DENVIL R. DUNCAN

August 2010

Committee Chair: Dr. James R. Alm

Major Department: Economics

This dissertation comprises two essays that attempt to determine, empirically, the relationship between personal income taxation and income inequality. A key feature of the analysis is that it highlights the role played by behavioral responses in this relationship. The first essay 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. Our inequality measures are taken from a country-level dataset of GINI coefficients calculated separately for gross income, net income, and consumption. The relationship is estimated using two stage least squares to account for the endogeneity of the progressivity measures. We use the weighted sum of progressivity measures in neighboring countries as instruments; each measure is weighted by population and distance.

Our findings suggest that progressivity has a strong negative effect on inequality in reported gross and net income and that this negative effect is strongest in countries whose institutional framework supports pro-poor redistribution. However, the effect of progressivity on true inequality, which is approximated by consumption-based measures of the GINI coefficient, is significantly smaller. The results also show that tax progressivity has a much weaker effect on true inequality in countries with weak "law and order" and a large informal nontaxable sector.

The second essay relies on household level data and complements the first in its empirical approach. We simulate the distributional impact of the Russian personal income tax (PIT) following the flat tax reform of 2001 using data from the Russian Longitudinal Monitoring Survey. We use a series of counterfactuals to decompose the change in the distribution of net income into a direct (tax) effect and an indirect behavioral effect. The indirect effect is further decomposed into evasion and productivity effects using existing estimates of these respective elasticities. Again, a distinction is made between reported income and true income (approximated by consumption) inequality.

As expected, the direct tax effect increased net income inequality. Changes in the pre-tax distribution (indirect effect), on the other hand, had a large negative impact on inequality thus leading to an overall decline in net income inequality. We also find that the tax-induced evasion response increased reported net income inequality while reducing consumption based measures of net income inequality. To the extent that consumption approximates true income, these results demonstrate that the PIT affects true income inequality differently than it does reported income inequality. The results further imply

that countries with very large informal sectors may not be restricted by the equity efficiency trade-off and that redistribution policy should target gross income rather than the progressivity of the tax schedule.

INTRODUCTION

Countries throughout the world have made a major shift toward flatter personal income tax structures over the last two decades. Since flattening the income tax structure reduces structural progressivity, many have argued that these flatter schedules may have reduced the ability of the personal income tax to redistribute income. If this conclusion is correct, it casts serious doubts over the appropriateness of the trend towards linear personal income tax schedules that has been taking place in developing countries. Although very intuitive, it is not immediately clear that flattening personal income tax schedules will increase inequality. This potentially counterintuitive result is especially possible in the presence of tax induced behavioral responses such as evasion. Therefore, arguing for or against the adoption of a flatter personal income tax schedule requires a very detailed understanding of the relationship between structural progressivity and income inequality.[1]

This dissertation comprises two essays that attempt to address the issue raised above. The essays are inextricably linked by the concepts of "taxes and income distribution." The first essay seeks to determine, empirically, the relationship between the structural progressivity of personal income taxes and income inequality, with a special emphasis on the differential effect of progressivity on observed vs. actual

[1] Another equally important consideration is the effect on efficiency. However, we do not address this issue here. The term *structural progressivity* denotes changes in the average tax rate along the income distribution. In other words, it measures the rate at which tax rates increases with income.

inequality.[2] Although a lot of work has been done to assess the impact of tax reforms on the distribution of income, 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 2010). If progressive rates and income inequality are negatively related, then there are important implications of such policies for the distribution of income. However, it is not clear that shifting to flat taxes – or more generally, to income tax structures with lower levels of structural progressivity – will necessarily lead to greater levels of income inequality.

Another important contribution of this essay 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 (Altig and Carlstrom 1999; Martinez-Vazquez 2008).

[2] Observed inequality refers to the inequality of reported income; i.e., income reported on surveys or tax returns. True inequality, on the other hand, includes both reported and hidden income.

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, ceteris paribus. 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 possible, 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.

The second essay is an attempt to get a more detailed understanding of the relationship between tax rates and the distribution of income. Numerous researchers have identified the fact that tax payers change their behavior in response to changes in tax rates. While these behavioral changes are at the core of studies that look at efficiency and optimal tax policy[4], little is known about their impact on income inequality. The

---

[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 (Deaton 1997; Milanovic 1999).

literature on taxes and income distribution has acknowledged that taxes have a direct effect and an indirect behavioral effect on inequality (Karoly 1994). However, most of the previous studies fail to separate the two effects or identify the driving forces behind the indirect behavioral effect.[5]

Therefore, the objective of the second essay is to (1) determine the relative size of the direct and indirect effects and (2) determine the relative size of the behavioral responses that are driving the indirect effect. By relying on estimates of the various behavioral responses, the essay also identifies the true-tax induced-change in inequality. The analysis is done at the micro level using household surveys. The key contribution of this essay is the identification of two main behavioral responses that drive the indirect effect (productivity and compliance). Gramlich, Kasten, and Sammartino (1993) and Altig and Carlstrom (1999)are limited in this respect as they focus primarily on the labor supply response.[6] At the same time, the analysis allows us to identify the true changes in the distribution of income.

Another contribution is its implication for the commonly perceived trade-off between efficiency and equity. To see this contribution, it is important to recognize that changes in inequality that arise from changes in evasion are artificial. In other words, observed inequality can increase if a lower tax rate causes rich tax payers to report a relatively greater share of their income. This increase in inequality represents a shift

---

[4] See Saez (2001), Gruber and Saez (2002) and, Kumar (2008) for a description of two branches of the literature that discusses the importance of behavioral changes for efficiency and tax policy design.

[5] Alm, Lee, and Wallace (2005) and Poterba (2007) identify the direct and indirect effects while Gramlich, Kasten, and Sammartino (1993) and Altig and Carlstrom (1999) identify some of the behavioral responses that contribute to the indirect effect.

[6] Gramlich, Kasten, and Sammartino (1993) also included the response of capital gains.

toward the true inequality that existed prior to the tax change. Therefore, to the extent that this "artificial" effect is relatively large, the actual equity cost of the efficiency gained from switching to a flatter tax schedule will be much lower than observed. In this case, it is optimal to adopt a flatter tax schedule not only because it is more efficient but also because negative equity effects are smaller than we think (and possibly positive). Regardless of its size, the evasion (artificial) effect will play an important role in the optimal progressivity debate.

The results are equally interesting if it turns out that the behavioral responses play a minor role in the determination of inequality. Such a result would indicate that the indirect effect is small, which would then imply that the optimal tax schedule may be made more progressive with little efficiency costs. Therefore, knowing if and how taxes affect the distribution of income and consumption is important for policy makers as they attempt to strike an important balance between efficiency and equity.

It is important that we point out at this stage that this dissertation focuses on the personal income tax only. As such, we ignore other aspects of the tax system and their possible feedback effects to the personal income tax. It would be preferable to account for these, but the data requirements cannot be met. In this respect, we follow a long and esteemed literature (Alm and Wallace 2007; Auten and Carroll 1999; Feldstein 1995; Gruber and Saez 2002; Kopczuk 2005).

The remainder of the dissertation discusses each of the essays in greater detail.

ESSAY 1: TAX PROGRESSIVITY AND INCOME INEQUALITY

Introduction

The economic literature has long viewed efficiency and equity as two important objectives of economic development. There is also a well established tradeoff between these two objectives; policies that tend to increase efficiency are also likely to increase inequality. This efficiency-equity tradeoff is especially pronounced in income taxation (Mirrlees 1971; Ramsey 1927). 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. It is not difficult to show that a structurally progressive tax (i.e., average tax rate increases with income) results in a more equal distribution of disposable income, assuming no behavioral responses to tax changes and holding redistribution constant. In reality, however, behavioral responses should not be ignored. For example, increased progressivity may lead to lower levels of tax compliance among the rich thus increasing their disposable income since they do not pay taxes on the hidden income. An implication of this behavioral response is that both efficiency and equity are reduced as a result of the increased progressivity. To the extent that the tax evasion response exists

and is significant, progressivity will have a different effect on observed inequality in reported income than on actual inequality in true income.

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 (2010) shows that personal income tax (PIT) structures 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 2009, 24 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. This is where the distinction between observed and true income distribution and the potential differential effect of progressivity on both becomes extremely important.

In this paper, we seek to determine, empirically, the relationship between structural progressivity of personal income taxes 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 inequality, this is the first known attempt to differentiate between these two effects. Furthermore, for the first time, this paper uses a unique dataset for a large panel of countries that contains time-varying country-specific measures of structural progressivity over the

period 1981-2005. In this regard, the study is different than most of the previous work, which has been country-specific and relied on micro-simulation exercises or computable general equilibrium models (Gravelle 1992; 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.[7] Nevertheless, macro data provide an exceptional opportunity 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. We also develop and estimate comprehensive, time-varying measures of structural progressivity of national income tax systems by using complete national income tax schedules with statutory rates, thresholds, country-specific tax formulas and other information. 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 a positive effect of progressivity on true inequality is plausible, especially in the presence of weak legal institutions that can trigger a very large

[7] In principle, policy makers could achieve the same level of income inequality by reducing the progressivity of the personal income taxes and increasing that of the corporate taxes. Alternatively, they could reduce the regressivity of the consumption taxes.

tax evasion response. The evidence provides some support for our hypothesis as we show that weaker law and order produce the 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 that an inverted U-shape relationship exists between income inequality and growth; 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 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. First, I provide the theoretical framework. This is followed by a description of the data, the empirical model, and the results. The last section concludes.

Theoretical Framework

More progressive taxes are often designed to collect a greater share 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 reducing

true income (productivity response) or simply reporting a smaller share of true income (tax evasion/avoidance response) and/or both. 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 true inequality in net income.

The existing estimates of the productivity response based on the labor supply elasticity with respect to tax changes are rather modest (Blundell, Duncan, and Meghir 1998; Eissa and Liebman 1996). 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 2009). Recently, Gorodnichenko, Martinez-Vazquez, and Sabirianova Peter (2009) (GMP henceforth) 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

(Feldstein 1995; Slemrod 1994). 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.

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 true distribution. Below we illustrate these possibilities more formally using both the Kuznets ratio and variance of log income as measures of inequality. We first model the effect of tax progressivity on observed income inequality and then on true income inequality.

We can show these results more formally by starting with a utility maximization problem that allows each person to choose the optimal amount of earned income and the amount of evasion. These utility maximizing quantities should be functions of the tax rate and other parameters and should therefore give us an indication of the effect a change in tax rates will have on the distribution of income. We assume that each individual's utility function, $U(C,y)=C-\psi(y)$, is concave, increasing in *C*, consumption, and decreasing in *y*, true income (Saez 2001),.[8] As specified, the utility function imposes the assumption of strong separability which may be quite restrictive,(Cowell 1985). However, we follow Chetty (2009)and Saez (2001) in writing the utility function this way; a more general model is derived in the appendix. It is also assumed that each tax payer must make a choice about how much of earned income to evade. This gamble is summarized by the probability of being caught, $0 \le \rho \le 1$, and the

[8]I follow Chetty (2009) in specifying ψ(y) as the disutility of earning income, which is increasing in y. A more general model that does not impose separability is derived in appendix A (section A1).

penalty structure, $tE + F(E)$, where E is hidden income, t is the tax rate, F is the fine, and $F^{/} > 0$. Therefore, consumption in the two states can be summarized as follows:

$$C_1 = (1-t)y + tE \qquad 1$$

$$C_2 = (1-t)y - F(E) \qquad 2$$

where C_2 is equal to C_1 minus the penalty. Consumption is C_1 in state one where the probability of not being caught is $(1-\rho)$, and C_2 in state two where the probability of being caught is ρ. The individual maximizes expected utility by choosing *y*, income, and *E,* hidden income to solve the following;

$$Max\ \text{EU} = (1-t)y + (1-\rho)tE - \rho F(E) - \psi(y)$$

subject to $E \geq 0, y \geq 0$

Differentiating with respect to *y* and *E* yields

$$\frac{\partial EU}{\partial y} = (1-t) - \psi^{/}(y) \leq 0 \qquad 3$$

$$\frac{\partial EU}{\partial E} = (1-\rho)t - \rho F^{/}(E) \leq 0 \qquad 4$$

Assuming we have values that satisfy interior solutions, we can write eq. (3) and (4) as

$$(1-t) = \psi^{/}(y) \qquad 5$$

$$(1-\rho)t = \rho F^{/}(E) \qquad 6$$

Equations (5) and (6) implicitly define the equilibrium level of earnings and hidden income as functions of the parameters of the model. From eq. (5) we observe that the individual will increase income until the expected marginal disutility from income is

equal to the marginal benefit of income. The marginal benefit from income is the net of tax expected change in utility that result from the change in *y*. Similarly, the optimal amount of hidden income is that amount which sets the expected marginal benefit of evasion equal to the expected marginal cost of evasion. These equations can be solved for *y* and *E* if a specific utility function is assumed. The expressions for *y* and *E* can then be used to construct measures of income inequality that can be used to determine the effect of taxes on the distribution of income.

Inequality in Observed Income

In this subsection, we use two inequality indices that demonstrate 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 the rich relative to that received by the poor. We can write the Kuznets measure of observed inequality in disposable income as:

$$I_y^o = \frac{y_r^o}{y_p^o + G} = \frac{Y_r^o(1-t_r)}{Y_p^o(1-t_p) + \theta(t_r Y_r^o)} \qquad 7$$

where Y^o is observed gross earned income reported for tax purposes, y^0 is observed earned income net of tax, *t* 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 (7) allows redistribution 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 hidden income E; $Y_r^o = Y_r^* - E_r$ for rich and $Y_p^o = Y_p^* - E_p$ for poor.

Holding the tax rate facing the poor constant, t_r becomes an indicator of structural tax progressivity. Changes in structural progressivity create behavioral responses among the rich – a likely negative productivity effect $\frac{\partial Y_r^*}{\partial t_r} < 0$ and a positive tax evasion effect $\frac{\partial E_r}{\partial t_r} > 0$. These assumptions follow from the earlier discussion. Furthermore, since the average tax rate facing the poor doesn't change, we assume no behavioral response for the poor.[9]

As illustrated below, $\frac{\partial I_y^o}{\partial t_r}$ is unambiguously negative under these assumptions.

$$\frac{\partial I_y^o}{\partial \tau_r} = \frac{\left[y_p^o + G\right]\left[\frac{\partial Y_r^o}{\partial \tau_r}(1-\tau_r) - Y_r^o\right] - \theta Y_r^o (1-\tau_r)\left[\tau_r \frac{\partial Y_r^o}{\partial \tau_r} + Y_r^o\right]}{\left(y_p^o + G\right)^2} \qquad 8$$

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

$$= \underbrace{-AY_r^o}_{direct\ effect\ <\ 0} + \underbrace{A(1-\tau_r)\frac{\partial Y_r^*}{\partial \tau_r}}_{productivity\ effect\ <\ 0} \underbrace{- A(1-\tau_r)\frac{\partial E_r}{\partial \tau_r}}_{evasion\ effect\ <\ 0} \underbrace{- \frac{\theta\left(Y_r^o\right)^2}{\left(y_p^o + G\right)^2}}_{redistribution\ effect\ <\ 0} < 0, \qquad 9$$

[9] 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.

where $A = \frac{y_p^o}{\left(y_p^o + G\right)^2}$. The first term in eq. (9) 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 relatively higher tax burden on the rich.

