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POVERTY AND THE OPTIMAL GENERAL INCOME TAX-CUM-AUDIT POLICY

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Poverty and the Optimal General Income Tax-cum-Audit Policy*

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Abstract

This paper investigates the optimal general income tax and audit policies when poverty is a public bad and income is not observed in an economy with two types of individuals. Differently from the traditional "non-distortion at the top" result of the optimal taxation literature, we find that the optimal marginal income tax rate on skilled individuals is positive when reducing poverty is one of the goals of the social planner and their consumption can affect negatively the poverty measure. Consequently, skilled individuals might be audited stochastically. We characterize a tax regime in which unskilled workers face a negative marginal tax.

Keywords: Poverty, Tax evasion, Optimum Taxation

JEL Classification: D82; H21; H26; I32

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Abstract

This paper investigates the optimal general income tax and audit policies when poverty is a public bad and income is not observed in an economy with two types of individuals. Differently from the traditional "non-distortion at the top" result of the optimal taxation literature, we find that the optimal marginal income tax rate on skilled individuals is positive when reducing poverty is one of the goals of the social planner and their consumption can affect negatively the poverty measure. Consequently, skilled individuals might be audited stochastically. We characterize a tax regime in which unskilled workers face a negative marginal tax.

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1 Introduction

This paper aims to integrate the existence of poverty as a negative externality and tax evasion into an optimal general income tax problem. We characterize the optimum income tax-cum-audit structure when the government does not have full information about households' income and the economy consists of two types of individuals: rich and poor. Both types are risk averse with identical preferences but different skills. Labor supply is endogenous and poor (unskilled) agents earn a lower wage than rich (skilled) agents. This paper distinguishes itself from earlier studies on this subject (e.g., Mirrlees, 1971; Cremer and Gahvari, 1996; Wane, 2001) by integrating a model in which taxpayers can mimic both their skills and income, represented by self-selection and moral hazard constraints, and poverty is a bad externality.

In this paper, we allow for a hybrid social welfare function of a full committed government and the following main results are obtained. First, the optimal marginal tax rate on rich individuals is positive when reducing poverty is one of the goals of the social planner and their consumption can affect negatively the poverty measure (relative poverty line). This result differs from the traditional "non-distortion at the top" result in the optimal taxation literature. Rich individuals are taxed in this economy to compensate for their negative influence on the poverty measure. There is discrimination at the top as long as those at the top can influence the welfare of the whole society through a measure of poverty and a distortion might be optimum to reduce aggregate poverty. Second, skilled workers might be audited stochastically. A positive marginal income tax imposed on skilled individuals create opportunities for tax evasion, and auditing the rich might be optimal. Third, individuals' honesty must be rewarded. And fourth, the marginal tax on poor is undetermined. However, we characterize a particular tax regime under which unskilled workers should optimally face a negative marginal tax. This happens when rich individuals do not want to mimic the poor.

Poverty is one of the most serious problems faced by developing and poor countries. An agent is identified as poor if his/her resources fall short of the poverty threshold. An absolute poverty measure determines that the poverty threshold does not change with the standard of living of the

society, i.e., it is fixed over time. A relative poverty measure specifies the poverty line as a cut-off value in the distribution of income or private expenditure and, hence, the line can be updated automatically for changes in living standards (Sen, 1979; Madden, 2000; Zheng, 2001; Pirttila and Tuomala, 2004; Ravallion, 2008). Poverty lines in Europe have been set at a constant proportion of average income (strictly the median), while the United States government has traditionally used absolute poverty lines (Ravallion, 2008). In the United States, there are roughly 13 to 17% living below the federal poverty line and around one person in 10 in OECD countries had in income below half of the national median in 2005 (OECD, 2008).

For many governments, the goal of poverty alleviation, together with job creation, is a key element for overall development. Amid a lack of action from the government, the informal sector thrives for precisely the same reason, i.e., to alleviate poverty and create jobs. Due to a lack of employment opportunities in the formal sector and long unemployment periods, many people are forced to join the informal sector to earn a living. Informal employment does not mean that workers are not living in poverty (Maloney, 2004; Chong and Gradstein, 2007)[1]. It is, on average, precarious, low-paid and risky. Income levels in the informal sector are generally low and the incidence of poverty high. In developing economies, workers employed in the informal sector tend to be younger, have less education, and earn less than their counterparts in the formal sector (Thomas, 1992; Maloney, 1999; Amaral and Quintin, 2006). But, not everyone engaged in informal activities is poor. Informal employment can also be seen as a part-time employment, a second job after (or even during) regular working hours or on weekends that provides a supplemental income to people's primary employment (Alden, 1981; Schneider and Enste, 2000; Pedersen, 2003).

Programs to combat poverty and reduce tax evasion are ultimately an information problem. First, the income of those individuals whose income is below the poverty line is rarely observed. Besides, as non-targeted groups may benefit from poverty reduction plans and have incentives to mimic the behavior of those targeted, government programs have to ensure that resources are concentrated on the poor, minimizing the leakages to the non-poor. Second, the taxpayers' true incomes (formal and informal) may not be publicly observed and the government can only

[1]In this paper, the terms informal activities and tax evasion refer to all income generating activities which do not comply with the tax obligations, tax evasion and non-compliance with economic legislation.

obtain information on individuals' income at a cost, i.e., by conducting audits. Although informal activities can potentially improve living standards by leaving more income in peoples' hands, tax evasion might as well contribute to poverty, for it deprives governments of needed resources to invest in economic development that would benefit the weaker segments of the population. Understanding the links between informality and poverty is critical for designing policy options targeted at tax evasion and poverty reduction.

