Inequality, the politics of redistribution and the tax-mix*

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Abstract

Several papers on the political economy of redistribution find that taxes and redistribution are positively correlated with income inequality. However there is not clear evidence that unequal societies redistribute more. When redistribution is financed through income taxes the existence of an informal sector that evades income taxes reduces the tax-base more the more unequal the society is. We find a more complex relationship between inequality and redistribution: redistribution is an inverted U-shaped function of the equality index. We show that the tax-base effect along with the political channel determines the structure of the tax-mix, composed by income and consumption taxes. Moreover we give a rationale for the fact that more unequal societies rely more heavily on indirect taxes.

JEL classification: D3, H24.

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1 Introduction

The aim of combining political economics and public economics is to understand what makes countries differ in their tax system, redistribution, unemployment, etc. In the models of Romer (1975), Roberts (1977), and Meltzer and Richard (1981) political competition between two office motivated candidates drives the redistribution level toward the ideal point of the median income voter. The greater the gap between the pretax earning of the median income voter and the mean income (higher inequality), the greater the political demand for redistribution (see also Persson and Tabellini, 1994). If the prediction of the traditional Downsian model was right, soon or later societies would converge to complete equalization of incomes.

However, previous empirical studies: Perotti (1996), Bénabou (1996) and Glaeser (2005); hardly support the findings of the traditional Downsian model. As Glaeser (2005) suggests there is rather a negative relationship between inequality and social welfare spending.

We investigate in this paper a possible channel to explain why unequal societies tend to redistribute less. Indeed, we find a non-linear relationship between redistribution and inequality even if the equilibrium tax-mix and redistribution level is the preferred policy of the voter with median income. The existence of an informal sector that evades income taxes reduces the tax base of the income tax instrument. Redistribution is costly in unequal societies, where the opportunity cost to go informal is low for an important part of the population.

Among the literature that find non-linear relationship between either inequality and growth or inequality and redistribution we may cite three: Perotti (1993), Bénabou (2000) and Lee and Roemer (1998, 1999). Credit market constraints prevents the poor to invest in education unless it is publicly financed (Lee and Roemer, 1999 and Bénabou, 2000) or the government redistributes income, which increases poor's disposable income (Perotti, 1993). If a positive externality is associated to total investment on education an equal society may support high levels of redistribution. The closest to this paper is Lee and Roemer (1999). Incomplete credit markets generates a division of the population into two classes: the one that privately invest on education and the one that doesn't. The poor support low tax rates since he doesn't benefit from the complementarity between public and private investment in education. They find that public education spending is an inverted U-shaped function of inequality. In our model preferences of the poor and the rich are not align. It is rather a tax-base problem which explains the low redistribution level in unequal societies.

In our model taxation is purely redistributive and has rather a negative effect, since the financing of redistribution through income taxes distorts the labor supply between the informal sector and the formal sector. We study the relationship between redistribution and inequality and the tax-mix and inequality. The fact that informal workers evade income taxes introduces a tax-base problem. We show that the tax-base effect along with the political channel determines the structure of the tax-mix, composed by income and consumption taxes. Moreover we give a rational for the fact that more unequal societies may rely more heavily on indirect taxes, though it is a regressive tax instrument.

We assume that voters can choose between working on a "formal" or "official" sector paying taxes or to work "underground"[1] with a fixed wage. To model the supply side of informal labor we have to take into account the income tax rates and the wage rates in the official economy since, higher marginal income tax rates imply a higher supply of underground labor (it reduces after-tax income at work). The informal sector or underground economy tends to be higher in poor countries given that the wage rates are lower there.[2] The firm demand for underground labor and supply of underground goods, that depends positively on the indirect tax, are not modelled here. We assume that the cost of indirect taxation is an exogenous and fixed administrative cost.

When inequality is very high a poor median pressures for the highest possible redistribution level. There are few contributors (formal sector workers) to finance such redistribution that ends up being very low. When inequality is very low the median voter is closer to the voter with mean income. The median voter is likely to be a formal sector worker, his preferred tax schedule then, minimizes his tax burden and redistribution is expected to be low. For intermediate levels of inequality, a poor median voter working in the formal sector may pressure for high redistribution. There is now an important number of formal sector workers, then, the tax base is high and redistribution would be also high. When inequality decreases, redistribution becomes less costly and at the same time the median becomes richer. The result is an inverted U-shaped pattern of the equilibrium redistribution level in the equality parameter.

We also find a positive relationship between inequality and the size of the informal workforce which is supported by the data. Loayza (1996) finds a negative correlation between the size of the informal sector with real per-capita GDP. While Chong and Gradstein (2004) finds no significant relationship between the size of the informal sector and GDP per-capita they find a positive relationship between inequality and the size of the informal sector (mea-

[1] For a more detailed description see Schneider and Enste (2000). See Gërxhani (2004) for a survey of the literature that studies the relationship between formal and informal sector in developed and less developed countries.

[2] Developing countries are characterized by a large informal sector and a small modern industrialized sector. For more on this topic and the causes of the informal sector size in developing countries see Auriol and Walters (2005).

sured as percentage of GDP). Since the informal sector is a labor intensive sector we expect to have a positive relationship between inequality and participation in the informal sector.