Equation (9) hints that the response of true and observed inequality to tax changes is likely to be different. Because the rich have greater access to the various means of hiding their income, they report a relatively smaller share of their income as structural progressivity increases, which 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 eq. (9) shows the negative redistribution effect. If the government succeeds in redistributing the collected revenues in a pro-poor or neutral manner, then the higher taxes on the rich are likely to reduce observed income inequality, *ceteris paribus*. On the other hand, if redistribution 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 two hypotheses that can be tested with macro data:

Hypothesis 1 *The statistical relationship between tax progressivity and income inequality as measured by observed, reported income is likely to be negative.*

Hypothesis 2 *Factors that are positively associated with pro-poor redistribution such as democracy and civil liberties (Meltzer and Richard 1983) are likely to reinforce the negative effect of structural tax progressivity on observed income inequality.*

Similar to the Kuznets ratio explored above, the effect of taxes on the distribution of income can be obtained by differentiating the variance of log net income index with respect to taxes. We write the variance of log net income as[10].

$$VLI = \text{var}\left(\log y^{o}\right) = \frac{1}{n}\sum_{i=1}^{n}\left(\log y^{o}{}_{i}\right)^{2} - \left(\log\tilde{\mu}\right)^{2} \qquad 10$$

where $\log\tilde{\mu} = \frac{1}{n}\sum_{i=1}^{n}\left(\log y_i^{o}\right)$ is the mean of log income. Totally differentiating eq. (10) with respect to t_i yields the following.[11]

$$d(VLI) = \frac{2}{n}\sum_{i=1}^{n}\left(\log\left(y_i^{o}\right) - \log\tilde{\mu}\right)y_i^{-1}\left[\left(Y_i^{*}\varepsilon_{yi} - E_i\varepsilon_{Ei}\right)\left(\frac{1-\tau_i}{\tau_i}\right) - \left(Y_i^{*} - E_i\right)\right]d\tau_i \qquad 11$$

which we rewrite as

$$d(VLI) = \frac{2}{n}\sum_{i=1}^{n}A_i\left[\left(\varepsilon_{yi} - \pi_i\varepsilon_{Ei}\right)\left(\frac{1-\tau_i}{\tau_i}\right) - \left(1-\pi_i\right)\right]d\tau_i \qquad 12$$

where $A_i = \left(\log\left(y_i^{o}\right) - \log\tilde{\mu}\right)\frac{\left(1-\tau_i\right)^{-1}}{\left(1-\pi_i\right)}$, $\pi_i = \frac{E_i}{Y_i^{*}}$, and $\varepsilon_j = \frac{\partial j}{\partial t}\frac{t}{j}$ is the elasticity of j (evasion or income) with respect to taxes.

It is clear from eq. (12) that the net effect of taxes on inequality depends on the sum of its effect on the various parts of the income distribution. While the sign of the

[10] Since y and E are derived from the maximization problem they are functions of the tax rate, and the other parameters specified in that problem. Note also, that we ignore transfers for this exercise. They can be easily included; see appendix A.

[11] We are assuming that individual *i's* tax rate does not affect individual *k*'s behavior.

term in square brackets is likely to be negative for everyone (as discussed in more detail later), the sign of the first term varies along the income distribution. It is negative for those earning less than mean income and positive for those earning more than mean income. Therefore, reducing the tax rate on individuals above mean income should increase income inequality, while reducing taxes on those below mean income should reduce inequality. The net effect will depend on which of these two effects dominates.[12] This finding is consistent with the previous literature. In particular, it is commonly known that the impact of any tax reform on the distribution of income depends on the existing income distribution (Fuest, Peichl, and Schaefer 2008; Poterba 2007).

Equation (12) also shows that taxes affect inequality through direct and indirect channels. The direct effect is captured by the term $(1-\pi_i)$ while the tax-induced indirect effects are captured by $\left(\varepsilon_{yi} - \pi_i \varepsilon_{Ei}\right)\left(\frac{1-\tau_i}{\tau_i}\right)$, which includes both the productivity effect, ε_{yi} and the evasion effect, $\pi_i \varepsilon_E$. Now, to see the distributional impact of a tax reform, let us assume that $dt_i=0$ for everyone below mean income, $dt_i<0$ for those above mean income, $\varepsilon_{yi} < 0$, and $\varepsilon_E > 0$.[13] Under these assumptions, all three channels contribute to an unambiguous increase in observed net income inequality. This result is due to the fact that both the evasion and productivity responses lead to a relative increase in reported gross income for the rich, which in turn leads to an increase in observed net income inequality. The direct effect is also straightforward; the lower rates on the rich reduce

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[12] Obviously, if a tax reform involves reducing top rates only, the change in inequality will be positive. This assumes that the top rate applies only to individuals whose income is above the mean.

[13] We make these assumptions to simplify the discussion. Note that A_i is positive for these individuals. Besides convenience, these assumptions are similar to the changes made via the tax reform that we analyze in the empirical section.

their tax burden relative to the tax burden facing the poor thus resulting in an increase in net income inequality.

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:

$$I_y^* = \frac{y_r^*}{y_p^* + G} = \frac{Y_r^o(1-\tau_r) + E_r}{Y_p^o(1-\tau_p) + E_p + \theta(\tau_r Y_r^o)} \qquad 13$$

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

$$\frac{\partial I_y^*}{\partial t_r} = \frac{\left[\frac{\partial Y_r^o}{\partial t_r}(1-t_r) - Y_r^o + \frac{\partial E_r}{\partial t_r}\right] - \frac{y_r^*}{y_p^* + G}\theta\left[t_r \frac{\partial Y_r^o}{\partial t_r} + Y_r^o\right]}{y_p^* + G} \qquad 14$$

$$\frac{\partial I_y^*}{\partial t_r} = \frac{\left[\frac{\partial Y_r^o}{\partial t_r}(1 - t_r - I_y^*\theta t_r) - (Y_r^* - E_r)(1 + I_y^*\theta) + \frac{\partial E_r}{\partial \tau_r} t_r (1 + I_y^*\theta)\right]}{y_p^* + G} \qquad 15$$

$$\frac{\partial I_y^*}{\partial t_r} = \frac{\frac{\partial Y_r^*}{\partial t_r} + (1 + I_y^*\theta)\left[E_r(1 + \varepsilon_{Et}) - Y_r^*(1 + \varepsilon_{*t})\right]}{y_p^* + G} \lesseqgtr 0 \qquad 16$$

where $\varepsilon_{Et} > 0$ and $\varepsilon_{*t} > 0$ is the elasticity of evasion and true income with respect to tax changes, respectively.

Equation (16) demonstrates that the effect of tax progressivity on true income inequality is ambiguous. 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 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 from lowering upper tax rates.

While we do not observe true income in a typical household survey, we agree with GMP that expenditures or consumption are more difficult to hide, and are therefore much closer to true permanent income than is reported income. The testable implication is that in the presence of a positive tax evasion response, an increase in structural progressivity should bring a more sizeable reduction in observed income inequality than in consumption inequality. A positive effect on consumption inequality is also possible.

Another important implication of eq. (16) 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. Assuming that the weakness of legal institutions is positively correlated with the share of hidden income, we may anticipate that a positive effect of structural progressivity on consumption inequality is more likely to be found in countries with weaker legal institutions.

Consequently, we can postulate two additional testable hypotheses:

Hypothesis 3 *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 possible.*

Hypothesis 4 *The positive effect of structural progressivity on consumption inequality is more likely to be found in countries with weaker legal institutions.*

Similar conclusions are reached using the variance of log income to assess the impact of changes in progressivity on income inequality. To see this, first write true net income as

$$y_i^* = (1 - t_i)Y_i^* + t_i E_i \qquad 17$$

Totally differentiate eq. (10) with y_i^* replacing y_i^o to get

$$d(VLI) = \frac{2}{n}\sum_{i=1}^{n}\left(\log(y_i^*) - \log\tilde{\mu}\right)y_i^{*-1}\left[\left(y_i^*\varepsilon_{yi} - E_i\varepsilon_{Ei}\right)\left(\frac{1-t_i}{t_i}\right) + \frac{E_i}{t_i}\varepsilon_{Ei} - \left(y_i^* - E_i\right)\right]dt_i \qquad 18$$

While the sign of the first term, $\left(\log(y_i^*) - \log\tilde{\mu}\right)$, varies along the income distribution as in the previous section, the sign of the last term is now ambiguous. Therefore, it is possible for a reduction in the tax rate, for example, to reduce inequality. This possibility is greatest when evasion is widespread and is very responsive (positively) to the tax rate. To see this, we order individuals according to income from lowest to highest. Let n_1 individuals have income lower than mean income and N-n_1 individuals have income above mean income. Now, suppose that dt_i is negative for all $i \in [n_1 + 1, N]$ and zero for all $i \in [1, n_1]$. This implies that eq. (18) can be rewritten as

$$d(VLI) = \frac{2}{n}\sum_{i=n_1+1}^{N}\left(\log(y_i^*) - \log\tilde{\mu}\right)\left[(1-t_i) + t_i\pi_i\right]^{-1}\left[\varepsilon_{yi}\left(\frac{1-t_i}{t_i}\right) + \pi_i\varepsilon_{Ei} - (1-\pi_i)\right]dt_i \qquad 19$$

which is negative if the evasion effect is positive and larger than the other two terms in the square bracket. That is, reducing the tax rate reduces income inequality. The implication of this result is that the shift to flatter personal income tax schedules that has taken place over the last two decades may have led to an improvement in the distribution of actual net income in countries where the "right" conditions exist. As such, we can derive similar hypotheses to those derived using the Kuznet Ratio.

The theoretical discussion above tells a compelling story about the possible distributional impact of tax reforms and how such effects should be evaluated. In particular, it points to the need to distinguish between direct and indirect effects by acknowledging the role played by behavioral responses, and between actual and observed net income inequality by acknowledging the role played by evasion. Ignoring these distinctions can lead to seriously misguided policy prescriptions. For example, whereas a reduction in tax rates can be expected to increase observed net income inequality, it can also reduce actual net income inequality. Similarly, the evasion response is shown to affect observed net income inequality differently than it does actual net income inequality; the evasion effect leads to increased observed inequality but may lower true inequality, ceteris paribus. An empirical analysis is therefore required to identify the sign and size of the various channels discussed above.

Measuring Inequality and Structural Progressivity

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.[14] 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 area coverage estimates, equivalence scales or per capita adjustment are chosen over no or unknown adjustment, and higher quality GINIs are preferred to those with lower quality.

This selection process left us with 1683 GINI estimates for 143 countries from 1981 to 2005.[15] The majority of the estimates meet the best practices as set out by the WIDER. Appendix Table B 1 shows that 93 percent of the GINI estimates have national coverage, 75 percent have been adjusted for the household size, and 71 percent 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

[14] 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.

[15] 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.

GINI estimates, 20 percent are based on consumption, 34 percent on gross income, and 46 percent 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.[16] 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 1980s and 1990s before declining during the 2000–2005 period. Figure 1 also reports the time trend weighted by a country's GDP in constant U.S. dollars and population.[17] 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.

[16] 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.

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

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 B 1). 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 B 1, 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 (Easterly 2007).

Figure 1. Global Trend in Income Inequality, 1981-2005

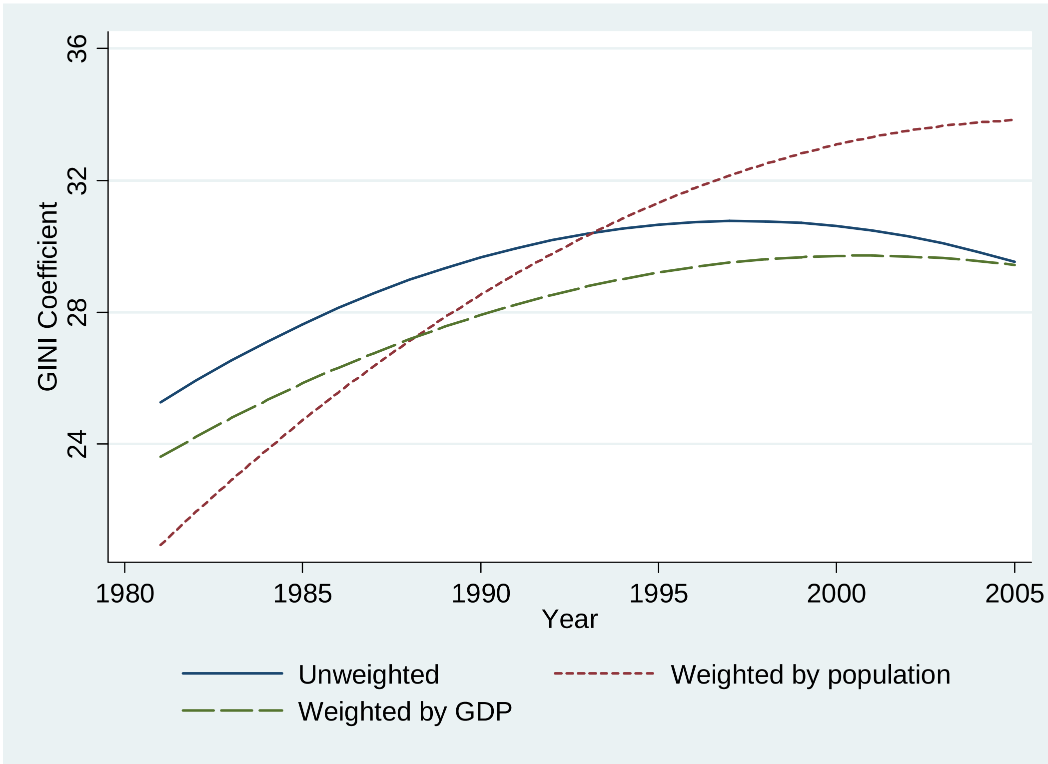


Table 1. Average GINI by Income Base and Period

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.

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 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.

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) Suits (1977), and others. The inequality-based measures generally require information on pre-tax 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.

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 measure 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 percent to 400 percent 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 (2010). 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[18] 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

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

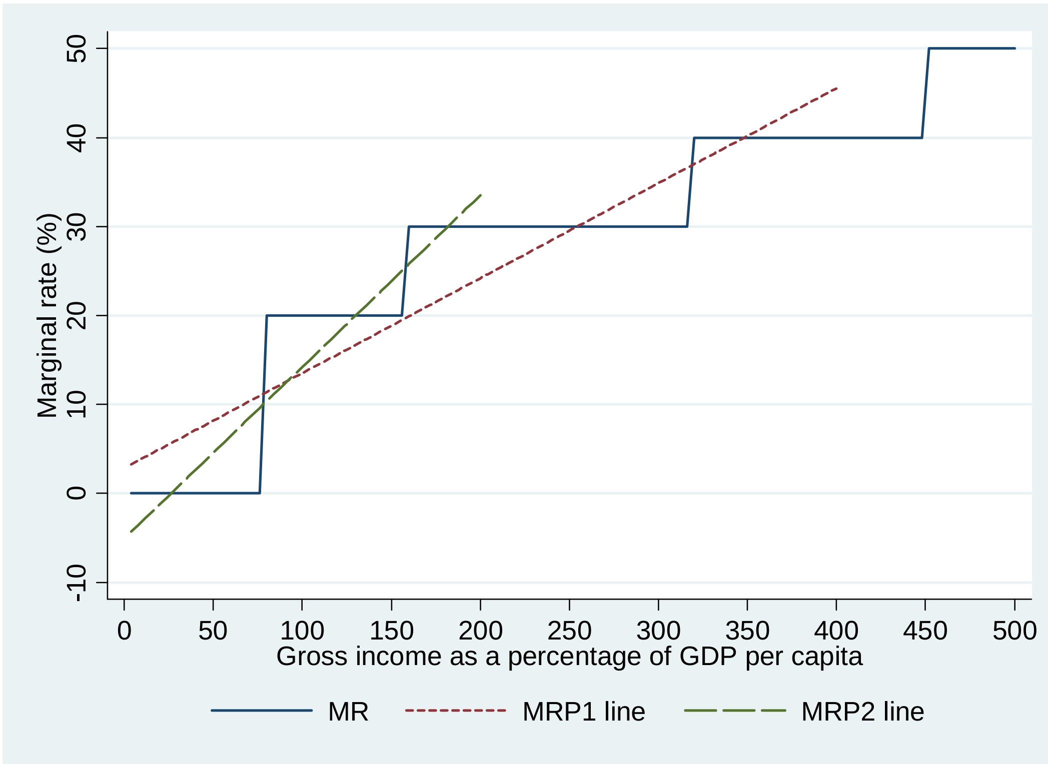
average rate progression (ARP1) for each country and year in our dataset. Figure 2 illustrates how the MRP1 is obtained for a hypothetical case with no allowances and other provisions.

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 , decline as one move 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 percent of a country's GDP per capita. Figure 2 illustrates MRP2 for a hypothetical case

.

Figure 2. Marginal Rate Progression: Illustrative Example



Notes: Figure 2 depicts a hypothetical schedule of marginal rates (MR), with top statutory PIT rate 50 percent 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 percent to 400 percent of *y*, MRP2 is calculated for gross income from 4 percent to 200 percent of *y*, where *y* is a country's GDP per capita.

Table 2 reports summary statistics on 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 percent in the 1981–1985 period to a low of 37 percent in the 2001–2005 period. Since these global trends follow closely those reported in Sabirianova Peter, Buttrick, and Duncan (2010), we refer the reader to that paper for a more detailed description of the changes that have taken place over the last 25 years.

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.