Many alternative approaches have been used to reduce poverty and they usually consider non-utility information as a criteria to evaluate the policy implemented. If the planner recognizes that it has to take into account this class of information, say income-poverty, when setting a policy that aims to increase society's welfare, then welfarist and non-welfarist considerations must be traded off in the objective function (Sen, 1982; Ravallion, 1994; Kanbur, Keen and Tuomala, 1994)[2]. Wane (2001) uses this approach to capture the pluralism of the government's objectives into the social welfare function. Poverty is considered a "public bad" or a negative externality to society's welfare and the income tax is the only instrument used as a redistributive policy. The author shows that poor individuals can face negative or positive marginal tax rates, and all the non-poor, except the most skillful, face a strictly positive marginal tax rate. As in Mirrlees (1971), individual's income is publicly observed but not their abilities[3].

This paper is related to a great deal of literature on poverty and optimal taxation (Kesselman, 1971; Zeckhauser, 1971; Garfinkel, 1973; Nichols and Zeckhauser, 1982; Besley and Coate, 1992, 1995; Moffit, 2003; Leblanc, 2004) which is silent with respect to the case where individuals can mimic their income and their type. This, however, is a common feature of the literature on tax evasion. The possibility that the government may not observe the income of the households adds an additional cost to the tax administration and must be considered in the tax design (Sandmo, 2005). Sandmo (1981) and Cremer and Gahvari (1996) study the optimal linear and general income tax, respectively, when tax evasion is introduced in the standard income tax model. In Cremer and

[2]Kanbur, Pirttila and Tuomala (2008) explore the theory of optimal income taxation when individuals behave according to the prospect theory and the implications of non-welfarist objectives under income uncertainty are examined.

[3]Besley and Coate (1992, 1995) show that a wage subsidy can be an optimal policy only when abilities are perfectly observable. Leblanc (2004) concludes that an universal provision of training is better than a negative income tax. In these studies, the program is chosen if it has the minimum cost amongst all the alternatives.

Gahvari (1995), tax evaders can influence the probability of being caught through expenditures on concealment and tax evasion can affect the progressiveness of the tax system depending on the concealment technology. In this literature, the poverty concern of the social planner, as well as the interactions between poverty and tax evasion, are not taken into consideration. This paper intends to fill out this gap.

The paper is organized as follows. Section 2 presents a model where poverty and tax evasion are integrated in a general income tax model with two types of individuals and enforcement is costly. In Section 3, we characterize the properties of the optimal tax-cum-audit policy. Section 4 offers concluding comments.

2 The Model

We consider an economy with two types of agents: rich (skilled) individuals and poor (unskilled) individuals[4]. Both types are risk averse with identical preferences but different skills. The model is built on Cremer and Gahvari (1995) and Wane (2001) integrating two aspects: taxpayers can mimic their skills and income and aggregate poverty is a bad externality. Preferences are separable in the numeraire, C, and labor supply, L. These are the only two goods in this economy and preferences, in the absence of taxes, are represented by

$$\begin{aligned} U &= u(C_i) + v(1 - L_i) - \beta_i P \\ L &= Y/w_i, \quad i = p, r. \end{aligned}$$

where U is continuous and twice differentiable, strictly increasing in C and decreasing in L, $u(C)$ is strictly concave and $u(0) = 0$. Consumption and labor are nonnegative. Agents of type p earn a lower wage than those of type r. Denote w_i the wage (or skills) of an agent of type $i = p, r$. The consumption of each type is given by $C_i = Y_i - T_i$, where Y_i is the individual's income and T_i is the amount of taxes paid by type $i = p, r$. Last, P denotes aggregate poverty and β_i, a common

[4]The terms rich and skilled and poor and unskilled are used interchangeably in this paper.

knowledge information, measures the aversion to aggregate poverty for agent i.[5]

Enforcement is costly and rich (skilled) and poor (unskilled) households' incomes are observable only with an audit cost A, which is strictly increasing in the number of people audited and $A' \in (0, +\infty)$. Penalties cannot exceed an individual's income and other punishments are excluded.

In this economy, the government maximizes social welfare, which is the sum of the individuals' true welfare. Given that individuals are concerned with aggregate poverty, its objective also embraces aggregate poverty reduction. That concern leads to an important matter, which relates to poverty measurement. We assess poverty based on a comparison of resources to needs. A household is identified as poor if his/her resources fall below the poverty threshold. There are several ways to measure poverty and we consider two main categories: absolute and relative poverty measures[6]. Absolute poverty measures consider exclusively the well-being of those who are defined as poor, thereby suggesting that only the condition of the poor and his/her deprivation is important, not the overall society, (Blackwood and Lynch, 1994; Simler and Arndt, 2007). Relative poverty measures define the segment of the population that is poor in comparison with the income (or consumption) of the general population. Thus, poverty is not determined by a discrete poverty line but rather it is determined relative to the overall income of the population. The relative method specifies the poverty threshold as a cut-off value in the distribution of income or expenditure and hence it can be updated automatically for changes in living standards (Foster, Greer and Thorbecke, 1984; Foster, 1998; Muller, 2006). The measurement of poverty is beyond the scope of this paper and questions such as, should poverty be measured using an "absolute" or a "relative" approach? or how does a policymaker choose an appropriate measure?, are not addressed here. Instead, we study the design of the optimal income taxation when either one of these two measures is exogenously chosen by the government.

We follow the literature (Wane, 2001; Kanbur, Keen and Tuomala, 1994) and consider a consumption-based poverty measure, by comparing an individual's consumption C_i, $i = r, p$, to a poverty line C^*. The poverty line can then be interpreted as a broad measure consisting of basic consumption goods and goods that are deemed valuable to acquire (e.g. medicine, children's

[5]The marginal tax rate on individual i is given by $MTR_i = 1 - ((\partial v(1 - Y_i/w_i)/\partial Y_i)/\partial u(C)/\partial C_i)$.