In developing countries employment in the underground sector is significantly higher than it is in the developed world. Employment in the underground economy ranges from values around 20 percent of total labor force in OECD countries to more than 70 percent in some Asian countries. In India the proportion of the active population in the informal sector (including agriculture) increased from 89 percent in 1978 to 92 percent in 1998. In Latin American countries in 1996 more than 40 percent of the population work in the informal sector in many countries:Venezuela (42 percent), Colombia (53 percent), Peru (51 percent) and Bolivia (58 percent).[3]

We are also interested in the political support of an indirect tax (a consumption tax) within this framework. We study the tax-mix structure for different societies when equilibrium taxes are determined by majority voting. We want to model the interaction between: first, the political effect under which voters from one sector (or class) want to shift the burden of the tax to the other sector (class); and second, the tax-base effect under which income taxes are relatively more costly in countries with a large informal sector. Developing countries, more unequal than developed countries, rely more heavily on indirect taxes (see Tanzi and Zee, 2000; Zolt and Bird, 2005). In our setting, for some parameter values, not only redistribution is low for unequal societies but they rely more on regressive tax instruments like the indirect tax.

By simplicity, we assume we can not evade indirect taxes. We believe it is not a misleading assumption if we consider that indirect taxes are less easy to evade. When introducing the consumption tax the problem becomes bidimensional. Given the nature of voters' preferences a CW exists. We have a median-voter type of equilibria and we show by means of simulations that the combination of the tax-base along with the political channel determines the equilibrium tax-mix. From the political effect workers from the official sector want to increase the consumption tax relative to the income tax to shift the burden of the tax to workers in the informal sector. This will be actually the case as long as the administrative costs from indirect taxation are sufficiently small relative to the cost of the income tax (tax-base effect). The equilibrium tax-mix will depend finally on the median voter class and on the relative cost of each tax instrument.

In section 2 we sketch the model when only income taxes are available. In section 3 we solve for the choice of participation (in the formal sector) stage of a voter. In section 4 we prove that a median voter equilibrium exist and we study the relationship between

[3]Data on the OECD countries comes from Scheneider and Enste (2000). The remaining data comes from International Labour Organization (ILO, 1999).

redistribution and inequality. In section 5 we introduce the indirect tax, we perform some simulations to investigate the political equilibrium tax-mix and redistribution for different societies as a function of the model parameters. We conclude in section 6.

2 The Model

We model the political competition between two-office motivated parties A and B. Both parties announce a purely redistributive tax schedule and fully commit to the platform announced. The equilibrium concept is majority voting. Voters when casting their ballots evaluate the economic impact of such policies. Once the policy is implemented voters decide whether to participate or not in the "formal" sector.

The sequence of choices is as follows: in a first stage each party announces the political platform that maximizes his voting share. A tax schedule is a pair (t, β), where t is the constant income tax rate and β stands for redistribution.[4] β is a lump-sum transfer benefiting all voters irrespective of the sector they work for. In a second stage voters choose between the two parties. The party holding the majority of votes wins the election. Voters in the informal sector evade income taxes. They face a common wage in the underground/informal sector but they are differentiated by their skill level when working in the formal sector.

2.1 Preferences

Voters are differentiated by their ability to generate earnings. We have a continuum of types in $W = [0, 1]$ where w is interpreted as the skill level or wage of type w. The probability distribution of types is $F(w)$ and its density is $f(w)$. Assume $F(w)$ is strictly increasing on w and $f' < 0$. A family of distribution functions F_k over $[\underline{k}, \overline{k}]$ ranks societies from the most unequal, $\underline{k}$, to the most equal, $\overline{k}$, according to first order stochastic dominance (FSD). Then, k is our index of equality. If $k' > k$, $F_{k'}$ first order stochastic dominates distribution F_k. By FSD $F_{k'}(w) \leq F_k(w)$ for all $w \in [0, 1]$. Let's define the mean wage level: $\mu = \int_0^1 w dF(w)$, and the median wage level, m, is determined implicitly by $\int_0^m dF(w) = \frac{1}{2}$. For the time being we assume all societies share the same average wage. We further assume that $0 > \frac{f_k(x)}{f_k(x)} x \geq -3$ (this guarantees concavity of the redistribution function, see Lemma 1). To a one percentage change in w is associated a percentage change in the value of $f(.)$ smaller than three.

Voters face an imposed tax/transfer $T(w)$, and decide whether to work underground or not. This divides the population into two classes: employed (formally), differentiated by

[4] We do not consider indirect taxes for the moment.

their skill level with a pre-tax income w; and workers in the informal sector who evades the income taxes.

The utility u^w they derive from consumption is assumed to be linear.

The utility of an informal worker:

$$u^0\left(c^0\right) = \eta - T(0)$$

where u^0 is the utility of a voter working underground, η is her income. Since she declares zero income, $T(0)$ is the tax-payment (transfer) a voter in this sector pays (receives). Our model has a different setting than that of Snyder and Kramer (1988). In their model high ability workers could get higher wages in *both* sectors, while in our setting the underground economy held a fixed wage, making it unattractive for high skilled workers. This distinction is crucial to get the results. The crucial assumption is that η -in case it increases with w- doesn't increase faster than w for high levels of w.

The utility of a $w-$worker in the formal sector:

$$u^w\left(c^w\right) = w - T(w)$$

Consumption equals after-tax income, $c^w = w - T(w)$. When working in the formal sector the income level is simply the marginal productivity or skill level w. Note that a setting in which voters can choose to work in both sectors and decide how much labor to be supplied to each sector is equivalent to this setting.[5]

2.2 The tax schedule

The Government collects taxes trough a linear income tax function to finance redistribution.

The income tax rate is constant and equal to t. The income collected from taxes is used to finance a lump-sum transfer β. Since no one can be taxed more than 100% and because β should be positive we obtain boundaries for t, $t \in [0,1]$.

The Government budget constraint (GBC):

$$t\int_W wf(w)\,dw - \beta = 0 \qquad (1)$$

Where W is the set of formal workers. Only formal workers pay income taxes.