Empirical Methodology

The OLS Model for Observed Income Inequality

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

$$I_{it} = \xi_t + \beta P_{it} + \delta Z_{it} + \phi W_{it} + \varepsilon_{it} \qquad 20$$

where I_{it} is observed inequality measured by income-based GINI coefficients (either net or gross income) in country *i* and year *t*, ξ_t captures year effects, P_{it} is the relevant measure of PIT progressivity, Z_{it} is a vector of control variables, and W_{it} is a vector of auxiliary variables that are included to control for consistency of the GINI coefficients (a dummy for national area coverage, a set of dummies for the type of income adjustment, and a dummy to indicate the type of income base (gross or net income), 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 B 2 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 coefficient of interest, β, captures the effect of progressivity on inequality in observed income, and is expected to be negative.

The OLS results reported in Table 3 and Table 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.[19] 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. However, the magnitude of the marginal effects is small. A 100 percent increase in any progressivity measure reduces the GINI coefficient by less than 20 percent 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.

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

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	7.041***	6.904***	6.985***	0.414
(dummy)	(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.

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.[20] 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 2002). 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,(Barro 2000; Milanovic 2000; Perotti 1992; Persson and Tabellini 1994). The general argument, based on the median voter 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

[20] 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.

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 eq. (20).

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 use two instruments in column 3, we are able to implement the Sargan-Hansen overidentification test. The large p-values reported in Table 3 mean 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 percent increase at the mean), for example, reduces the GINI coefficient by 3.9 points or about 10 percent. 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.

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 economic 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 the 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 2002). 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 eq. (9) and our second hypothesis, 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 eq. (20) 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 effect 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 may require not only progressive tax structures, but also active redistribution policy on the expenditure side of the budget.

Table 5. Structural Progressivity 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).

The Effect of Progressivity on Inequality in Consumption

One of the main predictions of the theoretical model 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 more equalizing. For example, one argument against implementing a flat rate personal income tax is that it is unfair and will lead to high levels of inequality. However, if tax evasion is widely spread and the evasion response to tax changes is large relative to the productivity response among the rich, then increases in observed inequality can be misleading. That is, such observed changes would hide the equalizing effect on the distribution of true (reported and hidden) after-tax income. According to our theoretical framework, this differential effect of tax changes is increasing with the share of unreported income in the economy.

The difficulty in testing this hypothesis is that no measure of true income inequality exists. 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 it is relatively more difficult for individuals to hide their expenditures. That is, we assume

that the consumption levels people report on surveys is closer to true net 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 B1, 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 percent 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:

$$I_{it} = \alpha + \xi_t + \beta P_{it} + \lambda_1 P_{it} \cdot D_g + \lambda_1 P_{it} \cdot D_n + \delta Z_{it} + \phi W_{it} + \varepsilon_{it} \quad (21)$$

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 remaining variables are as defined in eq. (20) except that W no longer includes the indicator for income base. From hypothesis 3, 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 may be 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 shifting 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.

Table 6. Differential Effect on Consumption vs Observed Income Inequality

	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 – *Continued*.

	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.

We argued earlier 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). Thus, we can anticipate that countries with stronger law and order will have a greater impact of progressivity on consumption inequality. This last hypothesis 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:

$$I_{it} = \alpha + \xi_t + \beta P_{it} + \sigma L_{it} + \pi P_{it} \cdot L_{it} + \delta Z_{it} + \phi W_{it} + \varepsilon_{it} \qquad 22$$

where L_{it} is the 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 the 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 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.

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.

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 (hypothesis 1), and that this effect depends on the type of redistributive environment (hypothesis 2). We also show that structural progressivity has

a differential effect on observed vs. actual income inequality (hypothesis 3), and that the difference between two effects is positively related to the spread of tax evasion in the economy (hypothesis 4).

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 cost 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 with higher tax compliance rates to begin with, however, may not benefit much from this evasion effect. This may explain why flat taxes are relatively more popular in developing countries than developed countries.

Our 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 higher 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.

ESSAY 2: BEHAVIORAL RESPONSES AND THE EQUITY EFFECTS OF PERSONAL INCOME TAXES

Introduction

A casual inspection of personal income tax systems across the world reveals a dramatic shift in income tax policy over the last thirty years. Top statutory PIT rates have fallen by more than 20 percentage points on average (Sabirianova Peter, Buttrick, and Duncan 2010). Marginal rates throughout the income distribution as well as measures of average rate progression all point to lower levels of income tax progressivity. In fact, regardless of the measure used, PIT schedules are significantly flatter today than they were in the late 1970s. Additionally, an increasing number of countries have adopted or are considering the adoption of a linear PIT schedule. The most popular among these is the Russian flat tax reform of 2001, which is believed to have acted as a catalyst for other countries in recent years.[21]

This trend toward flatter PIT schedules has generated significant debate in tax policy circles. For example, Fuest, Piechl, and Schaefer (2008)is among a long list of papers that try to evaluate the distributional impact of flat taxes. These studies unanimously argue against the adoption of a flat tax in Western European countries on the grounds that the equity costs are too high. In other words, flattening the PIT schedule would increase efficiency but worsen the distribution of income.

[21] Current estimates put the number of countries with a flat rate PIT at 24 as at January 1st 2009. This number is up from 14 in 2005. The majority of countries using the flat rate PIT are the former communist countries of Eastern Europe.

However, these results fail to explain the continuous decline in income inequality in Russia even after the flat tax was adopted in 2001. One is therefore left to question whether a flatter PIT schedule necessarily increases income inequality.

The conventional argument is simple; a flatter PIT reduces the tax burden facing the rich relative to the poor thus increasing the inequality in net income. Simultaneously, those affected by the lower tax burden are induced to change their behavior in ways that improve efficiency. Then, if these tax-induced behavioral responses are relatively greater among the rich, the pre-tax income of the rich increases relative to that of the poor thus leading to a further increase in net income inequality. That is, flattening PIT schedules increases income inequality due to changes in the tax burden as well as through tax-induced changes in behavior. Following this reasoning, one is forced to reject efforts to flatten PIT schedules if equity is a major policy concern.

However, the analysis above ignores the fact that tax-induced behavioral responses include evasion and avoidance, both of which are income shifting activities rather than real changes in income. These income shifting activities necessitates that a distinction be made between observed and actual net income inequality. While the conclusions above still hold for observed net income, the distributional impact of PIT rates on actual net income inequality is likely to be ambiguous and possibly counterintuitive under certain conditions. For example, if the rich are induced to report a greater share of their hidden income, both reported gross and net income inequality will rise while actual net income inequality will fall. This example is simple but quite powerful. It shows that studying the distributional impact of tax reforms requires that a distinction be made between actual and reported income inequality. It also points to the

need to carefully identify the various channels through which taxes affect the distribution of income as these channels need not all work in the same direction.

The objective of the current paper is to decompose the distributional effect of the personal income tax (PIT) into its direct effect and indirect effect. The direct effect is the change in net income distribution that occurs if PIT rates change and pre-tax income remains the same. The indirect effect, on the other hand, arises because of changes in pre-tax income induced by the tax reform as well as other factors unrelated to the tax system. We also extend the literature by identifying the tax-induced behavioral responses that contribute to the indirect effect. The tax-induced indirect effect is comprised of several components related to the many dimensions along which individuals may adjust their income in response to tax changes. Following GMP, we classify these responses into two broad categories; evasion/avoidance and real productivity effects.[22]

In sum, the paper answers the following questions; how much of the change in the distribution of net income can we attribute to the personal income tax system? How much of the tax-induced change in the distribution is due to the direct tax effect vis-à-vis the indirect effect? Which channel, evasion or productivity, for example, is the major driving force behind the indirect effect? Do these tax-induced behavioral responses affect reported net income inequality differently than actual net income inequality?

We implement the analysis using data from the Russian Longitudinal Monitoring Survey (RLMS) to study the distributional impact of the Russian flat tax reform. We rely

[22]The productivity effect is broadly defined to include all the possible behavioral changes that can affect the total income earned except compliance, which is identified separately. The indirect effect also includes non-tax induced changes in behavior. However, the primary focus of this paper is on the distributional impact of tax-induced behavioral responses.

on a micro-simulation counterfactual analysis and elasticities of evasion and productivity to decompose the change in income inequality into the various channels. Following the literature, we use consumption as a proxy for actual net income with the gap between consumption and reported net income reflecting the extent of underreporting.

The results show that indirect behavioral responses had a significantly larger effect on the distribution of income than the mechanical direct tax effect. We identify the tax-induced components of the indirect effect and show that the evasion response had a larger impact on inequality than productivity responses. While the qualitative effect of productivity responses is the same for both reported net income and actual net income (consumption), we find that the sign of the evasion effect depends on the income measure. The results show that the evasion response lowered actual net income inequality while increasing reported net income inequality. However, the combined tax-induced effects cannot explain the decline in income inequality observed in Russia over the sample period.

This analysis makes several important contributions to the literature. It is the first study to identify the relative size and sign of the various channels through which the Russian flat tax reform affected the distribution of income. The existing literature either focuses on the US PIT system (Alm, Lee, and Wallace 2005; Poterba 2007) or use hypothetical flat tax reforms in Western Europe (Fuest, Peichl, and Schaefer 2008). It is also the first paper to decompose the tax-induced behavioral effects into evasion and productivity responses. Existing work in this area have identified parts of the

productivity response (Altig and Carlstrom 1999) while no one has so far identified the evasion effect.[23]

The paper also makes worthy contributions to tax policy debates. For example, we show that changes in gross income are more important that changes in tax rates, income shifting (evasion/avoidance responses) has a greater effect than real productivity changes, and that tax-induced responses are not as important as other factors that affect gross income. These results imply that separating tax policy from income redistribution policies is more effective than redistribution via taxes. Therefore, our results will help policy makers design policies that target specific channels in an effort to improve the distribution of income. For example, our results imply that investing in education and other training programs that improve employability and earning power would have a more significant effect on reducing inequality than tax progressivity.

A final contribution of the paper relates to the popular efficiency equity trade-off literature. To see this contribution, it is important to recognize that changes in inequality that arise from income shifting via evasion/avoidance reflect pre-existing inequality and are therefore somewhat artificial. In other words, observed inequality can increase if a lower tax rate causes individuals in the right tail of the income distribution to report a relatively greater share of their income. This increase in inequality represents a shift toward the true inequality that existed prior to the tax change. Therefore, to the extent that this "artificial" effect is relatively large, the actual equity costs of the efficiency

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[23] We distinguish between the compliance effect and productivity effect. Gramlich, Kasten, and Sammartino (1993) and Altig and Carlstrom (1999) are limited in this respect; the first focus on labor supply and capital gains while the latter focuses on labor supply and savings. Also, Alm, Lee, and Wallace (2005) and Poterba (2007) only identify the direct and indirect effects. They don't identify the tax-induced behavioral effects.

gained from switching to a flatter tax schedule will be much lower than observed. In this case, it is optimal to adopt a flatter tax schedule not only because it is more efficient but also because the true equity effects are smaller than we think. In fact, our results show that it is possible to improve both efficiency and equity in countries with high levels of evasion that is very responsive to tax rates.

The remainder of the essay is structured as follows. A brief review of the relevant literature and the theoretical framework is presented in that order. This is followed by a discussion of the empirical strategy, a brief summary of the Russian tax reform, and the data. The paper ends with a discussion of the results and concluding remarks.

Literature Review

As indicated throughout the introduction, the broad question addressed in this chapter is not entirely new. In fact, it has been shown that behavioral responses to tax changes have important distributional consequences. The two previous studies in this area that are most closely related to our work are (Alm, Lee, and Wallace 2005; Poterba 2007). Both studies examine the effect of U.S. taxes on the distribution of income and find that the income tax is progressive as it helps to equalize the post tax distribution of income. More importantly, they both conclude that changes in pretax income have a greater effect on post tax income distribution than changes in the effective tax rate. While it is clear that most of the effect is via indirect behavioral changes such as labor supply, avoidance, and evasion, neither Poterba (2007) nor Alm, Lee and Wallace (2005) attempt to separate these effects. They instead focus on the aggregate indirect effect.

While informative, this approach masks much of the more detail responses that would be of interest to policymakers. For example, which behavioral responses are the main drivers of the indirect effect? Are individuals changing their labor supply, their saving pattern, or are they changing how they report income? It is also important to know if each of these responses affects the distribution of income in the same direction.

Two earlier studies, Altig and Carlstrom (1999) and Gramlich, Kasten, and Sammartino (1993), made important contributions in this regard using different methodologies. Altig and Carlsrom (1999) use a computable general–equilibrium (CGE) framework to determine the effect of marginal tax rates on the distribution of income and find that behavioral responses in the form of labor supply and savings have a significant impact on income inequality. On the other hand, Gramlich, Kasten, and Sammartino (1993) rely on a simulation approach with previous estimates of net wage labor supply elasticities for primary and secondary earners and the elasticity of capital gains to taxes.[24] According to their results, the net effect of these two behavioral responses is approximately zero. That is, when taken together, they find that these two responses did not contribute much to the increased inequality observed over the period of study.

Although Altig and Carlstrom (1999)and Gramlich, Kasten, and Sammartino (1993) identify particular behavioral responses, they do not include all the possible sources of behavioral responses that may affect the distribution of income. While savings, labor supply, and capital gains should definitely be included, they do not capture the full range of responses that account for changes in pretax income distribution. For

[24] Gramlich, Kasten, and Sammartino (1993) uses the response of capital gains and labor supply in their assessment of taxes on the pretax income distribution. We intend to group all productivity effects together and also identify a compliance effect.

example, hours worked is only one way in which individuals may adjust their labor income in response to higher taxes. Besides the many other ways in which earned income may be adjusted, the authors also exclude many of the other productivity responses such as accounting, timing and consumption patterns. In particular, there is no mention of evasion as a possible behavioral response.

One way to capture the full range of behavioral responses is to use a measure of income elasticity instead of labor supply or saving elasticities. For example, Auten and Carroll (1999) and Gruber and Saez (2002) use the taxable income elasticity approach popularized by Feldstein to emphasize the importance of tax rates in explaining changes in the distribution of income. Since this elasticity captures all the various tax induced behavioral responses, it should give a more accurate picture of the distributional changes that are due to behavioral responses. However, this approach is not without its own problems. While the income elasticity does contain information that is pertinent to determine the effect of taxes on the distribution of income, its aggregate nature is a disadvantage especially if the various behavioral responses don't all work in the same direction.

For example, we argue in this and the previous chapter that the evasion response will have an artificial effect on the distribution of income and will affect true and reported income differently while real side responses will affect both true and reported income the same way. Because both effects are aggregated in the income elasticity, this approach does not provide a completely accurate picture of the impact of tax changes on the distribution of income. That is, the reason for the change in income will not be clear. Is it that (1) compliance increased, (2) productivity increased or (3) both? If the change

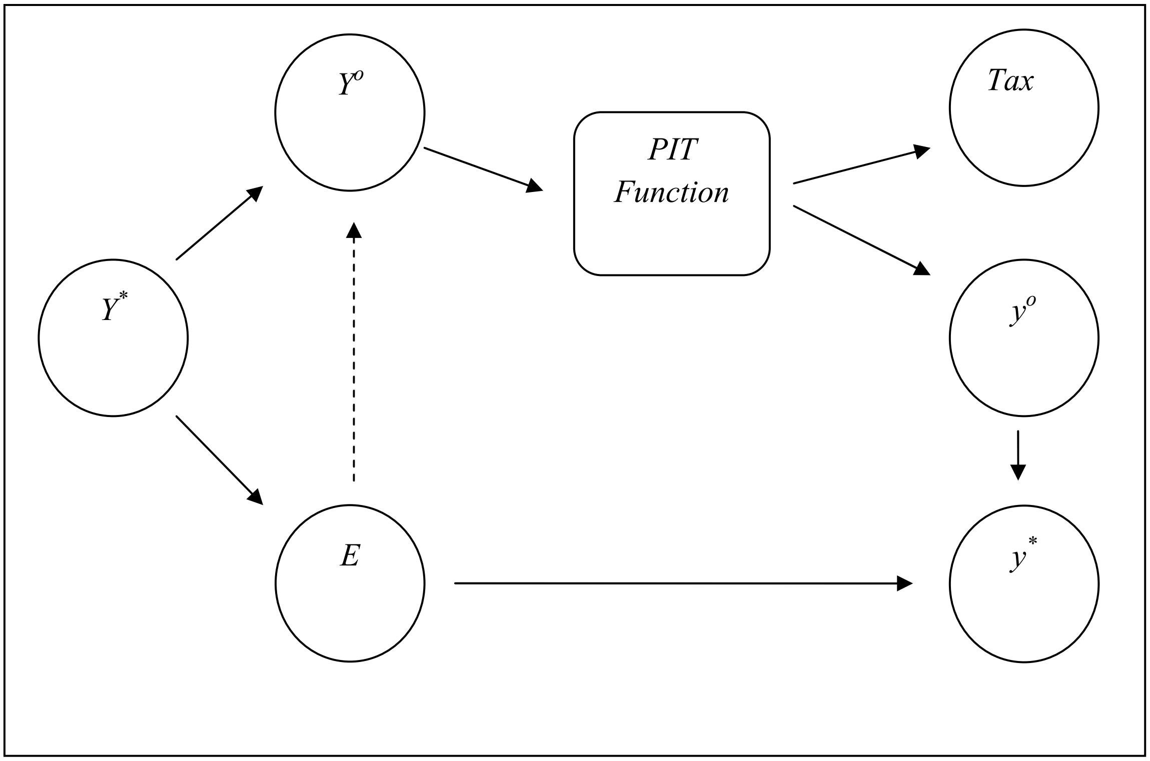
in income is driven by compliance alone then the effect on the distribution of income is likely to be artificial. The presence of a productivity effect, on the other hand, may have a real impact on the distribution of income. It is important, then, that these two effects be disentangled if one is to arrive at a complete and accurate picture of how taxes affect the distribution of income.