[6]See, for instance, Ravallion (1994) for further details.

equipment, housing, etc.). A benefit associated with measuring poverty by consumption is that it may convey better information about actual deprivation than information on income (Pirttila and Tuomala, 2004). We address the case that only the consumption of the poor C_p can be below the poverty line and it is given by $P(C_p, C^*)$. Therefore, poverty reduction improves social welfare[7].

The absolute poverty line determines a poverty threshold that does not change with the standard of living of the society, i.e. it is fixed over time at $C^* = \bar{C}^*$. The main implication of this poverty measure is that the consumption of rich individuals, C_r, does not affect the aggregate measure of poverty, i.e., $\partial P(C_p, C^*)/\partial C_r = P_{C_r}(C_p, C^*) = 0$ for $C_r \geq C^*$, and the poverty index is decreasing in the consumption of the poor, that is, $P_{C_p}(C_p, C^*) < 0$, $P_{C_p,C_p}(C_p, C^*) > 0$ and $P(C_p, C^*) \geq 0$ for all $C_p \in [0, C^*)$.

A relative measure of poverty uses a poverty line that is related in some way to the general standard of living of the society. In this case, both the consumption of the poor, C_p, and the consumption of the rich, C_r, can affect the poverty line, defined as $C^* = C^*(C_p, C_r)$, and consequently the poverty measure. The consumption of the poor has two - direct and indirect - effects on the poverty measure $P(C_p, C^*(C_p, C_r))$. The direct effect is negative and indicates that if the consumption of the poor increases the aggregate measure on poverty decreases ($\partial P(\cdot)/\partial C_p < 0$). On the other hand, the indirect effect is positive, as an increase in C_p raises the poverty line which, given C_r, increases the poverty index, that is, $(\partial P(\cdot)/\partial C^*(\cdot))\,(\partial C^*(\cdot)/\partial C_p) > 0$, where $C^*(\cdot) = C^*(C_p, C_r)$. Since relative poverty lines are often defined as a certain fraction of some central summary statistic (a fraction of the mean or median per capita income), the direct effect is assumed to be larger than than the indirect effect[8]. This implies that the total effect is that the poverty index is decreasing in the consumption of the poor ($dP(\cdot)/dC_p < 0$). If only the consumption of the rich increases, the relative poverty measure will increase as a result of larger income inequality, i.e. $dP(\cdot)/dC_r = [(\partial P(\cdot)/\partial C^*(\cdot))\ \ (\partial C^*(\cdot)/\partial C_r)] > 0$.

[7]Kanbur, Keen and Tuomala (1994) use the same formulation to define aggregate poverty. However they consider the case that minimizing poverty is the only objective of the government.

[8]Consider Wane (2001)'s poverty function but with a relative poverty line instead $(C - C^*(C_p, C_r))^2$. According to United Nations and World Bank standards, a person is poor when his or her income is less than 60 percent of the average per capita income in the country of residence. Assume then that $C^*(C_p, C_r) = (0.6)[(C_p + C_r)/2]$. In this case (and related ones), our assumption that the direct effect dominates the indirect effect is reasonable. There are important measurement issues in selecting the standard of living (see Citro and Michael, 1995; Foster, 1998; Muller, 2006).

The direct mechanism consists of four functions: $Y(\bar{w})$, $p(\bar{w})$, $T(\bar{w})$, $F(\bar{w}, Y_A)$ where $\bar{w}$ is the reported type and Y_A is the income revealed through an auditing process. It works as follows: after the agent reports his type, $\bar{w}$, the tax administrator assigns the income, $Y(\bar{w})$, the probability of auditing, $p(\bar{w})$, the amount of taxes to be paid, $T(\bar{w})$, and the fines of $F(\bar{w}, Y_A)$ if s/he is audited and found to have a true income of Y_A.

Individuals can cheat in two different ways: (i) by misreporting their type and (ii) by misreporting their income. It is assumed that only the misreported income action can be detected through an audit. Since the individuals can be audited (or not) and pay fines (or taxes) two different states arise. Let EU_{ik} be the expected utility of type i individual who reports to be of type k and earns income Y_k given by[9]

$$EU_{ik} = (1-p_k)u(Y_k - T_k) + p_k u(Y_k - F_k) + v_i(Y_k) - \beta_i EP(C_p, C^*(C_p, C_r)), \quad i,k = p,r. \tag{1}$$

where $v_i(Y_k) = v(1 - Y_k/w_i)$ for $i = p, r$. The expected aggregate poverty $EP(C_p, C^*(C_p, C_r))$ is defined as follows

$$EP(C_p, C^*(C_p, C_r)) = P(C_p^e, C^*(C_p^e, C_r^e)) \tag{2}$$

where $C_p^e = (1-p_p)(Y_p - T_p) + p_p(Y_p - F_p)$ and $C_r^e = (1-p_r)(Y_r - T_r) + p_r(Y_r - F_r)$. To avoid additional notation, we will treat the absolute poverty measure as a special case of our relative measure. In the case of an absolute poverty line, the poverty measure $P(C_p, C^*(C_p, C_r))$ simplifies to $P(C_p, \bar{C}^*)$, and the expected aggregate poverty is given by $EP(C_p, \bar{C}^*) = P(C_p^e, \bar{C}^*)$.

Now, define the maximum utility of an individual with skill w, who faces a audit probability of p and pays a fine equal to the maximum possible income if audited and a tax T if s/he is not, as follows[10]

$$V_{i,k} = (1-p_k)u(\tilde{Y}(w,p,T) - T_k) + v_i(\tilde{Y}(w,p,T)) - \beta_i EP(C_p, C^*(C_p, C_r)),\ i,k = p,r. \tag{3}$$

[9]This structure guarantees the existence of the revelation principle. More complicated structures could have been presented but this model is sufficient to show the arguments.