[5] Assume voters can work in both sectors. Each voter divides his time, normalized to one, between the two sectors. Consumption in this setting is: $c^w = wl + \eta(1-l)$. Note that this yields a corner solution over l, since their is no preferences for leisure.

From the GBC we can express the lump-sum transfer β as a function of the income tax rate t,

$$\beta(t) = t \int_W w f(w)\, dw$$

Note that the per-capita lump-sum transfer β is decreasing in the proportion of formal sector workers. The lower the participation in the formal sector is the higher will be the burden of the tax workers have to pay for a given β. In other words, a higher participation rate in the informal sector decreases the lump-sum transfer level to be financed with a given income tax rate.

3 Choice of Participation

A voter with marginal wage w decides to enter into the formal sector whenever his extra gain in consumption compensates his loss in other income:

$$(1-t)w + \beta > \beta + \eta$$

Since $t < 1$, consumption is increasing in gross wage, w. Then for an income tax t, there exists a unique w^* that is indifferent between working underground and not:

$$w^*(t) = \frac{\eta}{1-t} \tag{2}$$

Note that the informal workforce is strictly positive for any $\eta > 0$, even without taxation, $t = 0$.

From the GBC we get the lump-sum transfer as a function of the income tax rate, the inequality parameter and the informal sector wage:

$$\beta = t \int_{w^*(t,\eta)}^{1} w f(w)\, dw \tag{GBC}$$

Lemma 1 below summarizes the main properties of the *redistribution function*. We face a Laffer curve. When the income tax rate is sufficiently small an increase in t causes an increase in β, since we are getting more revenue from each contributor. On the other hand, an increase in the income tax rate decreases labor participation in the formal sector, decreasing the amount of contributors. For t large enough, an increase in t will lead to a decrease in β. Since the amount of contributors along with their average income determine the tax base, for a given t, more equal societies (higher k) can finance a larger lump-sum transfer. In other words, redistribution becomes cheaper as equality increases. Finally, the higher the fixed wage is in the underground sector, η, the lower will be the incentives to work in the formal sector; and then, the lower the lump-sum transfer will be.

Lemma 1 *a) β is concave on t.*

$\frac{\partial\beta}{\partial t} = \int_{w^*(t,\eta)}^{1} wf(w)\,dw - \frac{t}{1-t}(w^*)^2 f(w^*)$.

$\frac{\partial^2\beta}{\partial t^2} = \frac{t}{(1-t)^2}(w^*)^2 f(w^*)\left(-2\frac{(1-t)}{t} - 3 - \frac{w^* f'(w^*)}{f(w^*)}\right) < 0$.

For a given $t > 0$,

b) The lump-sum transfer is increasing in equality.

$\beta(t;k') - \beta(t;k) = t\left(\int_{w^*(t,\eta)}^{1} wf_{k'}(w)\,dw - \int_{w^*(t,\eta)}^{1} wf_k(w)\,dw\right) > 0$

With a common mean in both societies we have: $\int_0^x wf_{k'}(w)\,dw + \int_x^1 wf_{k'}(w)\,dw = \int_0^x wf_k(w)\,dw + \int_x^1 wf_k(w)\,dw$. From FSD $\int_0^x f_{k'}(w)\,dw < \int_0^x f_k(w)\,dw$ which implies $\int_0^x wf_{k'}(w)\,dw < \int_0^x wf_k(w)\,dw$ for f everywhere positive. Then necessarily $\int_x^1 wf_{k'}(w)\,dw > \int_x^1 wf_k(w)\,dw$.

c) The lump-sum transfer is decreasing in the outside wage η.

$\frac{\partial\beta}{\partial\eta} = -\frac{t}{(1-t)}w^* f(w^*) < 0$.

For a given tax rate the size of the formal sector workforce is increasing with equality. An increase in the equality index leads then, to a higher tax-base. To understand the role of inequality consider two societies with different equality indices $k' > k$, for a given tax t and a given fixed mean wage $\overline{\mu}$, we will have: $\beta(t;k') > \beta(t;k)$, simply because the number of contributors increase. We have then, a tax-base gain from reducing inequality.

4 Political Competition

Two office- motivated parties A, B announce a political platform specifying an income tax rate and a lump-sum transfer: (t, β), satisfying the GBC. Parties choose the political platform in order to please a majority of voters.

Voters' preferences toward policies depend on the sector they work for. Voters in the informal sector are all equal because they earn a fixed wage, η. Voters in the formal sector are differentiated by their skill level. In the next subsection we study the preferences of voters over the tax rate depending on the group they belong to, the lump-sum transfer being determined by the GBC.

4.1 Preferences over tax schedules:

4.1.1 Informal sector worker:

Workers in the informal sector do not contribute to the tax system. The objective function of a voter in the informal sector: $V^0 = \beta(t) + \eta$.

The preferred tax rate for a voter in this group is the peak of the Laffer curve. The tax rate t_0, maximizing redistribution, for which $\frac{\partial \beta}{\partial t} = 0$. For any (k, η), $t_0 > 0$ since $\frac{\partial \beta(t)}{\partial t} |_{t=0} = \frac{k}{k+1}\left(1 - \eta^{k+1}\right) > 0$.

Voters with earnings ability below the informal sector wage, $w < \eta$, will have a higher consumption level working in the informal sector for any t. So, for this group of voters $V^0(t) > V^w(t)$, their most preferred tax rate is unambiguously t_0.

4.1.2 Formal sector worker:

The objective function of a voter working in the formal sector: $V^w = (1-t)w + \beta(t)$.