Theoretical Framework

In this section we describe the theoretical framework used to inform the empirical analysis. To fix ideas, consider Figure 3. Assume that the rich hide a greater share of their income relative to the poor[25] and that the PIT schedule is progressive. Under these assumptions, actual gross income is more unequally distributed than reported gross income, $\psi(Y^*) > \psi(Y^o)$ and actual net income is more unequally distributed than reported net income $\psi(y^*) > \psi(y^o); \psi(*)$ is an inequality index with larger values indicating higher levels of inequality. Now assume that a linear personal income tax schedule is adopted, which induces individuals to increase actual gross income, Y^* and decrease hidden income, E.

[25] This is not an innocuous assumption as there is evidence that compliance is lowest at the two endpoints of the income distribution (Alm, Bahl, and Murray 1990; Bloomquist 2003). Third-party reporting and the high share of labor income for individuals in the middle of the distribution explain much of this relationship. However, we make this assumption since the focus is on developing countries where it is more likely to hold due to less effective third party reporting and law enforcement. Most incidence studies find that PIT schedules, even in developing countries, are progressive; Martinez-Vazquez (2008) provides an extensive review of the tax incidence literature.

Figure 3. True and Reported Income Flow



Notes: The arrows indicate the direction in which income flows. For example, an individual must allocate true pre-tax income, Y^*, between evaded income, E, and reported income, Y^o. Reported income passes through the PIT function which produces taxes and reported net income, y^o. The evaded income plus the reported net income gives the true net income, y^*. The broken arrow indicates one possible reallocation of income following a reduction in tax rates. That is, lower tax rates may induce individuals to report a greater share of their income, thus reducing the share that is hidden. A missing link in this figure is the flow of welfare benefits to true pre-tax income (if taxable) or to observed net income (if non-taxable).

It is important to realize that the tax reform will affect the distribution of reported net income via a direct channel and an indirect channel, which is due to tax-induced changes in Y^* and E, and other non-tax related factors. If the indirect effect is relatively greater among the rich, then reported net income will become more unequally distributed. More importantly, the change in reported inequality is likely to be different than the change in actual inequality because of the evasion effect. To see this more clearly, assume that the tax-induced productivity effect is zero and that compliance increases to 100 percent. Under these assumptions, hidden income falls to zero and the new observed

net income distribution would be more unequal than its pre-reform counterpart but less unequal than the pre-reform true net income distribution; i.e., $\psi\left(y_{t-1}^{*}\right) > \psi\left(y_{t}^{*}\right) = \psi\left(y_{t}^{o}\right) > \psi\left(y_{t-1}^{o}\right)$. While it is clear that observed inequality has increased, the reality is that the distribution of true post-reform net income is more equal than its pre-reform counterpart. In other words, the evasion response increases observed inequality but reduces true inequality. It also follows from this example that the observed change in the distribution of net income includes an artificial component, which results in an overstatement of the change in inequality.[26]

See Duncan and Sabirianova Peter (2008) (Essay I) for a more formal treatment of the above analysis.

Russia and the Flat Tax

Although the issues discussed in this paper apply broadly to all countries, the data requirement greatly restrict the number of countries for which the analysis can be implemented. The ideal data set would have longitudinal data on true and reported gross income before and after a major tax reform. This would allow us to identify the evasion and real productivity elasticities using appropriate econometric techniques. The data would also include information on deductions, credits and other allowances, tax liability, and hence measures of net income. Unfortunately, these data do not exist for any country in the world. We overcome these data limitations by focusing on Russia. We should note that Russia does have certain limitations that must also be addressed for the study to

[26] Implicit in this example is the assumption that the percentage change in evasion is greater than the percentage change in the tax rate and that the tax reform affects the rich disproportionately.

be feasible. Below we describe the pros and cons of analyzing Russia as well as the assumptions under which the analysis is valid.

The most critical parameters needed for the analysis are the evasion and productivity elasticities. Although Russia does not have data on true gross income or evasion, a recent study by GMP uses the 2001 Russian flat tax reform and data from the Russian Longitudinal Monitoring Survey (RLMS) to estimate these elasticities based on the consumption income gap approach. Their approach is valid under the assumption that consumption is a good proxy for actual net income and that the gap between consumption and reported net income is due primarily to underreporting rather than dissaving.[27] For these same reasons, we are able to use consumption as a proxy for actual net income in our analysis. The corresponding gross income measures are obtained by inverting the tax function in each period taking into account basic deductions, which are available to everyone.

Also contributing to the choice of Russia is the fact that they implemented one of the most significant PIT reforms of the 21st century. The graduated PIT schedule was replaced with a linear PIT on January 1st 2001 (Table 8). The two top rates of 30 and 20 percent were eliminated and the threshold increased from 3168 rubles to 4800 rubles. The reform also eliminated the 1 percent social contribution, which employees were required to pay. Therefore, everyone paid the same flat rate of 13 percent after the

[27] GMP provides a number of reasons and empirical test to demonstrate that this is indeed the case for Russia. They show that consumption is greater than income for the entire sample period, that the gap declined after the tax reform, that the saving rate remained stable for the duration of the sample at around 6 percent, and that the level of saving required to explain the gap is approximately -30 percent.

reform as long as their income was above 4800 rubles.[28] From Table 8, we observe that individuals making over 50,000 rubles were the primary beneficiaries of the reform. Therefore, focusing on Russia allows me to identify the distributional impact of an actual flat PIT reform, which is an advantage over studies that focus on hypothetical reforms (Fuest, Peichl, and Schaefer 2008). We describe the data set used and provide more information on the required variables in the following sections.

[28] For a more extended description of the reform see Martinez-Vazquez, Rider, and Wallace (2008) and Ivanova, Keen, and Klemm (2005).

Table 8. The PIT Rate Structure Before and After Reform

Before Reform (2000)		After Reform (2001-2004)	
Taxable Income1	Marginal Rate	Taxable Income1	Marginal Rate
Below 3,168	0	Below 4,800	0
3,168 to 50,000	13	Above 4,800	13
50,000 to 150,000	21		
Above 150,000	31		

Source(s): Ivanova, Keen, and Klemm (2005)

Note: Marginal rates include the 1% payroll tax.

Empirical Strategy

This section outlines the empirical approach that is used to determine the effect of taxes on the distribution of income. We use estimates of the elasticity of true gross income with respect to taxes and the elasticity of evasion with respect to taxes to simulate counterfactual net income distributions, which are then used to decompose the change in the distribution of net income into direct, evasion and productivity effects.[29] Auten and Carroll (1999) and Gruber and Saez (2002) use the reported taxable income elasticity popularized by Feldstein (1995)to emphasize the importance of tax rates in explaining changes in the distribution of income. Although this approach can be used to identify the tax-induced indirect effect, we argue that it will lead to an overstatement of the change in the distribution of net income because it fails to distinguish between evasion and real productivity responses.[30] To illustrate, write reported taxable income as $Y^o = \left(Y^* - E\right)$.

[29] Poterba (2007) and Alm, Lee, and Wallace (2005) uses a similar counterfactual analysis to identify the direct and indirect effects.

[30] It has been shown, both theoretically and empirically, that the taxable income elasticity also overstates the efficiency gains/losses of a tax change if the elasticity is driven by evasion or avoidance that involves

Differentiating with respect to *t* and writing in elasticity form yields $\frac{\partial y^{O}}{\partial t} = \frac{1}{t}\left(Y^{*}\varepsilon_{y} - E\varepsilon_{E}\right)$, which includes the two main parameters of interest: the elasticity of true income ε_y and the elasticity of evasion ε_E. Since evasion leads to artificial changes in the distribution of net income, using the responsiveness of taxable income to identify the effect of taxes on the distribution of income would lead to incorrect conclusions. It is for this reason that each component must be separately identified.

Identification of the distributional effect

The distributional impact of the tax reform is obtained using a counterfactual based analysis as in Alm, Lee, and Wallace (2005) and Poterba (2007). Implementation is via micro-simulation exercises that allow me to examine the effect of taxes on the distribution of income with and without behavioral responses. The methodology is implemented in several steps. First, we calculate an index of the income distribution for the pre-reform period (year 2000) and the post-reform period (years 2002 and 2003).[31] These two measures are used to calculate the total change in the distribution of net income between the two periods. We then calculate two counterfactual net income distributions; net income when pre-reform tax schedule is applied to post-reform income and net income when post-reform tax schedule is applied to pre-reform income.[32] The

only transfer costs (Chetty 2009; and GMP). Slemrod (1998), Slemrod and Kopczuk (2002), and Gruber and Saez (2002) provide useful summaries of the taxable income elasticity literature.

[31] We exclude the year of the reform since it may take some time for individuals to fully respond the incentives created by the reform (Duncan and Sabirianova Peter, 2010).

[32] See Table 9 and Table 10 for a summary of the counterfactual income distributions and how they are compared to identify the various components of the change in income distribution. Estimating the

indirect effect is obtained by comparing the former counterfactual distribution with the observed pre-reform net income distribution. Similarly, we obtain the direct effect by comparing the latter counterfactual distribution with the observed pre-reform net income distribution.

The second step is to identify the tax-induced behavioral effects which are part of the indirect effect. This is done under two separate approaches. Under the first, we ignore the presence of evasion and treat all changes in reported gross income as real changes. By ignoring the fact that the evasion response affects the distribution of actual income differently than it does reported income inequality, this approach should overestimate the distributional impact of the tax changes. We correct for this in the second approach, which distinguishes between evasion/avoidance and real productivity responses. Both approaches require information on elasticities of evasion, productivity, and reported gross income, the pre-reform gross income distribution, and the pre-reform tax schedule.

Adjusting for behavioral responses

Below we give a brief description of the approach used to adjust reported gross income for evasion and productivity responses.[33] First, write reported gross income as $Y_{ig} = Y^*_{ig} - E_i$ and define the tax-induced change in evasion and true gross income as follows:

counterfactuals require several steps of which the most important is the imputation of gross income. The steps are outlined in detail in the accompanying simulation appendix.

[33] A more detailed step by step description of the approach used to adjust gross income for evasion and productivity responses is provided in the simulation appendix.

$$\Delta E_i = E_i \times \varepsilon_e \times \frac{\Delta\tau_i}{\tau_i} \Rightarrow E_i^{'} = E_i(1+\varepsilon_e \times \frac{\Delta\tau_i}{\tau_i}) \quad 23$$

$$\Delta Y_{ig}^{*} = Y_{ig}^{*} \times \varepsilon_y \times \frac{\Delta\tau_i}{\tau_i} \Rightarrow Y_{ig}^{*/} = Y_{ig}^{*}(1+\varepsilon_y \times \frac{\Delta\tau_i}{\tau_i}) \quad 24$$

Equations (23) and (24) give us the new level of hidden income and true gross income induced by a change in the tax rate. Using eq. (23) and the definition of reported gross income, we can write down an expression for the new level of reported income - due to the change in evasion as

$$Y_{ig}^{'} = Y_{ig}^{*} - E_i(1+\varepsilon_e \times \frac{\Delta\tau_i}{\tau_i}) \quad 25$$

which then implies that the percentage change in individual reported gross income due to the change in evasion (assuming no productivity response) is

$$\%\Delta Y_{ig} = (Y_{ig}^{'} - Y_{ig})/Y_{ig} = -\varepsilon_h \times \frac{\Delta\tau_i}{\tau_i} \times \frac{\pi}{1-\pi}; \qquad \pi = E/Y \quad 26$$

Similarly, the percentage change in individual reported gross income due to the change in productivity (assuming no evasion response) can be written as

$$\%\Delta Y_{ig} = \varepsilon_y \times \frac{\Delta\tau_i}{\tau_i} \times \frac{1}{1-\pi} \quad 27$$

Finally, the percentage change in individual reported gross income due to the change in both evasion and productivity is

$$\%\Delta Y_{ig} = \frac{\Delta\tau_i}{\tau_i} \times \frac{\varepsilon_y - \varepsilon_e\pi}{1-\pi} \quad 28$$

Equations (26), (27), and (28) allow me to write reported gross income adjusted for evasion and productivity as $Y_{ig}^{ey} = Y_{ig} + Y_{ig} \times [\frac{\Delta\tau_i}{\tau_i} \times \frac{\varepsilon_y - \varepsilon_e\pi}{1-\pi}]$, which nests the evasion effect ($\varepsilon_y = 0$), the productivity effect ($\varepsilon_e = 0$), and the myopic view that ignores

the distinction between evasion and real productivity changes (set π=0 and replace the elasticity of true income, ε_y with the elasticity of reported gross income).

The beauty of this approach is that the level of evasion, which cannot be observed, is not needed. Although the share of evasion in true income, π is unknown, sensitivity analysis can be used to determine its effect on the results. Using a similar procedure, we calculate the change in true gross income as $Y_{ig}^{*y} = Y_{ig}^{*} + Y_{ig}^{*} \times \varepsilon_y \times \frac{\Delta\tau}{\tau}$. The premise of this derivation is that the level and responsiveness of evasion does not affect true gross income.[34] Adjusting income as suggested above ignores the fact that, tax induced changes in savings, say, may lead to changes in capital, which in turn affects income. Our analysis ignores these second round effects.[35]

The above procedure allows me to write down counterfactuals that we use to determine the size and sign of the evasion and productivity effects.[36] We estimate the evasion effect, by comparing the pre-reform (year 2000) distribution of net income with the distribution of net income that would obtain if the only tax-induced behavioral response to the tax reform was evasion. The productivity effect is obtained similarly, except that we assume the only response is through productivity changes. We also estimate the total behavioral effect by allowing both evasion and productivity to change simultaneously (calculations are summarized in Table 9 and Table 10). Finally, we

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[34] It is possible that the ability to hide income affects the amount of income earned just as the amount of income earned might affect the amount of income that individuals hide (Slemrod 2001). However, estimates of these cross elasticities do not yet exist. As such, we ignore any possible cross effects.

[35] See Elmendorf et. al.(2008) for a discussion of these additional second round effects.

[36] The adjustments use income in year 2000 as the base. Additionally, we hold the tax schedule constant so that any change must be due to the change in income only; base calculations are done using the pre-reform tax schedule.

estimate the total tax-induced behavioral effect using the reported gross income elasticity, which ignores the difference between evasion and real productivity responses.

Data

The data are taken from the Russian Longitudinal Monitoring Survey (RLMS), which is a household level survey conducted annually since 1992 in two phases.[37] It is widely representative of the Russian population, covering approximately 32 regions, 38 randomly selected primary sampling units, and 7 Russian federal districts. The survey is administered in the last quarter of each year and includes four separate questionnaires; one for each household, each adult in the household, each child in the household, and a community questionnaire. According to the host website of the RLMS, the response rate exceeds 80 percent for households and 95 percent for individuals within each household. The data cover more than 4000 households and 10000 adults on average. Besides the relatively large sample size, the data set has a panel feature with two years before and 4 years after the Russian tax reform, which makes it suitable for our purposes.

The sample used in the empirical analysis is restricted to households in which at least one individual is between the ages of 25 and 60 years old. This restriction eliminates households that are either too young or too old, which may contribute to non-random fluctuations in income. Additionally, we focus on the years 2000 (pre-reform base year) and 2002 for our base results. Although the reform became effective on

[37] No survey was conducted in 1997 and 1999. The survey is a joint project between the Population Center at the University of North Carolina and the Russian Academy of Sociology. Information on sample selection, attrition and the like can be obtained from the host site; http://www.cpc.unc.edu/projects/rlms, accessed October 2009.

January 1st 2001 and data are collected in the last quarter of the year, we exclude the year 2001 from the analysis to allow individuals more time to respond to the new tax schedule.