[10]Note that individuals are infinitesimal and cannot affect the measure of aggregate poverty. This assumption is used throughout the text.

where $V_{i,k} = V(w_i, p_k, T_k)$ and $\tilde{Y}(w, p, T)$ corresponds to the income that an agent chooses for himself under this situation and maximizes the above utility. This formulation corresponds to an agent of type i that claims to be of type k but declares a different income than the one assigned to type k. Since this type of cheating is detected, we call it income misreporting.

In equilibrium, as in Mookherjee and Png (1989) and Cremer and Gahvari (1996), the revelation principle (truth-telling equilibrium) also applies in this case. Therefore, any strategy out of the equilibrium path can be punished using the highest penalty (total income) without affecting the equilibrium utility of the individuals[11]. This implies that $F(\bar{w}, Y_A) = Y_A$. We assume that the minimum amount of taxes and fines is equal to $-C^*$, meaning that if the optimal policy calls for a transfer from the government to households, that must be at most C^*. This assumption simplifies the proof of the existence of optimal mechanisms and also is realistic. There is no reason for the government to redistribute more goods than the minimum to the poverty line.

3 Poverty and Optimal Tax-cum-Audit Policy

This section characterizes the optimal income tax, fines, auditing probabilities, consumption and leisure for both types of households, when poverty and tax evasion are integrated in a general income tax model. In an environment where enforcement is costly and incomes are observable only through an audit cost, the social planner maximizes

$$
\begin{aligned}
W &= EU_{pp} + \delta EU_{rr} && (4)\\
&= (1-p_p)u(Y_p - T_p) + p_p u(Y_p - F_p) + v_p(Y_p) && (5)\\
&\quad +\delta\left[(1-p_r)u(Y_r - T_r) + p_r u(Y_r - F_r) + v_r(Y_r)\right] && (6)\\
&\quad -\beta[P(C_p^e, C^*(C_p^e, C_r^e))] && (7)
\end{aligned}
$$

[11] The magnitude of penalties is the object of debate in the enforcement literature. If the government is free to choose the penalties, Becker (1968), Chander and Wilde (1998), among others, have shown that (extremely) severe penalties are optimal. However, less-than-maximum fines can be optimal when enforcement is uncertain (see Polinsky and Shavell (2005) for a survey) or social norms impose economic restrictions on the penalty function (see Marhuenda and Ortuno-Ortin, 1997).

where δ is the relative social weights imposed on skilled (rich) and $\beta = \beta_p + \beta_r$ is the aggregate aversion to poverty. The planner's problem is also subject to the revenue and incentive compatibility constraints. Hence, the social planner maximizes equation (4) with respect to Y_p, Y_r, p_p, p_r,T_p, T_r, F_p and F_r, subject to the following self-selection constraints [12]

$$EU_{rr} \geq EU_{rp}, \tag{8}$$

$$EU_{rr} \geq V_{rr}, \tag{9}$$

$$EU_{rr} \geq V_{rp}, \tag{10}$$

$$EU_{pp} \geq V_{pp}. \tag{11}$$

and the revenue constraint

$$N_p[(1-p_p)T_p + p_pF_p] + N_r[(1-p_r)T_r + p_rF_r] - A(N_pp_p + N_rp_r) \geq \bar{R} \tag{12}$$

where $\bar{R}$ stands for the necessary tax revenue, N_p and N_r are the proportion of poor and rich individuals in this economy, respectively. We ignore an "upward" incentive constraint, i.e., the constraint that the poor individual tries to mimic the rich is not binding.

The constraint (8) is the usual self-selection constraint when incomes are not observable and constraints (9), (10) and (11) are so-called the moral hazard conditions and have to be satisfied to avoid tax evasion. Self-selection constraints (8), (9) and (10) ensure that a rich/skilled household prefers a truthful statement of his type and income than mimicking the poor/unskilled person and his associate income, misreporting his income while declaring a rich/skilled person and misreporting his income and his type, respectively. The constraint (11) ensures that poor/unskilled individual prefers a truthful statement of his type and income than misreporting his income.

The Lagrangian expression for the planner's problem when enforcement is costly and incomes

[12]Note that the incentive compatibility constraints force all consumers to correctly state income in equilibrium which characterizes the optimum tax-cum-audit policy.

are observable only through an audit cost is written as

$$
\begin{aligned}
\Lambda \;=\; & [(1-p_p)u(Y_p-T_p)+p_p u(Y_p-F_p)+v_p(Y_p)] \\
& +\delta\,[(1-p_r)u(Y_r-T_r)+p_r u(Y_r-F_r)+v_r(Y_r)]-\beta[P(C_p^e,C^*(C_p^e,C_r^e))] \\
& +\lambda_1\begin{bmatrix} (1-p_r)u(Y_r-T_r)+p_r u(Y_r-F_r)+v_r(Y_r)-\beta_r EP(C_p,C^*(C_p,C_r)) \\ -(1-p_p)u(Y_p-T_p)-p_p u(Y_p-F_p)-v_r(Y_p)-\beta_r EP(C_p,C^*(C_p,C_r)) \end{bmatrix} \\
& +\lambda_2\,[(1-p_r)u(Y_r-T_r)+p_r u(Y_r-F_r)+v_r(Y_r)-\beta_r EP(C_p,C^*(C_p,C_r))-V_{rr}] \\
& +\lambda_3\,[(1-p_r)u(Y_r-T_r)+p_r u(Y_r-F_r)+v_r(Y_r)-\beta_r EP(C_p,C^*(C_p,C_r))-V_{rp}] \\
& +\lambda_4\,[(1-p_p)u(Y_p-T_p)+p_p u(Y_p-F_p)+v_p(Y_p)\beta_p EP(C_p,C^*(C_p,C_r))-V_{pp}] \\
& +\mu\left[N_p[(1-p_p)T_p+p_p F_p]+N_r[(1-p_r)T_r+p_r F_r]-A(N_p p_p+N_r p_r)-\bar{R}\right] \qquad (13)
\end{aligned}
$$

where the λ_1 denote the Lagrangian multiplier for the self-selection constraint, λ_2, λ_3 and λ_4 represent the Lagrange multiplier of moral hazard constraints and μ is the marginal cost of an additional unit of revenue in utility terms.