The preferred tax rate for an $w-$worker is: t_w for which $\frac{\partial \beta}{\partial t} = w > 0$. A formal sector worker chooses an income tax rate to the left of the peak of the Laffer curve, where β is increasing.

From the concavity of $\beta(t)$, the higher the earnings ability, w, the lower would be the preferred income tax rate $\left(\frac{\partial t_w}{\partial w} < 0\right)$.

Next plot shows the preferred income tax rate for different earnings ability, w.

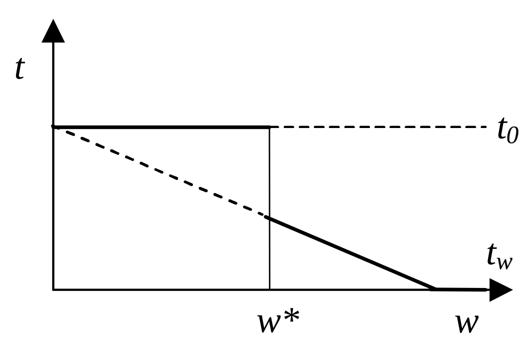

Figure 1: The $w-$preferred income tax rate.

We next show that voters have unambiguous preferences toward policies as a function of their earnings ability w.

Consider voter w_2 in Figure 2 and Figure 4 (in the appendix), he is indifferent between working underground and in the formal sector at $t = t_0$. Any voter $w > w_2$, then, prefers to work in the formal sector for any $t \leq t_0$. Note that the equilibrium income tax lies on the interval $[0, t_0]$. For voters with skill level on the interval $w \in \left(\eta; \frac{\eta}{1-t_0}\right)$ the analysis is less clear.

Figure 2 summarizes the different relationships between voter types and their preferred income tax rate, as well as the w^*-voter for different tax rates. The function $w(t_w)$ is the skill level for whose preferred income tax rate when working in the formal sector is t_w. We call $\bar{t}(w)$ the tax rate for which the w-voter is indifferent between working in the formal sector and working underground, and is the inverse of the function $w^*(t)$. Note that for each society (η, k) there is a unique t_0 that maximizes the lump-sum transfer $\beta(t)$.

Consider voter w_1, whose preferred income tax rate is t_{w_1}, his preferred income tax rate when working formally is precisely the one that makes him indifferent between working in the formal sector and working underground: $w(t_{w_1}) = w^*(t_{w_1})$. At t_{w_1} he is the *indifferent* voter, then, $V^0(t_{w_1}) = V^w(t_{w_1})$. Remember that the indirect utility of an informal sector worker is given by $V^0(t) = \beta(t) + \eta$ and it is maximized at t_0. Thus, voter w_1 maximizes his utility at $t = t_0$. The following order is satisfied: $V^0(t_0) > V^0(t_{w_1}) = V^w(t_{w_1})$.

For all voters $w \leq w_1$, $t_w > \bar{t}(w)$. If the income tax rate was t_w they would prefer to work in the informal sector. For all these voters $V^0(t_0) > V^0(t_w) \geq V^w(t_w)$.

From our previous analysis we conclude that all voters with skill levels $w \leq w_1$ maximize their utility at $t = t_0$. The preferred income tax rate for all voters $w \geq w_2$ is given by the function t_w.

The $w^*(t)$ and the $w(t_w)$ functions that determine the location of voters w_1 and w_2 for a society (k, η) are represented in Figure 2.[6]

What about voters lying on the interval (w_1, w_2)? Do they have unambiguous preferences over t? The answer is yes, all voter's types have unambiguous preferences over taxes. This idea is captured in Proposition 1.

Proposition 1 *There is a unique cut-off* $\widetilde{w}$ *such that* $V^0(t_0) = V^{\widetilde{w}}(t_{\widetilde{w}})$. $V^0(t_0) > V^w(t_w)$ *for all voters to the left of* $\widetilde{w}$ *and* $V^0(t_0) \leq V^w(t_w)$ *for all voters to the right of* $\widetilde{w}$.

Proof. *In the appendix* ■

The above proposition leads us to the application of the median voter theorem. Now preferences are group-independent. Irrespective of whether a $w-$voter is going to be working in the formal or informal sector he has unambiguous preferences over t. Only the $\widetilde{w}-$voter is indifferent between t_0 and $t_{\widetilde{w}}$. The preferred income tax rate $t(w)$ is decreasing in w

[6] We plotted the special case where $w_1 = \eta$ in Appendix B (as Figure 4). In that case w_1 is rather determined by the intersection between $\bar{t}$ and the y-axis. This case may be interpreted as k being very small.

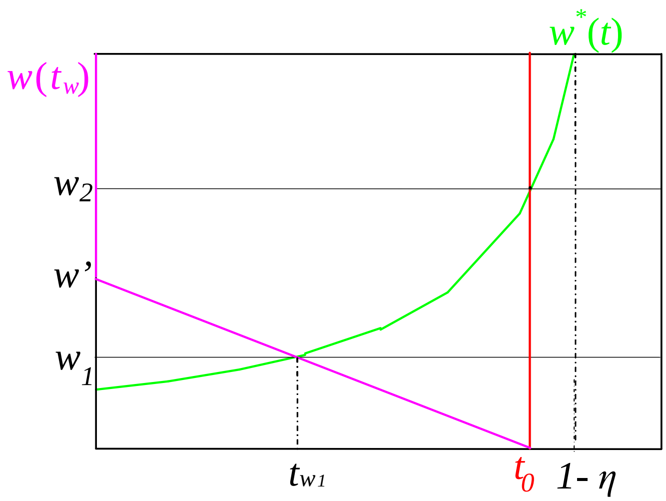

Figure 2: The tax functions.