Sample attrition is relatively minor in the RLMS as compared to other large panel datasets. Nonetheless, there is some evidence that the attrition is nonrandom; those who leave the sample tend to be more educated, have higher income, and are more likely to have lived in Moscow and St. Petersburg (Mu 2006). This non-random attrition means that any observed decline in inequality maybe due to the fact that the upper tail of the income distribution loses a relatively larger share of people over time. However, the RLMS makes an effort to replenish the sample over time, especially for Moscow and St. Petersburg, thus partly solving the attrition (Gorodnichenko, Sabirianova-Peter, and Stolyarov 2009).

Variables

The RLMS has some, but not all, of the ideal variables needed to complete the analysis. No data is available for true gross income, reported gross income, true net income, or tax liability. We do have data on reported net income and the tax function, including the rules for calculating basic deductions. We also have data on consumption, which we use as a proxy for true net income under the assumption that the consumption income gap observed in Russia cannot be explained by dissaving (Gorodnichenko, Martinez-Vazquez, and Sabirianova Peter 2009). The core analysis is conducted at the household level because data on consumption and some components of income are only

available at the household level. Where possible we do provide individual level results as well. Below we briefly describe each measure of income.[38]

Reported Net Income

The RLMS collects reported net income data at both the individual and household levels. Individual measures include actual monetary labor income earnings received last month and contractual monetary labor earnings (received on average over the last 12 months). Contractual monetary labor earnings are used to create a third income measure; imputed contractual monetary labor earnings.[39] Actual income is more prone to monthly income shocks, which may be the result of wage arrears, forced leave, and sickness, among others. Contractual earnings on the other hand, are more stable as they reflect the usual income received per month over a one year period. Using the imputed contractual earnings is advantageous because it provides a more accurate description of income within households, which is the unit of measurement used to test the main hypotheses of the paper. The baseline results at the individual level use imputed contractual labor earnings at the primary and secondary job. Although labor earnings are the only component of income available at the individual level, it represents over 80 percent of income and should therefore do a good enough job of describing the distributional impact of the tax reform at the individual level.

Imputed contractual labor earnings are summed across individuals within households to obtain a base measure of household reported net income. A second

[38] The simulation appendix outlines the iterative process used to recover gross income measures.
[39] The imputation is for working non-respondents. Because the PIT is assessed on the individual, the imputation is done in an effort to obtain an accurate measure of household net income, which involves summing tax liability across individuals within households.

measure, reported disposable income before public transfers is obtained by adding non-labor income to household labor earnings.[40]

Actual Net Income

We use consumption as a proxy for actual net income, which is, by definition, unobservable. The fact that consumption is also subjected to under-reporting means that it gives us a lower bound on actual net income. Therefore, any differential effect of taxes on consumption should represent a lower bound to the differential effect on actual net income. While income measures are available at both individual and household level, consumption is only available at the household level. We use non-durable consumption, which includes expenditure data on more than 55 food items at home and away from home plus durable consumption as our baseline measure of true income.[41]

Gross Income Measures

Unfortunately, the RLMS does not collect information on gross income. Since the analysis requires these data, we impute them by inverting the tax function for each period. The implicit assumptions underlying the inversion are that monthly income is received uniformly throughout the year and that reported net income reflects tax liability actually paid. Starting with net income, we recover the gross income measures using an iterative process in STATA. The iterative process simultaneously imputes gross income and the implied tax liability for each individual. Next, we calculate gross income at the

[40] These include net private transfers and financial income, which are received at the household level. Net private transfers refer to receipts (money and in kind) from non-government sources minus contributions to individuals outside the household unit.

[41] Food items are reported for the last 7 days while other non-durables are reported for the last 30 days. See Table B 3 for a detail description of each variable.

household level by adding household level tax liability to the respective measures of household net income, where household tax liability is the within household summation of the individual level tax liability based on imputed contractual earnings.[42] We then proceed with the analysis as described in the empirical section and the simulation appendix.

Results

Implementation of the micro-simulation exercise involves a number of steps that are outlined in the simulation appendix. The first step in the exercise is to recover the gross income measures since the RLMS only reports net figures. The imputed gross income measures are then used to calculate each of the counterfactual net incomes in Table 10 using the formulas in Table 9. The counterfactual net incomes are then used to calculate several indices of income inequality. These include the GINI coefficient, coefficient of variation (CV), and the variance of log (Var-log). Baseline indices are calculated using only non-zero values of each income measure. All income/consumption measures are converted to December 2002 prices, and household measures are adjusted using the OECD equivalence scale. Additionally, the individual (household) level

[42] This is necessary because tax is administered at the individual level. The alternative would be to impute household level gross income measures directly using the iterative procedure that is used for individuals. However, this approach would lead to incorrect estimates of pre-reform gross income since the effective tax rate of the household would be at least as great as the effective rate facing any given member of that household. This is due to the fact that the pre-reform tax schedule is a graduated one. It doesn't matter which approach is taken in the post reform period since the tax rate is flat. We base all household level gross income measures on the individual level imputed contractual earnings variable in an effort to deal with non-response of working adults within some households.

inequality indices are calculated using the RLMS individual (household) sample weights to address sample attrition and other sampling errors.[43]

[43] The RLMS sample weights adjusts for sample design factors and deviations from the census characteristics, which implicitly address sample attrition.

Table 9.

Level of analysis	Evasion effect	Productivity effect	Combined effect
	E1	**F1**	**G1**
Individual	$Y^{e}_{in} = Y^{e}_{ig} - T_{2000}(Y^{e}_{ig} - D_{2000})$	$Y^{y}_{in} = Y^{y}_{ig} - T_{2000}(Y^{y}_{ig} - D_{2000})$	$Y^{ye}_{in} = Y^{ye}_{ig} - T_{2000}(Y^{ye}_{ig} - D_{2000})$
Household	$Y^{*e}_{hn} = Y^{*}_{hg2000} - \sum_i T_{2000}(Y^{e}_{ig} - D_{2000})$	$Y^{*y}_{hn} = Y^{*y}_{hg} - \sum_i T_{2000}(Y^{y}_{ig} - D_{2000})$	$Y^{*ye}_{hn} = Y^{*y}_{hg} - \sum_i T_{2000}(Y^{ye}_{ig} - D_{2000})$
	E2	**F2**	**G2**
Individual	$Y^{e}_{in} = Y^{e}_{ig} - T_{2001}(Y^{e}_{ig} - D_{2001})$	$Y^{y}_{in} = Y^{y}_{ig} - T_{2001}(Y^{y}_{ig} - D_{2001})$	$Y^{ye}_{in} = Y^{ye}_{ig} - T_{2001}(Y^{ye}_{ig} - D_{2001})$
Household	$Y^{*e}_{hn} = Y^{*}_{hg2000} - \sum_i T_{2001}(Y^{e}_{ig} - D_{2001})$	$Y^{*y}_{hn} = Y^{*y}_{hg} - \sum_i T_{2001}(Y^{y}_{ig} - D_{2001})$	$Y^{*ye}_{hn} = Y^{*y}_{hg} - \sum_i T_{2001}(Y^{ye}_{ig} - D_{2001})$

Notes: The top panel (E1, F1, and G1) uses the pre-reform tax schedule to calculate net income while the bottom panel (E2, F2, and G2) uses the post-reform tax schedule. Superscripts e and y indicate that income has been adjusted for evasion and productivity, respectively. Consumption based measures of household income is adjusted for productivity only. However, evasion activity at the individual level indirectly affects consumption measures via changes in tax liability. Household tax liability is first calculated at the individual level and then summed over individuals within the household.

Table 10. Summary of Counterfactual Measures of Net Income

			Panel A			
Tax schedule	*Pre-reform*	*Pre-reform*	*Post reform*	*Post reform*	-	-
Income year	*Pre-reform*	*Post reform*	*Pre-reform*	*Post reform*	-	-
$\psi(y)$	**A**	**C**	**D**	**B**	**-**	**-**
			Panel B			
Tax schedule	*Pre-reform*	*Pre-reform*	*Pre-reform*	*Post reform*	*Post reform*	*Post reform*
Income	*Adjust E*	*Adjust Y*	*Adjust Y&E*	*Adjust E*	*Adjust Y*	*Adjust Y&E*
$\psi(y)$	**E1**	**F1**	**G1**	**E2**	**F2**	**G2**
			Panel C			
	Tax	*Behavior*	*Tax and Behavior*	*Evasion*	*Productivity*	*Productivity and evasion*
	D-A	**C-A**	**B-A**	**E1-A**	**F1-A**	**G1-A**
	B-C	**B-D**		**E2-D**	**F2-D**	**G2-D**

Note: $\psi(y)$ is a summary measure of **net** income distribution (eg., GINI, coefficient of variation etc.). Counterfactuals in *Panel A* are used to separate the direct (tax) effect from the indirect effect while those in *Panel B* are used to identify the tax-induced indirect (behavioral) effects (evasion and productivity); these are illustrated in Panel C. For example, the direct (tax) effect is calculated by holding the pre-tax distribution of income constant while allowing the tax schedule to change. This can be done by comparing D with A (pre-reform income held constant) or B with C (post-reform income held constant). The counterfactuals E1 to G2 use income in year 2000 as the base; E1 through G1 uses the pre-reform tax schedule to calculate net income while E2 to G2 uses the post-reform tax schedule.

PIT progressivity

Measures of tax progressivity can be broadly classified into two categories; structural and effective (Musgrave and Thin 1948). Each category has several methods that can be used to calculate progressivity.[44] Here we will discuss two such measures of effective progressivity before discussing the direct/indirect effects of the tax reform. Table 11 shows how the ability of the pre-reform and post-reform PIT schedules to reduce income inequality changed over the sample period under study. The first measure, percent change in the GINI coefficient captures the degree to which the tax schedules reduce the inequality in gross income by taking the difference between the GINI of individual reported gross contractual earnings and the GINI of net contractual earnings (Alm, Lee, and Wallace 2005). The second is a measure of effective progressivity defined as $1-G_a/1-G_b$, where G_a is the GINI of net income and G_b is the GINI of gross income; a value above (below) 1 indicates that the tax is progressive (regressive) (Musgrave and Thin 1948). Panel A of Table 11 applies the pre-reform tax schedule to gross income in each year while Panel B uses the post-reform tax schedule. This implies that each panel captures the effectiveness of each tax schedule to reduce inequality over time.

The results show that the graduated tax schedule of the pre-reform era is more effective at reducing income inequality than the linear post-reform schedule. In fact, the effectiveness of the pre-reform schedule increases over the sample period while the post-reform schedule becomes less effective. For example, the pre-reform PIT schedule

[44] For example, Duncan and Sabirianova Peter (2008), use two measures of structural progressivity, which does not rely on any information about the distribution of income.

reduced inequality, as measured by the GINI coefficient, by 4 percent in 2000. This is compared to a 2.7 percent decline that would have taken place had the post-reform PIT schedule existed in the year 2000. A similar comparison for the remaining years reveal that the pre-reform schedule out performs the post-reform schedule throughout the sample period. The implications of these results are addressed in the next sections where we decompose the change in the distribution of income across periods into direct and indirect effects.

Table 11. Progressivity of PIT Schedules

	Panel A: Pre-reform Tax Schedule				
Income year	**2000**	**2001**	**2002**	**2003**	**2004**
Gross income	0.3620	0.3342	0.3189	0.3081	0.3013
Net income	0.3475	0.3207	0.3016	0.2907	0.2832
Percent change in GINI	-4.0161	-4.0428	-5.4245	-5.6619	-6.0174
Effective progressivity	1.0228	1.0203	1.0254	1.0252	1.0260
	Panel B: Post-reform Tax Schedule				
Gross income	0.3620	0.3342	0.3189	0.3081	0.3013
Net income	0.3521	0.3277	0.3150	0.3053	0.2994
Percent change in GINI	-2.7372	-1.9203	-1.2299	-0.9167	-0.6556
Effective progressivity	1.0155	1.0096	1.0058	1.0041	1.0028
Observations	4176	4724	4949	5095	5213

Note: Reported are the within period differences between gross income and net income GINI coefficients, and a measure of effective progressivity. Effective progressivity is calculated as 1 minus after tax GINI divided by 1 minus before tax GINI (Musgrave and Thin 1948). All calculations are for non-zero values of imputed contractual earnings at the individual level.

Direct Vs Indirect Effect

Decomposing the total change in net income inequality between 2000 and 2002 into its direct and indirect effects is done using the counterfactuals in panel A of Table 10. For example, we calculate the net income that would be observed if the post-reform

gross income existed in the pre-reform period (counterfactual C in panel A of Table 10). As indicated in panel C of Table 10, the direct tax effect can be measured by comparing the counterfactual net income labeled D with the net income distribution observed in the pre-reform year. The indirect effect, on the other hand, is obtained by comparing counterfactual C with the net income distribution observed in the pre-reform year. The results from this exercise are reported in Table 12.

Table 12. Distributional Impact of the Flat Tax Reform: Direct Vs. Indirect Effect

Tax Year **Income Year**	***2000*** **2000**	***2002*** **2002**	***2000*** **2002**	***2002*** **2000**	***Total effect***	***Indirect effect***	***Direct effect***
Panel A: Individual		*GINI Coefficient*				*% change in GINI*	
Contractual Earnings	0.4812	0.4402	0.4230	0.489	-8.515	-12.091	1.623
Panel B: Household							
Consumption	0.495	0.449	0.447	0.497	-9.395	-9.857	0.350
Income	0.479	0.445	0.433	0.486	-7.089	-9.616	1.408

Notes: Reported are the GINI coefficients in levels and percent changes. The sample is restricted to non-zero values for each variable; imputed contractual labor earnings at the individual level and durable plus non-durable consumption and reported income before public transfers at the household level. Decompositions are calculated as follows: the total effect is the change between the first two columns, the indirect effect is the change between columns one and three, and the direct effect is the change between columns one and four. All changes are in percent.

Panel A of Table 12 reports the results for individual level reported imputed contractual earnings. The results show that inequality declined between the year 2000 and 2002; the GINI fell from 0.48 to 0.45. We decompose this total change into direct and indirect effects and find that indirect behavioral responses are the primary reasons for the decline. The change in the distribution of gross income between 2000 and 2002 would have led to a 12 percent decline in the GINI coefficient of net income had the pre-reform tax schedule existed in 2002. The direct effect, on the other hand, would have increased the GINI by 1.6 percent had the post reform tax schedule existed in the year 2000. Similar results are observed in Panel B where the analysis is at the household level using durable plus non-durable consumption as a proxy for actual net income and reported net income before public transfers. The direct effect had a relatively larger impact on consumption while the indirect effect is approximately equal for both measures of income.

Tax-Induced Indirect Effect

The results in Table 12 are consistent with previous work in this area (Alm, Lee, and Wallace 2005; Poterba 2007).[45] However, it is important to note that the indirect effect includes responses that are tax-induced as well as responses that are induced by other factors unrelated to the change in the tax schedule. This section identifies the tax-induced portion of the indirect effects under two separate assumptions; that there is tax evasion and that there is no tax evasion.

[45] These results remain consistent across inequality indices, measures of income, and choice of post-reform year.

The last column of Table 13 reports the percent change in the GINI coefficient assuming there is no tax evasion. That is, we treat the tax-induced change in reported gross income as a real change in total income available to the individual/household and adjust income using the reported gross income elasticity; GMP estimates this elasticity to be -0.21.[46] The results show that the tax induced change in reported gross income led to a 15.8 percent increase in the GINI coefficient of individual contractual earnings. In other words, tax induced responses, under the assumption that there is no tax evasion, increased inequality in each measure of net income at both the individual and household level. This result is in line with expectations given that the tax reform induced individuals in the right tail of the income distribution to increase their reported income.[47]

As discussed in the empirical strategy, using this elasticity to determine the distributional impact of a tax reform will lead to biased estimates because it fails to distinguish between evasion and real productivity responses. We distinguish between these responses by using the counterfactuals in panel B of Table 10. Before applying the relevant tax schedules, we adjust the gross income of year 2000 using the procedure outlined in appendix C. We set the baseline parameter values equal to 0.26, -0.04, and 0.25, for evasion and productivity elasticities and evasion share, respectively; elasticities are from GMP and the evasion share is from Ivanova, Keen, and Klemm (2005).

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46 The important thing to note here is that no distinction is made between the various behavioral responses; real productivity responses and evasion responses are treated as one and the same.

[47] Only individuals earning above 50,000 rubles were affected by the tax reform; see Table 8. GMP finds that individuals affected by the rate changes increased their reported income relative to those not affected by the reform. Duncan and Sabirianova Peter (2010) also find evidence that labor supply increased among males who were affected by the rate changes relative to those not affected.