The first order conditions of this problem with respect to Y_p, Y_r, T_p, T_r, F_p, F_r, p_p and p_r are, respectively:

$$
\begin{aligned}
(1+\lambda_4)\left[E\frac{\partial u_p}{\partial C_p}-\frac{\partial v_p(Y_p)}{\partial Y_p}\frac{1}{w_p}\right]-\lambda_1\left[E\frac{\partial u_p}{\partial C_p}-\frac{\partial v_r(Y_p)}{\partial Y_p}\frac{1}{w_r}\right]-\beta\frac{dEP(\cdot)}{dC_p^e} &= 0 \qquad (14)\\
(\delta+\lambda_1+\lambda_2+\lambda_3)\left[E\frac{\partial u_r}{\partial C_r}-\frac{\partial v_r(Y_r)}{\partial Y_r}\frac{1}{w_r}\right]-\beta\frac{dEP(\cdot)}{dC_r^e} &= 0 \qquad (15)\\
-(1-\lambda_1+\lambda_4)(1-p_p)\frac{\partial u_p^T}{\partial C_p}-\lambda_3\frac{\partial V_{rp}}{\partial T_p}-\lambda_4\frac{\partial V_{pp}}{\partial T_p}+\mu N_p(1-p_p)+\beta(1-p_p)\frac{dEP_p^T(\cdot)}{dC_p^e} &= 0 \qquad (16)\\
-(\delta+\lambda_1+\lambda_2+\lambda_3)(1-p_r)\frac{\partial u_r^T}{\partial C_r}-\lambda_2\frac{\partial V_{rr}}{\partial T_r}+\mu N_r(1-p_r)+\beta(1-p_r)\frac{dEP_r^T(\cdot)}{dC_r^e} &= 0 \qquad (17)\\
-(1-\lambda_1+\lambda_4)\frac{\partial u_p^F}{\partial C_p}+\mu N_p+\beta\frac{dEP_p^F(\cdot)}{dC_p^e} &= 0 \qquad (18)\\
-(\delta+\lambda_1+\lambda_2+\lambda_3)\frac{\partial u_r^F}{\partial C_r}+\mu N_r+\beta\frac{dEP_r^F(\cdot)}{dC_r^e} &= 0 \qquad (19)\\
(1-\lambda_1+\lambda_4)\left[u_p^F-u_p^T\right]-\lambda_3\frac{\partial V_{rp}}{\partial p_p}-\lambda_4\frac{\partial V_{pp}}{\partial p_p}+\mu N_p\left[F_p-T_p-A'\right]-\beta\frac{dEP(\cdot)}{dp_p} &= 0 \qquad (20)\\
(\delta+\lambda_1+\lambda_2+\lambda_3)\left[u_r^F-u_r^T\right]-\lambda_2\frac{\partial V_{rr}}{\partial p_r}+\mu N_r\left[F_r-T_r-A'\right]-\beta\frac{dEP(\cdot)}{dp_r} &= 0 \qquad (21)
\end{aligned}
$$

where $u_p^T = u(Y_p - T_p)$, $u_r^T = u(Y_r - T_r)$, $u_p^F = u(Y_p - F_p)$, $u_r^F = u(Y_r - F_r)$, $P_p^T = P(Y_p - T_p, C^*(Y_p - T_p, C_r^e))$, $P_p^F = P(Y_p - F_p, C^*(Y_p - F_p, C_r^e))$, $P_r^T = P(C_p^e, C^*(C_p^e, Y_r - T_r))$, $P_r^F = P(C_p^e, C^*(C_p^e, Y_r - F_r))$, $dEP(\cdot)/dC_p^e = \partial EP(\cdot)/\partial C_p^e + (\partial EP(\cdot)/\partial C^*(\cdot))\left(\partial C^*(\cdot)/\partial C_p^e\right)$, $dEP(\cdot)/dp_r = (\partial EP(\cdot)/\partial C^*(\cdot))(\partial C^*(\cdot)/\partial p_r)$, $dEP(\cdot)/dC_r^e = (\partial EP(\cdot)/\partial C^*(\cdot))(\partial C^*(\cdot)/\partial C_r^e)$ and $dEP(\cdot)/dp_p = \left(\partial EP(\cdot)/\partial C_p^e\right)\left(\partial C_p^e/\partial p_p\right) + (\partial EP(\cdot)/\partial C^*(\cdot))(\partial C^*(\cdot)/\partial p_p)$.