(although not in a strict sense). So, preferences over tax rates have the same shape as in Figure 1 but eliminating the discontinuous lines and making $w^* = \widetilde{w}$.

Proposition 2 *a) There exist a unique equilibrium. The most preferred tax rate of the median skill voter.*

b) The equilibrium income tax rate is such that whenever $m < \widetilde{w}$, $t^{eq} = t_0$ *and for* $m \geq \widetilde{w}$, $t^{eq} = t_m$.

Proof. *In the appendix* ■

The $\widetilde{w}$-voter location along with the median determines the political equilibrium income tax rate and redistribution level. There is two types of equilibria. In one equilibrium the median voter works in the informal sector. His preferred income tax rate is t_0, where the redistribution level is at its highest possible level. In the other equilibrium the median works in the formal sector, his preferred income tax rate, t_m, minimizes his tax burden.

The relevant question is whether unequal societies redistribute less or more than more equal societies. To fulfil such a task we need to know how these two crucial voters: $\widetilde{w}$ and m are determined as a function of k. We are going to show that when the wage level in the informal sector is sufficiently small there exist a $k \in (0, 1)$ for which $\widetilde{w} = m$.

Proposition 3 *Assume* η *is sufficiently small, such that at* $\underline{k} : \eta > m(\underline{k})$ *and at* $\overline{k} : m(\overline{k}) = \mu > \eta$. *To guarantee concavity of the redistribution function we further assume that* $0 > \frac{f_k(x)}{f_k(x)} x \geq -3$. *There exists a unique* $\widetilde{k}$, *such that, for* $k < \widetilde{k}$ *the median works in the informal*

sector and the equilibrium income tax is of the type $t^{eq} = t_0$. For $k \geq \widetilde{k}$, the median works in the formal sector and the equilibrium income tax rate is of the type $t^{eq} = t_m$.
Proof. *In the appendix* ■

The following propositions show the main results, that redistribution, the lump-sum transfer β, increases with equality in more unequal societies (lower k). For a particular distribution function we show that redistribution is inverted U-shaped in the equality index.

In an unequal society, the median voter works underground and pressures for the highest "possible" redistribution level. If inequality is very high the set of formal sector workers is small and the equilibrium redistribution level is in fact small. Unequal societies redistribute less due to the tax-base problem.

Proposition 4 *Whenever $k < \widetilde{k}$ redistribution, $\beta(t^{eq})$, is increasing in k.*
Proof. *At $k < \widetilde{k}$ the equilibrium income tax rate is maximizes the lump-sum transfer β. Applying the envelope theorem to $\beta(t_0, k)$ and from Lemma 1 we have that $\frac{d\beta}{dk}(t^{eq}) = \frac{\partial \beta}{\partial k}(t; k) > 0$.* ■

We assume throughout the paper that the wage in the informal sector is constant. However, we can expect it to be a decreasing function of the size of the informal sector. This will crowd-out the redistribution gain from decreasing inequality. Since in a more equal society, a lower informal sector workforce would generate a more attractive wage in the informal sector. The following corollary generalizes our findings. Inequality still has a role to play if the informal sector wage elasticity is low enough.

Corollary 1 *Assume the wage in the informal sector takes the form, $\aleph = \frac{\eta}{(F(w^*))^{\alpha}}$, where $\alpha > 0$ is the elasticity of the informal sector wage to employment in the informal sector: $F(w^*)$. There exists a unique $\widetilde{k}$, such that, for $k < \widetilde{k}$ the median works in the informal sector and the equilibrium income tax rate is t_0. For $k \geq \widetilde{k}$, the median works in the formal sector and the equilibrium income tax rate is $t^{eq} = t_m$. Redistribution increases with equality in more unequal societies, with $k < \widetilde{k}$.*
Proof. *In the appendix* ■

A competitive wage in the informal sector would crowd-out the positive gain from equality. If the elasticity of the informal sector wage to labor participation at the sector is sufficiently small; the main relations found in Lemma 1 hold.

In a very unequal society (k small), the median voter works underground. He free rides on formal workers contributions. Thus, his preferred income tax is the one that maximizes redistribution, but, when inequality is very high there are few contributors to finance it. So, the maximum possible redistribution level end ups been very small. For a more equal society (larger k), the median voter contributes to the tax system. His preferred income tax rate minimizes his tax burden and is smaller than t_0. Since there are more contributors in this society, the redistribution level may be higher than the equilibrium redistribution level in the more unequal society. When $k = 1$ the median earnings ability coincides with the mean earnings ability, since he gains nothing from redistribution the equilibrium redistribution level equals zero.[7]. Whenever $k > \widetilde{k}$, we expect redistribution to be either decreasing or to reach a maximum within this range. If we assume $F(w) = w^k$ some numerical examples are performed confirming the inverted U-shaped functional form of redistribution on equality (see Appendix C).

5 Political support for indirect taxation

The empirical work of Kenny and Winer (2006) points out that the tax base of a tax instrument is very important in determining the observed tax-mix. We study in this section the political support for an ad-valorem tax also called a consumption tax, τ, to finance redistribution. As a benchmark, the tax-mix that maximizes the weighted sum of utilities equals zero, because income taxation and indirect taxes are distortionary and generate no positive externality (apart from redistribution).

A positive indirect tax over consumption may emerge as an equilibrium outcome of the political process. The reason is that the indirect tax is another instrument to collect resources to redistribute. If this instrument is less distortive than the income tax, then voters will agree to rely on it.