Table 13. Distributional Impact of the Flat Tax Reform: Tax-Induced Behavioral Effects

	Levels				Indirect effect when π>0			Indirect effect when π=0
Tax Schedule Adjustment	**2000 None**	**2000 Evasion**	**2000 Real**	**2000 Both**	**Evasion effect**	**Real effect**	**Combined effect**	
Panel A: Individual	*GINI Coefficient*				*% change in GINI*			
Contractual Earnings	0.4812	0.5169	0.5040	0.5356	7.4251	4.7386	11.3207	15.8223
Panel B: Household								
Consumption	0.4954	0.4949	0.5038	0.5029	-0.1003	1.6886	1.5085	9.2662
Income	0.4792	0.5049	0.4951	0.5198	5.3540	3.3180	8.4710	6.5628

Notes: Reported are the GINI coefficients in levels and percent changes. The sample is restricted to non-zero values for each variable; imputed contractual labor earnings at the individual level and durable plus non-durable consumption and reported income before public transfers at the household level. Decompositions are calculated as follows: the evasion effect is the change between the first two columns (assumes productivity response is zero), the real (productivity) effect is the change between columns one and three (assumes evasion response is zero), and the total effect is the change between columns one and four (assumes both productivity and evasion responds). The last column reports the tax-induced indirect effect if evasion is ignored; i.e., it lumps the evasion and productivity responses together using the elasticity of reported gross income. Adjustments are made using the following baseline parameters: evasion elasticity 0.26, productivity elasticity -0.04, and reported gross income elasticity -0.21 from GMP; evasion as a share of true income 0.25 is from Ivanova, Keen, and Klemm (2005). All changes are in percent.

One of the main problems encountered when adjusting gross income for evasion and productivity is the application of the elasticities. All tax liability figures have to be calculated at the individual level while the parameters are estimated at the household level. For example, suppose that evasion is the only tax induced behavioral response to the reform. Estimating the distributional impact of this response on household net income requires information on the gross income and tax liability implied by the evasion response. Therefore, the first step is to obtain the household gross income implied by the evasion response. As discussed above, this can only be done if we have individual level gross income, making individual level evasion elasticity the more suitable parameter. To get around this problem, we assume that the evasion elasticity for each household applies to each member of that household.[48]

The adjustments also apply the same evasion share to everyone. While this is a strong assumption, we believe that it works in our favor because only individuals with income above 50,000 rubles are affected by the reform. Therefore, the results if we were to apply the evasion share by deciles, for example, should be stronger than those reported here.

The results reported in Table 13 show that distinguishing between evasion and real productivity responses is important when analyzing the distributional impact of a PIT rate change. First, we find that the combined effect of evasion and real productivity responses increases inequality in both reported net income and consumption. In other

[48] Since the estimated elasticity is for the average household, we are implicitly assuming that this is representative of the average individual. This is a strong assumption. Since the GMP method on which we rely can only be applied at the household level, we have no alternative. A similar procedure is followed for productivity. The reader should keep this in mind when interpreting the results. See the simulation appendix for details on the procedure.

words, tax-induced behavioral responses, like the direct effect, led to an increase in net income inequality. The implication of this result is that non-tax related factors are the main driving force behind the decline in income inequality in Russia over the sample period.[49]

The importance of separating the evasion from the real productivity effects is also made clear by comparing columns 5 and 6 of Table 13. Such a comparison shows that the evasion effect is relatively larger than the real productivity effect regardless of income measure and unit of analysis. This suggest that a relatively larger share of the tax-induced increase in reported net income inequality at both the individual and household levels is being driven by increased reporting among those affected by the tax reform. For example, inequality in imputed contractual earnings (Panel A of Table 13), as measured by the GINI coefficient, increases by 7.4 percent if evasion is the only response compared to 4.7 percent when productivity responses are the only behavioral effect. A similar pattern is observed for reported household income in Panel B. Since the evasion response involves shifting existing income, it represents an artificial change in the distribution of reported net income thus leading to an overestimate of the distributional impact of the reform. As such, we argue that policy prescriptions should be based on the contribution of the real productivity effect instead of the combined effect.

The second argument in favor of decomposing the tax-induced indirect effect into evasion and real productivity effects is evident from panel B of Table 13. We compare the distributional impact of the evasion effect on reported net income with its effect on actual net income (approximated by consumption). The results show that the evasion

[49] Gorodnichenko, Sabirianova Peter, and Stolyarov (2009) provide a detail discussion of the trends in inequality in Russia between 1994 and 2005 including possible factors that may have contributed to the decline.

effect reduces consumption GINI by 0.1 percent while increasing reported net income GINI by 5.4 percent. Another obvious difference is that evasion has a much smaller effect on consumption than on reported income. Furthermore, the combined evasion and productivity effect is much larger for reported income than for consumption; GINI increase by 8.5 percent for reported income compared to 1.5 percent for consumption. These results are in line with expectation since evasion can only affect actual net income through income shifting while the reported net income is directly affected by both evasion and productivity. That is, the nature of the Russian PIT reform led to a relative decline (increase) in hidden (reported) income among the rich, which then caused a decline (increase) in actual (reported) net income inequality. The productivity effect, on the other hand, increased both actual and reported net income disproportionately among the rich. Therefore, tax policies that ignore the distinction between evasion and productivity responses as well as the distinction between actual and reported net income are likely to lead to incorrect policy prescriptions.

Robustness checks

The results discussed here are qualitatively the same regardless of income/consumption measure, parameter values chosen, and inequality index. Furthermore, the size of the parameters used in the analysis affect the results in an intuitive way. For example, the results in Table 14 show that the artificial change in reported net income inequality increases with the share of income evaded and the responsiveness of evasion to PIT rate changes. As expected, varying the evasion parameters have little effect on consumption inequality while the size of the productivity response matters. For example, a productivity elasticity of -0.1 increases consumption

GINI by 4.3 percent compared to an increase of only 1.7 percent when the productivity elasticity is -0.04. Robustness checks shown in Table B 4 are qualitatively the same as those discussed here. We conduct several additional robustness checks using various measures of income and consumption that control for savings, public transfers, home production, and service value of own home consumption. These checks all support the results presented here and are available upon request. We also restrict the analysis to individuals with non-zero vales for imputed contractual earnings and find similar results.

Table 14. Sensitivity Analysis of Tax-Induced Behavioral Effects

Parameters			**Contractual Earnings**			**Consumption**		
π	**ε(e)**	**ε(y)**	**Evasion effect**	**Real effect**	**Combined effect**	**Evasion effect**	**Real effect**	**Combined effect**
0.20	0.26	-0.04	5.7034	4.4585	9.5526	-0.0895	1.6982	1.5429
0.25	0.26	-0.04	7.4251	4.7386	11.3207	-0.1003	1.6886	1.5085
0.30	0.26	-0.04	9.2907	5.0562	13.2319	-0.0942	1.6780	1.4899
0.25	0.20	-0.04	5.8393	4.7386	9.9134	-0.0907	1.6886	1.5353
0.25	0.30	-0.04	8.4427	4.7386	12.2255	-0.1005	1.6886	1.4967
0.25	0.26	0.00	7.4251	0.0000	7.4251	-0.1003	0.0000	-0.1003
0.25	0.26	-0.10	7.4251	10.8599	16.4149	-0.1003	4.2874	3.9936

Notes: Reported are percent changes in GINI coefficients. The sample is restricted to non-zero values for each variable; imputed contractual labor earnings at the individual level, and durable plus non-durable consumption and income before public transfers at the household level. Decompositions are calculated as described in the notes to Table 13.

Table 14– *Continued*.

Parameters			**Income**		
π	**ε(e)**	**ε(y)**	**Evasion effect**	**Real effect**	**Combined effect**
0.20	0.26	-0.04	4.0378	3.1116	7.0324
0.25	0.26	-0.04	5.3540	3.3180	8.4710
0.30	0.26	-0.04	6.8227	3.5535	10.0651
0.25	0.20	-0.04	4.1404	3.3180	7.3235
0.25	0.30	-0.04	6.1493	3.3180	9.2206
0.25	0.26	0.00	5.3540	0.0000	5.3540
0.25	0.26	-0.10	5.3540	8.0927	12.8113

Conclusion

Numerous researchers have identified the fact that tax payers change their behavior in response to changes in tax rates. While these behavioral changes are at the core of studies that look at efficiency and optimal tax policy, little is known about their impact on the relationship between tax rates and the distribution of income. Additionally, the existing literature either fails to identify the distributional impact of tax-induced behavioral responses all together or ignore some dimensions. In particular, the distributional impact of tax-induced changes in evasion remains an unexplored area in the empirical literature. We attempt to bridge this gap in the literature by decomposing the change income inequality into direct and indirect effects. The indirect effect is further decomposed into tax-induced evasion and productivity effects using elasticities of evasion and productivity. The analysis also distinguishes between reported income and actual income (consumption) inequality.

The analysis focuses on Russia due to strict data requirements. In particular, we use data from the Russian Longitudinal Monitoring Survey to study the distributional impact of the Russian flat tax reform. Focusing the analysis on Russia is advantageous because there is an actual flat tax reform to analyze, the RLMS has very rich data on consumption and income, and evasion and productivity elasticities are available; the latter two are crucial for our analysis.

We find that the switch to a flat PIT reduced the ability of the PIT to equalize net income and that the post-reform PIT's ineffectiveness worsens over the sample period. The results also show that mechanical changes in the tax rates had a relatively smaller effect on the distribution of income compared to indirect behavioral responses, which actually reduced income inequality. We identify the tax-induced portion of the indirect effect by using the evasion and productivity elasticities to estimate a series of counterfactual reported and actual net income measures at the household level. Net income is approximated by consumption. The results from this analysis show that the combined effect of evasion and productivity is positive, i.e., led to an increase in income inequality. However, further analysis reveals that the evasion effect is relatively larger than the productivity effect for reported net income but smaller for actual net income. In fact, we find that while tax induced changes in evasion led to an increase in reported net income, they reduced actual net income inequality.

These results have very serious policy implications especially for policy makers currently contemplating the adoption of a flat/flatter PIT schedule. First, it is important that a distinction be made between evasion and real productivity effects. Failure to do so will lead to an overestimation of the distributional impact of tax rate changes and can

result in incorrect policy advice. This distinction is particularly relevant in countries with very high levels of evasion. The results also show that tax-induced changes in behavior are not as important as are other factors that affect earning potential. For example, it may be more useful to invest in education and other training programs that improve the employability of working age individuals than to rely on the tax schedule as a tool for redistributing income.

CONCLUSION

This dissertation provides an empirical analysis of the relationship between the structural progressivity of personal income taxes and income inequality, with a special emphasis on the differential effect of progressivity on observed versus actual inequality. Although much work has been done to assess the impact of tax reforms on the distribution of income, this is the first known attempt to differentiate between these two effects.

The first essay examines whether income inequality is affected by the structural progressivity of national income tax systems. 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, ceteris paribus. To test these hypotheses, we use a country-level dataset of GINI coefficients calculated separately for gross income, net income, and consumption. We also use detailed personal income tax schedules for a large panel of countries to develop and estimate comprehensive, time-varying measures of structural progressivity of national income tax systems over the 1981–2005 period.

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 possible, 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 produces 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.

The second essay complements the first in its empirical approach, but relies on household rather than country level data. We simulate the distributional impact of the Russian personal income tax (PIT) following the flat tax reform of 2001 using data from the Russian Longitudinal Monitoring Survey. We use a series of counterfactuals to decompose the change in the distribution of net income into a direct (tax) effect and an indirect behavioral effect. The indirect effect is further decomposed into evasion and productivity effects using existing estimates of these respective elasticities. Again, a distinction is made between reported income and true income (approximated by consumption) inequality.

As expected, the direct tax effect increased net income inequality. Changes in the pre-tax distribution (indirect effect), on the other hand, had a large negative impact on inequality thus leading to an overall decline in net income inequality. We also find that the tax-induced evasion response increased reported net income inequality while reducing consumption based measures of net income inequality. To the extent that consumption approximates true income, these results demonstrate that the PIT affects true income inequality differently than it does reported income inequality. The results further imply that countries with very large informal sectors may not be restricted by the equity efficiency trade-off and that redistribution policy should target gross income rather than the progressivity of the tax schedule.

Both essays together make clear that the popular efficiency equity trade-off related to tax progressivity is weaker than we think. These results are especially true for countries with weak tax administrative institutions. This conclusion becomes obvious once it is recognized that changes in inequality that arise from changes in evasion are artificial. In other words, observed inequality can increase if a lower tax rate causes rich tax payers to report a relatively greater share of their income. This increase in inequality represents a shift toward the true inequality that existed prior to the tax change. Therefore, to the extent that this "artificial" effect is relatively large, the actual equity cost of the efficiency gained from switching to a flatter tax schedule will be much lower than observed. In this case, it is optimal to adopt a flatter tax schedule not only because it is more efficient but also because the true equity effects are smaller than commonly assumed.

Therefore, knowing if and how taxes affect the distribution of income and consumption is important for policy makers as they attempt to strike an important balance between efficiency and equity.

APPENDIX A: THEORETICAL APPENDIX

A1: General utility model

Assuming the utility function is separable in consumption and income is a particularly restrictive assumption. In this section we derive the main theoretical results with a more general utility function and show that the conclusions are not greatly affected by the simplification imposed in the main text. The utility function has the same properties as before except that separability is relaxed. Therefore, we write the utility function as $U = U(C, y)$. The individual's objective is to

$$Max\ \text{EU} = (1-\rho)U(C_1, y) + \rho U(C_2, y)$$

subject to equations (1.1) and (1.2), and $E \geq 0, y \geq 0$

Differentiating with respect to *y* and *E* yields

$$\frac{\partial EU}{\partial y} = (1-\rho)\left[U'(C_1)(1-t) + U'(y)\right] + \rho\left[U'(C_2)(1-t) + U'(y)\right] \leq 0 \qquad \text{A1}$$

$$\frac{\partial EU}{\partial E} = (1-\rho)U'(C_1)t + \rho U'(C_2)\frac{\partial C_2}{\partial F}\frac{\partial F}{\partial E} \leq 0 \qquad \text{A2}$$

Both equations are satisfied with equality for interior solutions. The earnings and evasion functions are implicitly defined by these equations. Also, unlike the simple model, evasion is function of earnings and vice-versa. It has been shown in the existing literature that comparative statics in this setting produces ambiguous results (Cowell 1985).

An implication of this more complicated functional form is that eq. (9) and (16) will have extra terms (cross elasticities) in them that cannot be easily signed.

Ignoring these elasticity terms is likely to create a bias in the results that may affect the conclusions drawn in the main text. Therefore, knowledge of the sign and potential magnitude of this bias is important if we are to have any confidence in the results derived in the text. We show below that the bias created is most likely to be positive and very close to zero.