From equations (15) and (14), we obtain the following marginal tax rates on poor and rich individuals, respectively:

$$MTR^r = \frac{1}{E(\partial u_r/\partial C_r)}\left\{\frac{\beta}{(\delta + \lambda_1 + \lambda_2 + \lambda_3)}\left[\frac{dEP(\cdot)}{dC_r^e}\right]\right\} \tag{22}$$

$$MTR^p = \frac{1}{(1 - \lambda_1 + \lambda_4)\left(E(\partial u_p/\partial C_p)\right)}\left\{\lambda_1\left[\frac{\partial v_p(Y_p)}{\partial Y_p}\frac{1}{w_p} - \frac{\partial v_r(Y_p)}{\partial Y_p}\frac{1}{w_r}\right] + \beta\left[\frac{dEP(\cdot)}{dC_p^e}\right]\right\} \tag{23}$$

If the measure of poverty is absolute ($dEP(\cdot)/dC_r^e = 0$), rich (skilled) workers should face a zero marginal tax rate. Interestingly, it turns out that the optimal tax policy requires a positive marginal tax rate on rich individuals when their consumption affects the poverty measure, i.e., when a relative measure of poverty is considered. The optimal marginal tax rate on the poor can be positive, negative or zero in the case of either an absolute or a relative poverty measure. Notice that in this environment $\lambda_1 = 0$ does not imply $\lambda_4 = 0$. In the absence of poverty, if the first self-selection constraint, equation (8), is not binding, there is no reason to distort the unskilled individuals' labor supply ($\lambda_1 = 0$ implies $\lambda_4 = 0$). That is, if the rich prefers the truth than mimic the poor's income and type, the poor has no incentive to cheat by reporting an income different than its true one. However, in the presence of poverty, even if λ_1 is set to zero, the social planner still has reasons to distort the behavior of the poor. Concerned about aggregate poverty and consequently the consumption of the poor, the planner imposes a negative marginal tax rate on unskilled workers. The poor has now an extra incentive to work since s/he is being subsidized and the rich strictly prefers the truth-telling strategy. This in turn creates incentives for the poor to mimic their income and work less, implying that λ_4 may be greater than zero. The following proposition summarizes these results.

Proposition 1 *The optimal tax-cum-audit policy implies that* (i) *the marginal tax rate faced by skilled workers must be positive (zero) for a relative (absolute) poverty measure,* (ii) *marginal tax on the poor can be positive, negative or zero, for either an absolute or relative poverty line and* (iii) *unskilled workers face a negative marginal tax when rich individuals do not have incentives to mimic poor individuals and government is concerned with poverty as public bad.*

Proof. Our result (i) says the optimal marginal tax rate on the rich is positive when reducing poverty is one of the goals of the social planner and the consumption of the rich can affect the poverty measure (relative poverty line). In equation (22), the term $(\partial EP(\cdot)/\partial C^*(\cdot))\,(\partial C^*(\cdot)/\partial C_r^e)$ is positive. This term is null for either an absolute poverty measure or in the case we have less than half of the population rich and the poverty line refers to a fraction of the median income. Otherwise, rich (skilled) individuals should face a positive marginal tax rate. The proof of result (ii) follows follows from equation (23) and the optimum marginal tax imposed on the poor individuals may be either positive or negative. The rich individual consumes more leisure compared to the poor individual for the same amount of income, which implies a higher marginal utility of the leisure good for the poor agent. In addition note that $w_r > w_p$. This implies that $[\partial v_p(Y_p)/w_p - \partial v_r(Y_p)/w_r] > 0$. From the properties of a relative measure of poverty $P(C_p^e, C^*(C_p^e, C_r^e))$, it follows that $dEP(\cdot)/dC_p^e < 0$. Recall that this total effect is negative and the consumption of the poor affects the relative poverty measure direct $(\partial EP(\cdot)/\partial C_p^e < 0)$ and indirectly $((\partial EP(\cdot)/\partial C^*(\cdot))\left(\partial C^*(\cdot)/\partial C_p^e\right) \geq 0)$. Notice that the indirect effect is zero for an absolute poverty measure or in the case that less than half of the individuals are poor and the relative poverty line refers to a fraction of the median consumption. Hence, depending on the relative effects of the terms in brackets in equation (23), the optimum marginal tax imposed on the poor individuals may be positive, negative or zero for both relative and absolute poverty measure cases. For the result (iii), given that $\beta > 0$ (government's concern with poverty) and $\left[dEP(\cdot)/dC_p^e\right] < 0$, it follows from equation (23) that if $\lambda_1 = 0$, then $MTR^p < 0$. ■

Proposition 1 extends the existing results of the optimal taxation literature and qualifies the optimal policies when the government is concerned about poverty. In the case of an absolute poverty line, our result $(MTR^r = 0)$ reinforces one of the main findings in the optimal tax

literature: "no discrimination at the top". This happens because no one wants to imitate the rich and the consumption of skilled individuals does not affect the poverty measure. Hence, the social planner has no reasons to distort their decisions.

However, there is discrimination at the top ($MTR^r > 0$) and the decisions of the rich are distorted as long as poverty matters for the society (relative poverty line). Intuitively, although the rich still does not want to imitate the poor, a positive tax must be impose on the rich because relative poverty is increasing in the consumption of the rich. If the rich consumes more, the relative measure of poverty increases and it reduces social welfare. By taxing the rich, a planner concerned about aggregate poverty reduces income inequality and improves the society's welfare. Notice, from equation (22), that if poverty decreases the tax on the rich also decreases, consisting with the notion that rich individuals are taxed in this economy to compensate for their negative influence on the poverty measure. This interesting result goes in opposite direction of the famous "no discrimination at the top" result of the optimum income tax literature. Indeed, there is discrimination at the top as long as those at the top can influence the welfare of the whole society through a measure of poverty. Notice also that if the effective marginal tax on the poor is negative, the planner can potentially reduce poverty via subsidies to the poor and improve social welfare conditional on public expenditures $\bar{R}$. These public expenditures are assumed not influencing the individuals' decisions with respect to consumption or leisure.

Regarding audit probabilities, when reducing poverty is not a social planner's goal, high-wage reports are never audited. But, if poverty matters the optimal choice of the audit probability is not necessarily a zero probability of auditing skilled individuals' income. The income reports of the poor are audited stochastically, i.e., with a probability strictly less than one. The following proposition summarizes these results.