We have one consumption good. A uniform indirect tax, τ, is levied over consumption. Aggregate price level is normalized at 1. The demand of the consumption good is denoted by X. All after-tax income is consumed. So, $X^w = \frac{(1-t)w+\beta}{1+\tau}$ and $X^0 = \frac{\eta+\beta}{1+\tau}$ represents the demand of a consumer w working in the formal sector and a consumer working in the informal sector, respectively.

We assume indirect taxes have an administrative cost: $\lambda \in (0, 1)$. For any 1\$ collected from the consumption tax the Government only gets λ\$ to finance the lump-sum transfer or redistribution level $\beta(t, \tau)$. This means that $(1 - \lambda)$ \$ are the administrative costs from the tax collection process. The administrative cost of income taxes is normalized to one, since the 'indirect' cost of the income tax (tax evasion) is the most important in our model. If λ was equal to one, all informal sector workers would support the highest consumption tax,

[7] The redistribution level is smaller than $t\mu$, for any t since $\eta > 0$. The tax paid by the median equals $t\mu$ at $k = 1$. Thus, the preferred income tax of the median voter would be zero at $k = 1$.

$\tau = 1$. In this section we consider a more interesting case where τ^{eq} need not to be equal to one. With this purpose we assume $\lambda < 1$.

Assume $F(w) = w^k$. We rank redistribution function by the criterion of Generalized-Lorenz dominance (see Kleiber and Krämer, 2003). Then a society with $k' > k$ is more equal and has a higher average wage ($\mu' > \mu$).

The new Government budget constraint:

$$\beta(t,\tau) = t\mu^w(t) + \frac{\lambda\tau\eta(w^*(t))^k}{1+(1-\lambda)\tau} + \frac{\lambda\tau}{1+(1-\lambda)\tau}\mu^w(t) \tag{GBC'}$$

Where $\mu^w = \int_{w^*}^1 wf(w)\,dw = \frac{k}{k+1}\left(1-\left(\frac{\eta}{1-t}\right)^{k+1}\right)$.

The properties of the new redistribution function are given by Lemma 2 below:

Lemma 2 *For a given t:*

a) β is concave on τ.

$\frac{\partial\beta}{\partial\tau} = \frac{\lambda k\left(1+\left(\frac{1-t(k+1)}{k}\right)(w^*(t))^{k+1}\right)}{(k+1)(1+\tau(1-\lambda))^2} > 0.$

$\frac{\partial^2\beta}{\partial\tau^2} = -\frac{2\lambda(1-\lambda)\left(\frac{k}{k+1}\left(1-t(w^*(t))^{k+1}\right)+\frac{F(w^*)}{(1-t)(k+1)}\right)}{(1+\tau(1-\lambda))^3} < 0.$

b) The peak of the Laffer curve when $\tau > 0$ is to the left of the peak of the Laffer curve for $\tau = 0$.

$\frac{\partial}{\partial t}\beta(t,\tau) < \frac{\partial}{\partial t}\beta(t,0).$

$\frac{\partial}{\partial t}\beta(t,\tau) = \frac{\partial}{\partial t}\beta(t,0) - \frac{kt\tau\lambda(w^*(t))^{k+1}}{(1-t)(1+\tau(1-\lambda))}.$

c) For a given $\tau > 0$, β is concave on t.

$\frac{\partial^2\beta}{\partial t^2} = -\frac{k(w^*(t))^{k+1}(\tau(2-\lambda(1-t))+kt(1+\tau))}{(1-t)^2(1+\tau(1-\lambda))} < 0.$

From Lemma 2.1.b we can verify that for a given society (k,η) the peak of the Laffer curve (fixing τ) is to the left compared to the case where no indirect taxation was available. This is because the consumption tax is a partial substitute for the income tax.

The purpose of introducing the indirect tax is: first to check whether the main results of the previous section hold. Second, to investigate whether the presence of an informal sector *pushes* an unequal society to rely more heavily on regressive taxes.[8]

[8] The income tax in our setting is more average and marginal progressive. It is more marginal progressive because there is a fictitious first bracket $W_1 = [0, w^*]$ that pays no income taxes. Average progressivity is measured by the rate of growth of the tax burden per income: $\frac{\partial}{\partial w}\left(\frac{tw-\beta}{w}\right) > 0$ while the indirect tax turns out to be average regressive because the burden of the tax relative to income decreases with income: $\frac{\partial}{\partial w}\left(\frac{\tau X}{w}\right) = \frac{\partial}{\partial w}\left(\frac{\tau}{1+\tau}\left(\frac{w+\beta}{w}\right)\right) < 0$.

5.1 Preferences over tax schedules

In this section we study preferences over a tax-mix by voters. The choice of the preferred tax-mix depends upon the sector they work for. We start by describing the choice of the informal workers.

5.1.1 Informal sector workers

Workers in the informal sector can not evade consumption taxes. If these two tax instruments were perfect substitutes in maximizing redistribution the preferred tax-mix of the informal sector workers will rely exclusively on income taxes. However, the income tax base is limited, then, the preferred tax-mix of an informal worker may involve $\tau > 0$. The preferred tax-mix of an informal sector worker satisfies:

$$\frac{\partial \beta(t,\tau)}{\partial t} = 0.$$

$$\frac{\partial X_0}{\partial \tau} = \left(\frac{\partial \beta(t,\tau)}{\partial \tau} - \frac{(\eta + \beta(t,\tau))}{(1+\tau)} \right) \leq 0 \qquad (\tau = 0 \text{ if inequality})$$

The informal sector worker may favor a strictly positive consumption tax rate if the marginal benefit from an increase in redistribution exceeds the marginal consumption loss from the indirect tax ($\frac{\partial \beta}{\partial \tau}(t,\tau) > X_0(t,\tau)$ at $\tau = 0$). This will be the case if the cost of the consumption tax is sufficiently small (λ high). Note that $\frac{\partial X_0}{\partial \tau} |_{\tau=0} = \frac{k(\lambda - t)}{k+1}\left(1 + \frac{1}{k}(w^*)^{k+1}\right)$ is positive for λ sufficiently high. It will be positive at $\tau = 1$ if λ equals 1.