Consider the following simple illustration. Define the Kuznets inequality index as follows

$$I_y^o = \frac{y_r^o}{y_p^o + G} = \frac{\left(Y_r^* - E_r\right)\left(1 - t_r\right)}{\left(Y_p^* - E_r\right)\left(1 - t_p\right) + G} \qquad \text{A3}$$

$$G = \alpha\left[t_r\left(Y_r^* - E_r\right) + t_p\left(Y_p^* - E_p\right)\right]_r \qquad \text{A4}$$

$$\frac{\partial I_y^o}{\partial \tau_r} = \frac{\left(y_p^o + G\right)\left[\left(1-\tau_r\right)\left(\left(\frac{\partial Y_r^*}{\partial \tau_r} + \frac{\partial Y_r^*}{\partial E_r}\frac{\partial E_r}{\partial \tau_r}\right) - \left(\frac{\partial E_r}{\partial \tau_r} + \frac{\partial E_r}{\partial Y_r^*}\frac{\partial Y_r^*}{\partial \tau_r}\right)\right) - \left(Y_r^* - E_r\right)\right] - y_r^o\frac{\partial G}{\partial \tau_r}}{\left(y_p^o + G\right)^2} \qquad \text{A5}$$

$$\frac{\partial G_r}{\partial \tau_r} = \alpha\left[t_r\left(\left(\frac{\partial Y_r^*}{\partial \tau_r} + \frac{\partial Y_r^*}{\partial E_r}\frac{\partial E_r}{\partial \tau_r}\right) - \left(\frac{\partial E_r}{\partial \tau_r} + \frac{\partial E_r}{\partial Y_r^*}\frac{\partial Y_r^*}{\partial \tau_r}\right)\right) - \left(Y_r^* - E_r\right)\right] \qquad \text{A6}$$

If we substitute eq. (A6) into eq. (A5) and pull out the cross terms, we get

$$\frac{\partial I_y^o}{\partial \tau_r} = \frac{\left(y_p^o + G\right)\left[\left(1-\tau_r\right)\left(\frac{\partial Y_r^*}{\partial \tau_r} - \frac{\partial E_r}{\partial \tau_r}\right) - \left(Y_r^* - E_r\right)\right] - y_r^o\alpha\left[\tau_r\left(\frac{\partial Y_r^*}{\partial \tau_r} - \frac{\partial E_r}{\partial \tau_r}\right) + \left(Y_r^* - E_r\right)\right]}{\left(y_p^o + G\right)^2} + \qquad \text{A7}$$

$$\left(y_p^o + G\right)^{-1}\left(1-\tau_r\right)\left[\frac{\partial Y_r^*}{\partial E_r}\frac{\partial E_r}{\partial \tau_r} - \frac{\partial E}{\partial Y_r^*}\frac{\partial_r Y_r^*}{\partial \tau_r}\right] - \left(y_p^o + G\right)^{-2} y_r^o\alpha\tau_r\left[\frac{\partial Y_r^*}{\partial E_r}\frac{\partial E_r}{\partial \tau_r} - \frac{\partial E}{\partial Y_r^*}\frac{\partial_r Y_r^*}{\partial \tau_r}\right]$$

$$= \frac{y_p^o \left[\left(1-\tau_r\right)\left(\frac{\partial Y_r^*}{\partial \tau_r} - \frac{\partial E_r}{\partial \tau_r}\right) - \left(Y_r^* - E_r\right) \right]}{\left(y_p^o + G\right)^2} - \frac{y_r^o \alpha \left[\tau_r \left(\frac{\partial Y_r^*}{\partial \tau_r} - \frac{\partial E_r}{\partial \tau_r}\right) + \left(Y_r^* - E_r\right) \right]}{\left(y_p^o + G\right)^2} + \qquad \text{A8}$$

$$\frac{Z}{\left(y_p^o + G\right)} b$$

where $Z = \left[\frac{\partial Y_r^*}{\partial E_r} \frac{\partial E_r}{\partial \tau_r} - \frac{\partial E}{\partial Y_r^*} \frac{\partial_r Y_r^*}{\partial \tau_r} \right]$ and $b = \left[1 - t_r - \alpha t_r I_y^o\right]$. The sign of the first term is negative if the transfer effect (the second term) is positive or zero, the evasion response, $\frac{\partial E_r}{\partial \tau_r}$, is positive, and the income response, $\frac{\partial Y_r^*}{\partial \tau_r}$, is negative.[50] The objective of this section is to sign the third term, which requires knowledge of the sign of the cross terms. There is very little empirical evidence on the sign of these cross terms. Although it is possible to sign the income and evasion responses using current empirical evidence, signing the cross terms (effect of evasion on hours worked and vice versa) is difficult to obtained as we are not aware of any empirical work that directly estimate these relationships.[51] One solution would be to assume that higher income makes it easier to evade a given amount of income. Slemrod (2001) uses a similar assumption which he termed "the avoidance

[50] Since *G* is assumed to be a constant function of total tax revenues, a positive transfer effect simply means that higher taxes results in greater revenues. However, this is not necessarily an innocuous assumption. Changes in the tax rate will have two opposing effects on total revenue. Similar to a price change, there is a direct effect that moves in the same direction as the tax rate and an indirect effect (change in the tax base) that moves in the opposite direction of the tax rate. These effects are similar to those that affect the distribution of income. Therefore, if the tax base is very responsive to the tax rate then the transfer effect may be negative. This would imply that we are on the downward sloping section of the Laffer curve.

[51] The closest empirical work we have found tries to estimate the effect of taxes and wage rates in the formal sector on the supply of labor to the underground sector. These same studies also estimate the effect of wage rates in the underground sector on labor supply to the formal sector (Frederiksen, Graversen, and Smith 2005; Lemieux, Fortin, and Frechette 1994).

facilitating effect of income."[52] This assumption implies that the cross terms are positive. If we further assume that the evasion and income responses are positive and negative, respectively, then we can conclude that *Z<0*. On the other hand, *b* is positive if $1 > t_r\left(1+\alpha I_y^o\right)$ and negative otherwise. Despite the uncertainty about the sign of *b*, $\frac{Z}{\left(y_p^o + G\right)}b$ is likely to be zero since $\frac{Z}{\left(y_p^o + G\right)} \approx 0$. Therefore, any bias created by omitting the cross elasticities is also likely to be very small.

[52] Slemrod's application is between avoidance and labor supply. He argues that it is very likely that income has an avoidance facilitating effect. In other words, increased income makes it easier to avoid given amount of income.

A2 Inequality index with transfers

In this appendix we include transfers in the definition of net income. The variance of log income is define as in the text with the exception that transfers are now included as an additional source of income.

$$VLI = \text{var}\left(\log y_i\right) = \frac{1}{n}\sum_{i=1}^{n}\left(\log y_i\right)^2 - \left(\log\tilde{\mu}\right)^2 \qquad \text{A9}$$

where $\log\tilde{\mu} = \frac{1}{n}\sum_{i=1}^{n}\left(\log y_i\right)$ is the mean of log income, $y_i = \left(Y_i^* - E_i\right)\left(1-\tau_i\right) + B$ is reported net income, Y_i^* is true earned income, and B is government transfers and is defined as

$$B = a\left[\sum_{i=1}^{n} t_i\left(y_i - E_i\right)\right]$$

Totally differentiate eq.(9) with respect to t_i to get the following.[53]

$$d(VLI) = \frac{2}{n}\sum_{i=1}^{n}\left(\log(y_i) - \log\tilde{\mu}\right)y_i^{-1}\left[\left(y_i^*\varepsilon_{yi} - E_i\varepsilon_{Ei}\right)\left(\frac{1-\tau_i}{\tau_i}\right) - \left(y_i^* - E_i\right) + \alpha\Theta\right]d\tau_i \qquad \text{A10}$$

where $\varepsilon_j = \frac{dj}{d\tau} * \frac{\tau}{j}$ is the elasticity of *j* (true income and hidden income) with respect to taxes and $\Theta = \sum_{i=1}^{n}\left[\left(y_i^*\varepsilon_{yi} - E_i\varepsilon_{Ei}\right) + \left(y_i^* - E_i\right)\right]$.

Since neither true income nor evasion is known, we rewrite eq. (A10) as

$$d(VLI) = \frac{2}{n}\sum_{i=1}^{n}\left(\log(y_i) - \log\tilde{\mu}\right)\frac{\left(1-t_i\right)^{-1}}{\left(/-\pi_i\right)}\left[\left(\varepsilon_{yi} - \pi_i\varepsilon_{Ei}\right)\left(\frac{1-\tau_i}{\tau_i}\right) - \left(1-\pi_i\right) + \alpha\Gamma_i\right]d\tau_i \qquad \text{A11}$$

[53]We are assuming that individual *i's* tax rate does not affect individual *k*'*s* behavior.

where $\Gamma_i = \frac{\Theta}{y_i^*}$. Equation (A11) will be used to simulate the change in inequality. This follows since $\frac{y_i^*}{y_i} = \frac{1}{(1-t_i)(1-\pi_i)} = \frac{(1-t_i)^{-1}}{(1-\pi_i)}$ where $\pi_i = \frac{E_i}{y_i^*}$. Assuming that α remains constant, the sign of the transfer effect depends on which section of the Laffer curve we are on. If an increase in tax rates leads to an increase in tax revenues then inequality should decline via the transfer effect.[54] As in the theoretical section, the effect of transfer on income inequality depends on who finances it. If the increase in transfers is financed by a tax on individuals below mean income, the effect will be negative, that is, inequality increases. The opposite happens if financed by tax on individuals above mean income. The other effects –direct and indirect – are the same as in the main text.

[54] Since *B* is assumed to be a constant function of total tax revenues, a positive transfer effect simply means that higher taxes results in greater revenues. However, this is not necessarily an innocuous assumption. Changes in the tax rate will have two opposing effects on total revenue. Similar to a price change, there is a direct effect that moves in the same direction as the tax rate and an indirect effect (change in the tax base) that moves in the opposite direction of the tax rate. These effects are similar to those that affect the distribution of income. Therefore, if the tax base is very responsive to the tax rate then the transfer effect may be negative. This would imply that we are on the downward sloping section of the Laffer curve.

APPENDIX B: TABLE APPENDIX

Table B 1. Sample Composition

Categories of the GINI	**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 <u>or</u> survey is problematic <u>or</u> unknown <u>or</u> estimates not verified	0.315	0.317
3 - income concept <u>and</u> survey are problematic <u>or</u> unknown	0.292	0.265
N (GINI observations)	1683	1538

Table B 2. 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 Source: All tax variables are from World Tax Indicators v.1.
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).

Table B 2– *Continued*.

Variable Name	**Description of Variables and Data Sources**
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

Table B 2– *Continued*.

Variable Name	Description of Variables and Data Sources
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.

Figure B 1. Sample Composition of the GINI by Income Base

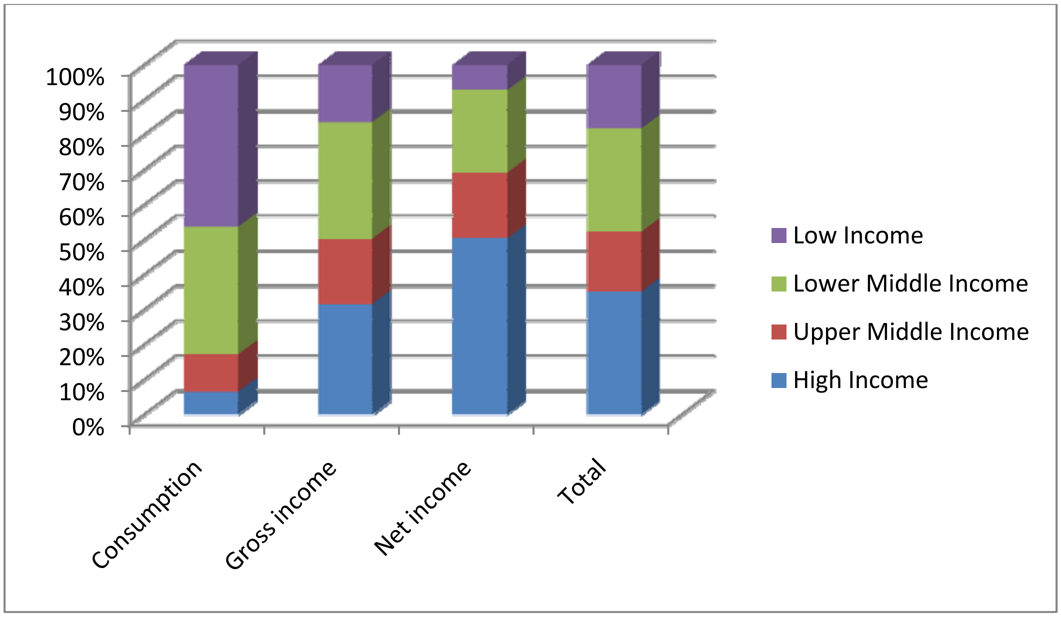

Table B 3. Variable Description and Notes

	Variable Name	Definition	Notes
		Individual Income	
IMP	Imputed contractual labor earnings per month		Labor earnings of working-age non-respondents are imputed as predicted earnings times the predicted probability of working using the full set of interactions between the four age groups (18-60) and two gender groups and controlling for urban and federal district dummies for each year separately.
		Household Income	
yL	Contractual labor earnings per month	= sum of IMP within each household.	
y	Household income before government transfers	= *yL* + net private transfers + financial income received last month.	"Private transfers received" include received alimonies and 11 subcategories of contributions from persons outside the household unit, including contributions from relatives, friends, charity, international organizations, etc. "Private transfers given" include alimonies paid and various contributions in money and in kind given to individuals outside the household unit (6 categories). Financial income includes dividends on stocks and interest on bank accounts.

Table B 3– *Continued*.

	Variable Name	Definition	Notes
		Household Consumption	
C	Non-durable expenditures	Sum of expenditures on non-durables in the last 30 days. Non-durable items include food, alcohol, tobacco, clothing and footwear, gasoline and other fuel expenses, rents and utilities, and 15-20 subcategories of services (such as transportation, repair, health care services, education, entertainment, recreation, insurance, etc.).	
cD	Aggregate expenditures	= *c* + expenditures on durables in the last 3 months/3. Durable items include 10 subcategories such as major appliances, vehicles, furniture, entertainment equipment, etc.	This is compared with purchases of goods and services from NIPA

Source: With permission from Gorodnichenko, Sabirianova-Peter, and Stolyarov (2009)

Table B 4. Distributional Impact of the Flat Tax Reform: Tax-Induced Behavioral effects

Parameters			**Contractual Earnings (IMP)**			**Consumption (cD)**		
π	**ε(e)**	**ε(y)**	**Evasion effect**	**Real effect**	**Combined effect**	**Evasion effect**	**Real effect**	**Combined effect**
0.20	-0.26	-0.04	3.974	4.459	9.553	-0.236	1.272	1.018
0.25	-0.26	-0.04	5.188	4.739	11.321	-0.259	1.255	1.019
0.30	-0.26	-0.04	6.511	5.056	13.232	-0.197	1.235	1.307
0.25	-0.20	-0.04	4.070	3.297	6.953	-0.240	1.255	1.011
0.25	-0.30	-0.04	5.908	3.297	8.610	-0.242	1.255	1.080
0.25	-0.26	0.00	5.188	0.000	5.188	-0.259	0.000	-0.259
0.25	-0.26	-0.10	5.188	7.630	11.648	-0.259	3.150	2.792

Notes: Reported are percent changes in variance of log coefficients. The sample is restricted to non-zero values for each variable; imputed contractual labor earnings at the individual level, and durable plus non-durable consumption and income before public transfers at the household level. Decompositions are calculated as described in the notes to Table 6 (also see Table 3).

Table B 4– *Continued*.

Parameters			**Income (y)**		
π	**ε(e)**	**ε(y)**	**Evasion effect**	**Real effect**	**Combined effect**
0.20	-0.26	-0.04	2.761	2.146	4.705
0.25	-0.26	-0.04	3.623	2.284	5.619
0.30	-0.26	-0.04	4.571	2.441	6.621
0.25	-0.20	-0.04	2.829	2.284	4.890
0.25	-0.30	-0.04	4.138	2.284	6.091
0.25	-0.26	0.00	3.623	0.000	3.623
0.25	-0.26	-0.10	3.623	5.379	8.324

APPENDIX C: SIMULATION APPENDIX

Introduction

The purpose of this document is to outline the mechanical procedure used to determine the effect of personal income taxes (PIT) on the distribution of income. We demonstrate how various counterfactuals of net income are calculated and how gross income is adjusted to reflect changes in evasion and productivity.

There are a number of problems that must be addressed in order to complete the analysis. One of the main ones is the fact that the Russian Longitudinal Monitoring Survey (RLMS) does not have direct measures of taxes paid, deductions, or gross income. The data set collects reported net income and reported consumption. While both are likely to suffer from underreporting, consumption is used as an approximation of true net income (GMP; Ivanova, Keen, and Klemm 2005). This implies that gross income (true and reported) can be obtained by inverting the tax function. We use this inversion technique as a starting point to estimate reported gross income, which we then use to calculate counterfactual measures of net income. The limitations mentioned above also imply that analyses focusing on true income can only be done at the household level since consumption data are only available at the household level.[55]

We discuss net income counterfactuals that do not distinguish among behavioral effects next and follow this with a demonstration of how we adjust reported gross income so that the evasion effect can be distinguished from the productivity effect. We then highlight the combination of counterfactuals used to identify the different components of

[55] Other problems and assumptions are discussed throughout the text. For example, taxation is at the individual level, which makes household level analyses problematic. We discuss this problem in more detail later in the text.

the change in income inequality. This is followed by a description of the inversion process and the variables used in the analysis.

Counterfactual net income

In this section we outline how each counterfactual net income variable is calculated. We first discuss counterfactuals that allow me to decompose the change in inequality into its direct and indirect components.[56] We then discuss how gross income can be adjusted to allow for the evasion and productivity effects. The analysis refers to years 2000 and 2001 only. However, actual implementation includes other post-reform years. We also make reference to counterfactuals at the individual (reported income) and household level (consumption based measures of true income).[57]

In the expressions below, Y=income, E is hidden income, T is the tax function, ε_y is the true income elasticity, ε_e is the evasion elasticity, τ is the statutory marginal tax rate, and the subscripts *i, h, n, g*, *t,* and superscript * indicate individuals, households, net, gross, time, and true, respectively.