Proposition 2 *The optimal audit policy is characterized by p_p, $p_r < 1$. And, the audit probability of skilled workers' income, p_r, is not necessarily zero.*

Proof. We prove each claim separately, beginning with the case of poor (unskilled, type-p) individuals. Consider any policy ($\bar{Y_p}$, $\bar{Y_r}$, $\bar{T_p}$, $\bar{T_r}$, $\bar{p_p}$, $\bar{p_r}$, $\bar{F_p}$,$\bar{F_r}$) that satisfies the constraints

$(8)-(12)$ and $\bar{p_p} = 1$. To prove that optimal audit policy is characterized by $p_p < 1$ it is sufficient to show that a change from $\bar{p_p} = 1$ to $\check{p}_p = 1-\epsilon$, for ϵ small enough, does not decrease the objective function of the government. First, notice that EU_{pp} remains the same under the alternative policy $\check{p}_p = 1-\epsilon$ and $\check{T}_p = \tilde{F}_p$, which leaves the planner's objective function unchanged. In the case of a planner concerned about poverty, we have to verify the effect of this alternative policy on social welfare, through the expected aggregate poverty $EP(C_p, C^*(C_p, C_r))$. Recall that $[\partial P(\cdot)/\partial C_p] < 0$. For $\bar{p_p} = 1$ the expected aggregate poverty is given by $P(Y_p - F_p, C^*(Y_p - F_p, C_r^e))$. Similarly, for the alternative policy $\check{p}_p = 1-\epsilon$, we have $P(C_p^e, C^*(C_p^e, C_r^e))$, where $C_p^e = \epsilon(Y_p - T_p) + (1-\epsilon)(Y_p - F_p)$. Since $C_p^e > (Y_p - F_p)$, it implies that $E\bar{P}(\cdot) > E\check{P}(\cdot)$ and the alternative policy $\check{p}_p = 1-\epsilon$ increases welfare. The feasibility of both policies is proven in Cremer and Gahvari (1996) and will not be repeated here. A similar approach can be used to show that $p_r < 1$ for rich (skilled, type-r) individuals. The proof of the second claim, p_r is not necessarily zero, follows from Cremer and Gahvari (1996) with the appropriate changes to reflect the effect of poverty on the audit probability of the rich. Consider again a policy $(\bar{Y}_p,\ \bar{Y}_r, \bar{T}_p,\ \bar{T}_r,\ \bar{p}_p,\ \bar{p}_r,\ \bar{F}_p,\ \bar{F}_r)$ that satisfies the self-selection constraints $(8)-(11)$, as well as the revenue constraint (12). We show that if the policy entails $\bar{p}_r > 0$, then changing it to another policy that never audits high-wage reports, and satisfies all the constraints, does not necessarily result in a higher level of social welfare. This occurs because the government's concern and goal of reducing poverty. There are two effects at work here. First, the effect of on the expected utility of rich individuals. Denote the value of the variables under an alternative policy with a "hat" over them, and define $\hat{p}_r = 0$, $\hat{T}_r = (1-\bar{p_r})\bar{T}_r + \bar{p}_r\bar{F}_r$, $\hat{Y}_r = \tilde{Y}(w_r, 0, \hat{T}_r)$, $\hat{Y}_p = \bar{Y}_p$, $\hat{T}_p = \bar{T}_p$, $\hat{p}_p = \bar{p}_p$, $\hat{F}_p = \bar{F}_p$. From these definitions, it follows that the value of EU_{pp} under both policies is the same. The strict concavity of u (risk aversion) implies that, even if Y_r were to remain at $\bar{Y}_r$, the suggested changes for p_r and T_r increase EU_{rr} (same expected taxes but no uncertainty). Since $\bar{Y}_r$ is replaced by $\hat{Y}_r$, expected utility can only increase further. Hence, $E\hat{U}_{rr} > E\bar{U}_{rr}$ and social welfare under the alternative policy $(\hat{p}_r = 0)$ would be higher than under the initial policy $(\bar{p}_r > 0)$. It can easily be shown that both policies are feasible. Second, we have to examine the effect of alternative policies on aggregate poverty. For the initial policy, the expected aggregate poverty is $P(\bar{C}_p, C^*(\bar{C}_p, \bar{C}_r))$. Under the alternative policy $\hat{p}_r = 0$,

the expected aggregate poverty is given by $P(\bar{C}_p, C^*(\bar{C}_p, \hat{C}_r))$, where $\hat{C}_r = \hat{Y}_r - \hat{T}_r$. Note that $\hat{Y}_r \geq \bar{Y}_r$ and $dP(\cdot)/dC_r = [(\partial P(\cdot)/\partial C^*(\cdot))\ (\partial C^*(\cdot)/\partial C_r)] > 0$, while government tax revenues are the same under both policies. This implies that $E\hat{P}(\cdot) > E\bar{P}(\cdot)$ and the alternative policy $\hat{p}_r = 0$ indeed reduces social welfare, by increasing aggregate poverty. Thus, the strategy of never auditing high-wage individuals has contradictory effects on social welfare. It increases the expected utility of the rich, improving welfare, while it reduces welfare through an increase in aggregate poverty. The final effect on the social welfare depends on the magnitude of these two effects. Thus, when reducing poverty is a social planner goal the optimal audit policy is not necessarily characterized by $p_r = 0$. ■

The first result in Proposition 2 is consistent with the existing literature. It is welfare improving because it implies lower audit costs and lower expected aggregate poverty. Also, the claim that income reports of the rich are never audited (Mookherjee and Png, 1989 and Cremer and Gahvari, 1996) still holds in our economy if the consumption of the rich can not affect the poverty measure (absolute poverty line). That is, if the planner is concerned about poverty but cares exclusively about the well-being of the poor and not of the overall society, then the optimal probability of auditing skilled individuals is zero.