For a given $\tau > 0$, the preferred income tax by an informal worker is t_0, which is decreasing in τ. For a given $t > 0$, $\frac{\partial^2 \beta(t,\tau)}{\partial t \partial \tau} = -\left(\frac{\lambda k t (w)^{k+1}}{(1-t)(1+\tau(1-\lambda))}\right) < 0$. The preferred consumption tax of an informal worker, $\tau_0(t)$, is such that $\frac{\partial \beta(t,\tau)}{\partial \tau} = \frac{\eta + \beta(t,\tau)}{1+\tau}$. It can be easily shown that $\tau_0(t)$ is decreasing in t at $t = t_0$: $sign\left(\frac{\partial \tau_0(t)}{\partial t}\right) = sign\left(\frac{\partial^2 \beta(t,\tau)}{\partial \tau \partial t}(1+\tau) - \frac{\partial \beta(t,\tau)}{\partial t}\right) < 0$.

5.1.2 Formal sector workers

Once we introduce the indirect tax τ, consumption of a formal worker becomes $X_w = \frac{(1-t)w + \beta(t,\tau)}{1+\tau}$. The preferred tax-mix of a formal worker with wage rate w satisfies:

$$\frac{\partial \beta(t,\tau)}{\partial t} \leq w \qquad (t = 0 \text{ if inequality})$$

$$\frac{\partial X_w}{\partial \tau} \leq \frac{\frac{\partial \beta(t,\tau)}{\partial \tau}(1+\tau) - (\beta(t,\tau) + (1-t)w)}{(1+\tau)^2} \qquad (\tau = 0 \text{ if inequality})$$

From Lemma 2.1.b we know that $\frac{\partial \beta(t,\tau)}{\partial t} < \frac{\partial}{\partial t}\beta(t,0)$, so $t_w(\tau) < t_w(0)$. Indeed t_w is decreasing in τ.

For any t we can identify a cut-off $\overline{w}$ such that all voters with wage $w > \overline{w}$ prefer $\tau = 0$. It is given by $\overline{w} = \frac{\frac{\partial \beta(t,0)}{\partial t} - \beta(t,0)}{(1-t)}$. For all $w < \overline{w}$ the preferred consumption tax is strictly positive. We call this function $\tau_w(t)$. Note that the $sign\left(\frac{\partial \tau_w(t)}{\partial t}\right) = sign$ $\left(\frac{\partial^2 \beta(t,\tau)}{\partial \tau \partial t}(1+\tau) - \left(\frac{\partial \beta(t,\tau)}{\partial t} - w\right)\right)$, at t_w, the second expression in parenthesis equals zero. Then, $\tau_w(t)$ is decreasing in t at t_w.

5.2 The Political equilibrium tax-mix

We next prove that each voter has a unique preferred tax-mix within each group.

We are interested in the function $\tau_0(t(\tau))$, when t is chosen by maximizing the utility function of a voter in the informal sector given τ. Let's define $G(s) = \tau_0(t(s)) - s$. We prove that $G(s)$ equals zero for a unique s, so there is a unique ideal vector for informal sector workers (t_0, τ_0). Analogous for all formal sector voters.

Lemma 3 *Let's define $G_i(s) = \tau_i(t(s)) - s; i = w, 0$. Where $t(s)$ maximizes the utility of a contributor (non-contributor) for a given $\tau = s$. There exist a unique τ such that $G_i(\tau) = 0$. This guarantees the existence of a unique ideal vector for all voters.*

Proof. *1.- We prove that $G_i(0) \geq 0$. At $s = 0, G_i(0) = \tau_i(t(0)) \geq 0$, since $\tau_i \in [0,1]$. Note that $G(1) \in [-1, 0]$. By the intermediate value theorem, since $G_i(0)$ is continuous, there exist s such that $G_i(s) = 0$.*

2.- Uniqueness. $\tau_i(t(s))$ is an increasing function, $\tau_i \geq s$ at $s = 0$, and $\tau_i \leq s$ at $s = 1$. Then there exist a unique τ such that $\tau_i(t(\tau)) = \tau$ ■

Once we know (t_0, τ_0) and (t_w, τ_w) we can compute the highest indirect utility in the informal and formal sector, V^0 and V^w, of a $w-$voter. Note that $V^w(t_w, \tau_w)$ is increasing in w for any (t, τ), indeed we have $\frac{\partial V}{\partial w} = \frac{1-t}{1+\tau} > 0$. This implies that for a society (k, η) we have a unique $\widetilde{w}$ defined implicitly by: $V_0(t_0, \tau_0) = V_{\widetilde{w}}(t_{\widetilde{w}}, \tau_{\widetilde{w}})$.

The utility functions can be rewritten as: $V^0 = \frac{1}{1+\tau}\eta + \frac{\beta(t,\tau)}{1+\tau}$, $V^w = \frac{1-t}{1+\tau}w + \frac{\beta(t,\tau)}{1+\tau}$. The condition to have a CW in a multidimensional problem is fulfilled in our setting, this condition is called the Intermediate Preferences condition (Grandmont, 1978). Depending on the society (k, η) the equilibrium income tax is either (t_w, τ_w) or (t_0, τ_0).