No distinction among behavioral effects[58]:

a. Net income under **pre**-reform tax schedule with **pre**-reform income **(A)**:
   i. Individual: $Y_{in\,2000} = Y_{ig\,2000} - T_{2000}\,(Y_{ig\,2000} - D_{i\,2000})$
   ii. Household: $Y^*_{hn\,2000} = Y^*_{hg\,2000} - \sum_i T_{2000}(Y_{ig\,2000} - D_{i\,2000})$

[56] The direct component is due to the change in the tax rate and the indirect component is due to the change in income.

[57] Although we do not present them here, the analysis will include reported income at the household level as well.

[58] Summation is within a given household.

b. Net income under **post**-reform tax schedule with **post**-reform income **(B)**:

i. Individual: $Y_{in\,2001} = Y_{ig\,2001} - T_{2001}(Y_{ig\,2001} - D_{i\,2001})$

ii. Household: $Y^*_{hn\,2001} = Y^*_{hg\,2001} - \sum_i T_{2001}(Y_{ig\,2001} - D_{i2001})$

c. Net income under **pre**-reform tax schedule with **post**-reform income **(C)**:

i. Individual: $Y_{inc} = Y_{ig\,2001} - T_{2000}(Y_{ig\,2001} - D_{i\,2000})$

ii. Household: $Y^*_{hnc} = Y^*_{hg\,2001} - \sum_i T_{2000}(Y_{ig\,2001} - D_{i2000})$

d. Net income under **post**-reform tax schedule with **pre**-reform income **(D)**:

i. Individual: $Y_{ind} = Y_{ig\,2000} - T_{2001}(Y_{ig\,2000} - D_{i\,2001})$

ii. Household: $Y^*_{hnd} = Y^*_{hg\,2000} - \sum_i T_{2001}(Y_{ig\,2000} - D_{i2001})$

Distinguishing among behavioral effects:

Decomposition assumes evasion takes place and is observed.[59] We first define the tax-induced change in both evasion and true gross income.

a. Tax induced change in evasion is

i. $$\Delta E_{ht} = E_{ht} \times \varepsilon_e \times \frac{\Delta \tau_i}{\tau_i} \;\Rightarrow\; E'_h = E_{h2000}(1 + \varepsilon_e \times \frac{\Delta \tau_i}{\tau_i})$$

b. Tax induced change in gross income is

i. $$\Delta Y^*_{hgt} = Y^*_{hgt} \times \varepsilon_y \times \frac{\Delta \tau_i}{\tau_i} \;\Rightarrow\; Y'_{hgt} = Y^*_{hg\,2000}(1 + \varepsilon_y \times \frac{\Delta \tau_i}{\tau_i})$$

We then calculate net income allowing each component of reported gross income to change by the tax induced amount. The calculation is done using both pre-reform and post-reform tax schedules.

There are two problems that must be addressed when conducting this analysis. First, taxes are assessed on individuals, not households. Therefore, adjustments for

[59] It is possible to do these calculations even if evasion is not observed. This is illustrated below.

evasion and productivity are required at the individual level when calculating tax liability even if the analysis is at the household level. This poses a problem because the elasticities needed to make the adjustments are estimated at the household level. Second, tax liability for individual *i* can be written as $T_i = T(Y^*_{ig} - E_i - D_i)$. The behavioral effects are obtained by adjusting Y^*_{ig} and E_{ig} according to the estimated elasticities outlined above. However, we observe neither Y^*_{ig} nor E_{ig}; we are able to estimate $Y_{ig} = Y^*_{ig} - E_{ig}$.[60] As such, it is not possible to directly adjust the amount of evasion or true gross income as indicated above.

Both problems are addressed by assuming that the percentage change in the amount of evasion at the household level applies to each working member of a given household. This implies that the new level of reported income - due to the change in evasion - can be written as

$$Y'_{ig} = Y^*_{ig} - E_i(1 + \varepsilon_e \times \frac{\Delta\tau_i}{\tau_i})$$

which then implies that the percentage change in individual reported gross income **due to the change in evasion** is

$$\%\Delta Y_{ig} = (Y'_{ig} - Y_{ig}) / Y_{ig} = -\varepsilon_h \times \frac{\Delta\tau_i}{\tau_i} \times \frac{\pi}{1-\pi}; \qquad \pi = E/Y$$

Similarly, the percentage change in individual reported gross income **due to the change in productivity** is

[60] This is done by inverting the tax function.

$$\%\Delta Y_{ig} = \varepsilon_y \times \frac{\Delta\tau_i}{\tau_i} \times \frac{1}{1-\pi} \quad .$$

Finally, the percentage change in individual reported gross income **due to the change in both evasion and productivity** is

$$\%\Delta Y_{ig} = \frac{\Delta\tau_i}{\tau_i} \times \frac{\varepsilon_y - \varepsilon_e\pi}{1-\pi}$$

Although we do not know π, it is possible compute the counterfactuals based on different values of π.[61]

With this in mind, we are able to write out the following;

1. Reported gross income adjusted for evasion is

$$Y_{ig}^{e} = Y_{ig} + Y_{ig} \times [-\varepsilon_e \times \frac{\Delta\tau_i}{\tau_i} \times \frac{\pi}{1-\pi}]$$

2. Reported gross income adjusted for productivity is

$$Y_{ig}^{y} = Y_{ig} + Y_{ig} \times [\frac{\varepsilon_y \Delta\tau_i}{\tau_i(1-\pi)}]$$

3. Reported gross income adjusted for evasion and productivity is

$$Y_{ig}^{ey} = Y_{ig} + Y_{ig} \times [\frac{\Delta\tau_i}{\tau_i} \times \frac{\varepsilon_y - \varepsilon_e\pi}{1-\pi}]$$

Using this same procedure, we calculate the change in true gross income (consumption) at the household level as[62]

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[61] GMP consider 1/3 to be a reasonable upper bound for π. It is possible to allow π to vary between 1/5 and 1/3, for example.

[62] Note that true income is only adjusted for changes in productivity. The implicit assumption here is that changes in evasion do not affect the amount of income earned except through its effect on individual tax liability. This is quite reasonable since evasion usually involves a reallocation of what is earned. Evasion may still have an indirect effect on how much is earned. For example, an increase in the ability to evade

$$Y_{hg}^{y} = Y_{hg}^{*} + Y_{hg}^{*} \times \varepsilon_{y} \times \frac{\Delta \tau_{i}}{\tau_{i}}$$

Reported household gross income is adjusted similarly to individual income. The above procedure allows me to write down counterfactuals that we use to determine the size and sign of the evasion and productivity effects.[63] We estimate the evasion effect, by comparing the pre-reform (year 2000) distribution of net income with the distribution of net income that would obtain if the only tax induced behavioral response to the tax reform was evasion. The productivity effect is obtained similarly, except that we assume the only response is through productivity changes. We also estimate the total behavioral effect by allowing both evasion and productivity to change simultaneously (calculations are summarized in Table 9 and Table 10).

Change in inequality

The change in inequality is determined by comparing several counterfactual measures of net income distribution (see Table 10). The primary reason for using these counterfactuals is that they allow me to separate the total change in the distribution of income into the components of interest. This approach is widely used in the literature (Alm, Lee, and Wallace 2005; Poterba 2007).

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taxes may act as an incentive to increase earnings (Slemrod 2001). However, we ignore these cross effects since there are no estimates available for them.

[63] The adjustments all use income in year 2000 as the base. Additionally, we hold the tax schedule constant so that any change must be due to the change in income only; base calculations are done using the pre-reform tax schedule.

No distinction among behavioral effects:

Panel C of Table 10 illustrates how the various counterfactual net incomes are combined to decompose the change in income inequality into its various components. The direct (tax) effect is defined as the change in income inequality that results from a change in the tax schedule holding the pre-tax distribution constant. Therefore, the direct effect can be estimated by comparing D and A (pre-reform income held constant) or B and C (post-reform income held constant). The indirect (behavioral) effect, on the other hand, is the change in the distribution of income that follows from a change in the distribution of pre-tax income with the tax schedule held constant. Again, this is estimated holding either the pre-reform tax schedule constant (compare C and A) or the post-reform tax schedule constant (compare B and D).

Decomposing the indirect (behavioral) effects:

The indirect effect obtained using the approach above included behavioral changes along many different dimensions. While some of these responses are most likely induced by the change in the tax schedule, others are totally unrelated and would have taken place even if no reform took place. The central objective of this essay is to determine how much of the indirect effect is tax-induced. For example, we ask the question, what would be the net income distribution if individuals were induced to change only the amount of income they evade? Similarly, what would be the resulting net income distribution if only tax-induced productivity responses took place? These questions are answered by using the counterfactuals in Panel B of Table 10.

For example, the distribution of net income when evasion is the only response, E1, is compared with the one that would have obtained had there been no change in the pre-reform income, A.[64] This is illustrated in panel C of Table 10 where we compare E1 with A (holding pre-reform tax schedule constant) and E2 with D (holding post-reform tax schedule constant). The productivity effect is similarly calculated by allowing productivity to be the only tax induced behavioral response and adjusting pre-reform pre-tax income accordingly. Here we compare F1 with A, which holds the pre-reform tax schedule constant, and F2 with D, which hold the post-reform tax schedule constant.

Implementation

In this section we discuss the steps used to implement the analysis. The analysis simulation exercise requires six steps.

1. Determine the amount of deduction for each individual
2. Invert the tax function to obtain gross income
3. Adjust gross income for evasion and productivity
4. Calculate the counterfactual net incomes outlined above
5. Calculate the indices of net income distribution
6. Calculate the change in distribution

Each step is discussed in more detail below.

Step 1: Determine the amount of deduction for each individual

Deduction for the year 2000 is summarized as follows:

1. 264 rubles per month every month for which accumulated income (up to that month) is less than or equal to 20,000 rubles
2. 132 rubles per month every month for which accumulated income is less than or equal to 50,000 rubles and greater than 20,000 rubles.
3. Zero for remaining months

[64] The net income distributions are calculated using both pre-reform (E1) and post-reform tax schedules (E2). As such, the evasion effect can be obtained by comparing E1 with A, or E2 with D. The same procedure is followed to obtain the productivity effect.

Deduction for the post-reform period is summarized as follows:

1. 400 rubles per month every month for which accumulated income is less than or equal to 20,000 rubles
2. Zero for remaining months

The expressions below are based on the following assumptions:

1. Since information is only available on income earned last month, we assume that income is received evenly throughout the year when accounting for these complex deduction rules (Ivanova, Keen, and Klemm 2005).
2. The rule for year 2000 also applies to 1998

Let d_1 equal deduction while accumulated income is less than or equal to 20,000 rubles and d_2 equal deduction while accumulated income is less than or equal to 50,000 rubles but greater than 20,000 rubles. Given the rules above,

$$d_1 = \begin{cases} \dfrac{20000*12}{Y_{ig}}*(264) & \textit{if } Y_{ig} \geq 20000 \\ 12*(264) & \textit{if } Y_{ig} < 20000 \end{cases}$$

$$d_2 = \begin{cases} \left(\dfrac{50000*12}{Y_{ig}} - \dfrac{20000*12}{Y_{ig}}\right)*(132) = \dfrac{30000*12}{Y_{ig}}*(132) & \textit{if } Y_{ig} \geq 50000 \\ \left(12 - \dfrac{20000*12}{Y_{ig}}\right)*(132) = \dfrac{(Y_{ig} - 30000)*12}{Y_{ig}}*(132) & \textit{if } Y_{ig} < 50000 \end{cases}$$

Define $C = \dfrac{20000*12}{Y_{ig}}$ and simplify deductions to get:

Deductions before reform:

$$D = d_1 + d_2 = \begin{cases} 12*(264) & \text{and } \mathrm{C} \geq 12 & \text{if } \mathrm{Y_{ig}} \leq 20000 \\ C*(132)+1584 & \text{and } 5 \leq \mathrm{C} < 12 & \text{if } 20000 \leq \mathrm{Y_{ig}} < 50000 \\ C*(462) & \text{and } 2 \leq \mathrm{C} < 5 & \text{if } 50000 \leq \mathrm{Y_{ig}} < 150000 \\ C*(462) & \text{and } 0 \leq \mathrm{C} < 2 & \text{if } 150000 \leq \mathrm{Y_{ig}} \end{cases}$$

Deductions after reform:

$$D = \begin{cases} 12*400 & \text{if } Y_{ig} \leq 20{,}000 \\ C*400 & \text{if } Y_{ig} > 20{,}000 \end{cases}$$

Step 2: Invert the tax function to obtain gross income

Gross income for each individual is imputed in STATA based on the PIT tax schedule summarized in Table 3 and the deductions outlined in step 1.

Pre-reform (1998-2000):

$$Y_{ig} = \begin{cases} \dfrac{Y_{in} - 0.13*12*264}{0.87} & \text{if } 3{,}168 < Y_{ig} \leq 20{,}000 \\ \dfrac{Y_{in} - 0.13*(C*132+1584)}{0.87} & \text{if } 20{,}000 < Y_{ig} \leq 50{,}000 \\ \dfrac{Y_{in} + (50{,}000 - C*462)*0.13 - 50{,}000*0.21}{0.79} & \text{if } 50{,}000 < Y_{ig} \leq 150{,}000 \\ \dfrac{Y_{in} + (50{,}000 - C*462)*0.13 + 100{,}000*0.21 - 150{,}000*0.31}{0.69} & \text{if } Y_{ig} > 150{,}000 \end{cases}$$

Post reform (2000-2004):

$$Y_{ig} = \begin{cases} \dfrac{Y_{in} - 0.13*C*400}{0.87} & \text{if } Y_{ig} > 4{,}800 \end{cases}$$

Step 3: Adjust gross income for evasion and productivity

The estimated gross income is adjusted for behavioral responses and used to determine counterfactual net income as described earlier. The baseline adjustments set the evasion parameter (π) at 25 percent, evasion elasticity at 0.26, and the productivity elasticity at -0.04.[65] The tax rates and change in tax rates are determined from Table 8. We place each individual (household) into a tax bracket based on their gross income and then assign the relevant tax rate.

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[65] Each of these parameters is adjusted in robustness checks. Simulations allow π to be equal to 20 percent and 30 percent.

Step 4: Calculate the counterfactual net incomes

The estimated gross income is used to determine counterfactual net income as described earlier while the adjusted gross income is used to determine counterfactual net income as described in Table 9.

Step 5: Calculate inequality indices for net income

With counterfactuals of net income determined, we calculate various measures of income inequality. These include the GINI coefficient, the coefficient of variation (CV), the relative mean deviation (RMD), and variance of log. We also calculate measures of effective progressivity. All income/consumption measures are converted to December 2002 prices, and household measures are adjusted using the OECD equivalence scale. Additionally, the individual (household) level inequality indices are calculated using the RLMS individual (household) sample weights to address sample attrition and other sampling errors.[66]

Step 6: Calculate the change in inequality

The decomposition involves two steps. First, we identify the direct and indirect effects using the counterfactuals in panel A of Table 10. Second, we use the counterfactuals in panel B of Table 10 to decompose the indirect effect into its evasion and productivity components. This is similar in spirit to the approach taken by Poterba (2007) and Alm, Lee, and Wallace (2005). In effect, we are able to see how the

[66] The RLMS sample weights adjusts for sample design factors and deviations from the census characteristics, which implicitly address sample attrition.

distribution changes when, say, evasion changes, *ceteris paribus*. The changes are calculated as percentages.

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VITA

Denvil Duncan is a native of Jamaica where he completed a B.Sc. degree in economics and accounting and a M.Sc. degree in economics from the University of the West Indies, Mona (UWI) in 2001 and 2003, respectively. Denvil then spent two years teaching economics at the UWI before entering the economics doctoral program in the Andrew Young School of Policy Studies, Georgia State University in 2005.

Denvil worked as a Graduate Research Assistant for most of his graduate years before being assigned to the International Studies Program, Andrew Young School of Policy Studies in the 2009/2010 academic year as a Research Associate. The research experience gained between these two appointments resulted in several economic conference presentations and two peer reviewed publications. He was also awarded the Economics Department/Jack Blicksilver Scholarship in Economics and the E.D. (Jack) Dunn Fellowship for his academic achievements in 2009 and 2010, respectively.

Denvil will graduate with a doctorate in economics from the Andrew Young School of Policy Studies, Georgia State University in August 2010 and will start as an assistant professor in the School of Public and Environmental Affairs, Indiana University in August 2010.