However, the rich might be audited stochastically if their well-being is considered in the measurement of poverty (relative poverty line). Some intuition for this result may be obtained from the arguments of the proof. First, notice that there are two benefits by changing from a positive audit probability to a probability of auditing equal to zero. The alternative policy ($\hat{p}_r = 0$) eliminates uncertainty in the consumption of risk averse rich individuals and audit cost are reduced. While the possibility of misreport his income without being audited makes the rich better off, enhancing welfare, this alternative policy has a negative impact on social welfare by increasing the aggregate poverty in this economy. As the rich becomes richer, the poor becomes relatively poorer. A planner concerned about poverty wants to minimize the impact of poverty on the economy's social welfare, which can be achieved by auditing the rich's income reports. This intuition is also related to results derived in Proposition 1, where we have shown that the decisions of the rich are distorted as long as poverty matters for the society (relative poverty line). A positive marginal

income tax imposed on skilled individuals create opportunities for tax evasion. If rich individuals are taxed to compensate for their negative influence on the poverty measure, and consequently on social welfare, a positive probability of auditing is consistent with the fact that skilled individuals might misreport their income in response to distortions created by a planner concerned about their negative impact on aggregate poverty and on social welfare. In summary, the reason to audit the rich randomly is twofold. First, it reduces aggregate (relative) poverty and improves welfare. And second, a positive marginal tax rate on the rich creates incentives for them to misreport their incomes, which in turn might require a positive audit probability on high-wage reports. Auditing is need to ensure compliance of both types of individuals.

In an environment where agents can evade taxes and the planner is concerned about poverty, individuals' honesty must be rewarded. Honest agents, both rich and poor, prefer to be audited and an agent who is audited and tells the truth is rewarded.[13] This is a well-known result in the auditing literature (Border and Sobel, 1987; Mookherjee and Png, 1989; Kaplow, 1990; Cremer and Gahvari, 1996) and it is stated and proved in the following proposition.

Proposition 3 *Individuals should be rewarded if caught telling the truth about their income. That is,* $F_r < T_r$ *and* $F_p < T_p$.

Proof. Dividing (17) by (19) and (16) by (18) and simplifying yield, respectively

$$\frac{\partial u_r^T/\partial C_r}{\partial u_r^F/\partial C_r} = \frac{\mu N_r + \beta(dEP_r^T(\cdot)/dC_r^e) - [\lambda_2/(1-p_r)]\,\partial V_{rr}/\partial T_r}{\mu N_r + \beta(dEP_r^F(\cdot)/dC_r^e)} \tag{24}$$

$$\frac{\partial u_p^T/\partial C_p}{\partial u_p^F/\partial C_p} = \frac{\mu N_p + \beta(dEP_p^T(\cdot)/dC_p^e) - [\lambda_3/(1-p_p)]\,\partial V_{rp}/\partial T_p - [\lambda_4/(1-p_p)]\,\partial V_{pp}/\partial T_p}{\mu N_p + \beta(dEP_p^F(\cdot)/dC_p^e)} \tag{25}$$

From the concavity of u and since $\partial V/\partial T < 0$, the right-hand side of (24) and (25) depends on whether moral hazard constraints (9), (10) and (11) are binding. In the case of rich individual's, λ_2 is not necessarily equals to zero. Due to the planner's poverty concerns it is optimal to distort rich individuals labor supply decisions. In consequence, they might evade taxes to avoid such distortion ($\lambda_2 > 0$) and must be rewarded if truly report their income. That is, the RHS of (24) is strictly

[13] The results do no change if we do not allow for rewards in honest reporting.

greater than one, and implies that $F_r < T_r$. Hence, the rich is always rewarded if caught telling the truth about his/her income. For poor individuals, if either skilled households are indifferent between truth-telling and mimicking their type and income ($\lambda_3 = 0$) or poor individuals are indifferent between truth-telling and mimicking their income ($\lambda_4 = 0$), the RHS of (25) is strictly greater than one, which implies that $F_p < T_p$. ■

An interesting situation, when $\lambda_3 = \lambda_4 = 0$, might occur when the planner is concerned about poverty reduction. In fact, the planner now balances its goals of poverty reduction and compliance with these constraints. Intuitively, if neither of these constraints is binding, it will be possible to reduce p_p and increase welfare. A lower audit probability of unskilled individuals' income increases the consumption of the poor, which in turn decreases aggregate poverty and improves social welfare. Moreover, as the probability of being audit decreases, a poor agent has less incentives to tell the truth about his/her income, which in turn reduces any incentive to reward him/her and, then, $F_p = T_p$.

Finally, if poverty is not in the social welfare function ($\beta = 0$), i.e., the planner does not care about poverty, rich individuals should face a zero marginal tax rate ($MTR^r = 0$) and a positive marginal tax has to be imposed on the poor ($MTR^p > 0$) to distort their behavior and make it less desirable for the rich to mimic them, standard results in the literature.

4 Conclusion

This paper integrates poverty consideration and tax evasion into an optimum general income tax problem with endogenous labor supply. The notion that both rich and poor individuals can evade taxes and policymakers can adopt different measures of poverty have important implications for the question of optimal income tax design. The main contribution of this paper is to show that the optimal marginal tax rate on rich individuals is positive when reducing poverty is one of the goals of the social planner and their consumption can affect negatively the poverty measure (relative poverty line). This result differs from the traditional "non-distortion at the top" result in the optimal taxation literature. Moreover, skilled workers might be audited stochastically if their

well-being is considered in the measurement of poverty. A sufficient condition for having unskilled workers with a negative marginal tax is that skilled counterparts do not have incentives to mimic them (poor individuals). Our findings have potentially important policy implications. We have shown that the measurement of poverty is crucial for the optimal income taxation design and it is worthwhile to further investigate the reasons behind different choices of standard of living to measure poverty.

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