Proposition 5 *a) There exist a unique equilibrium. The most preferred tax-mix of the median skill voter.*
b) The equilibrium income tax rate of the median skill voter is such that whenever $m < \widetilde{w}$, $T^{eq} = (t_0, \tau_0)$, whenever $m \geq \widetilde{w}$, $T^{eq} = (t_m, \tau_m)$.

Proof. *In the appendix* ■

The equilibrium tax-mix depends on the wage of the median relative to $\widetilde{w}$ and on the relative cost of one instrument with respect to the other, which is a function of k, η and λ. An unequal society has a small income tax base. An unequal society, then, may rely more on indirect taxes to finance redistribution, despite its regressivity.

At $T^{eq} = (t_0, \tau_0)$, when indirect taxes are available the Laffer-curve as a function of the income tax rate shifts upward and to the left for a given society (k, η). This points out the complementarity and substitutability between the two tax instruments. The substitution comes from the decrease of t_0 with the introduction of a positive indirect tax. Nevertheless, there exist complementarities among the tax instruments because we rely on both to finance redistribution.

In the next section we discuss the results from some numerical examples we performed.

5.3 Numerical examples

We summarize here the main findings from the simulations that we present in Appendix C. The first important result is that redistribution, β, is still an inverted U-shaped function of the equality index once we introduce an indirect tax. Redistribution increases with k for all $k \leq \widetilde{k}$. The most interesting result is the different patterns for the tax-mix. When administrative costs are very high ($\lambda = 0.8$) we rely exclusively on income taxation. There is then some substitutability between the two tax instruments. For the same society (k, η) the equilibrium tax-mix for different administrative costs involve, in general, a lower income tax rate and higher consumption tax the larger is λ. For the same λ, redistribution $\beta(t_0, \tau_0)$ is lower the higher the outside wage η. If the median works in the informal sector he prefers to rely on the indirect taxation to finance redistribution, specially if we have an important population working underground. By increasing the consumption tax rate the median voter shifts the burden of the tax to informal sector workers. Moreover even if the indirect tax seems to be inverted U-shaped the income tax does not necessarily follow such pattern, see Table 8.

Regarding the composition of tax revenue, income tax rates are higher than consumption tax rates in OECD countries.[9] In our numerical simulations such a pattern is compatible with the parameters $\lambda = 0.95$, $\eta = 0.1$ in Table 7. At $k = 0.8$, 21 percent of the population work underground, the income/consumption tax rate is in this case 2.2 (similar to the one of U.S.). Note that, for tables 7 and 8 the income/consumption tax rate is smaller than one even if the median works underground. This less intuitive pattern comes from the fact

[9] See Tanzi and Zee (2000). Indeed from 1995-97 the Income/Consumption tax is 1.2 in OECD countries (excluding Czech Republic, Hungary, Korea, Mexico and Poland) and 0.5 percent in a sample of developing countries.

that, if the median voter increases the indirect tax rate above the income tax rate, he then gains more from redistribution than he loses from consumption $\left(\frac{\partial \beta}{\partial \tau} > \eta\right)$ since the informal sector wage is too low ($\eta = 0.1$). If the outside opportunity (the fixed wage at the informal sector) is small, unequal societies will rely more on indirect taxes than on income taxes, the last one being more progressive. In remaining examples, the income/consumption tax ratio is decreasing in k, capturing the political channel effect under which the median voter shifts the tax burden to the sector he does not belong to.

In Table 10 we can observe that the size of the informal sector workforce is decreasing in the equality parameter. This is consistent with empirical observation. The size of the informal sector, measured as a percentage of GDP, increases with inequality. Since this sector is labor intensive, we expect to have a positive correlation between inequality and informal sector labor force.

6 Conclusion

The traditional literature on the political economy of taxation finds that redistribution is increasing with inequality. But this can not be supported empirically. This is one of the reasons why the Downsian model was criticized as a tool to explain the observed pattern of redistribution and inequality in industrialized economies. We show that this result comes not solely from the assumption of purely office-motivated candidates but from the lack of an endogenous tax base consideration. Income taxation leads to higher distortions than the usual one through decreasing labor effort. When income taxation is high, tax avoidance and tax evasion are more common. Some workers may prefer to work underground to avoid paying taxes. When such distortions are accounted for, very unequal societies, with many potential informal workers, have low redistribution levels. As the equality index increases we also have that the tax-base increases since more workers are now willing to contribute, making redistribution cheaper. When the consumption tax is introduced a CW exists, so the median voter is decisive. Even though this result simplifies our study of the equilibrium tax-mix, the political effect along with the tax-base effect seems less clear so we develop some numerical examples.

To summarize our findings, we have that redistribution is still an inverted U-shaped function of the equality index. Through the tax-base channel income taxes are lower when the cost of taxation is higher. Through the political channel, when the median is a poor formal sector worker, he prefers to rely more on consumption taxes to shift the burden of the tax to informal sector workers. Moreover we rely exclusively on one tax instrument either when the cost of the other instrument is very high or when we are in a too poor or too rich society.

We want a better understanding of how redistribution and taxes are determined as the outcome of a political process. We show that democracies may fail to equalize income among voters because of the tax-base problem.

The present chapter can be extended by introducing progressivity. This will raise the issue of whether we are going to rely more on indirect taxes (rather regressive) than on marginal progressive taxes (more redistributive). We should also consider the possibility of excluding the informal workers from government benefits in order to understand the differences in government expenditure composition across developed and less developed countries. Dynamics would allow us to endogenize inequality. It will allow us to determine the consequences of inequality on growth, through its effect on the informal sector size, the consequences of the informal sector size and growth on human capital investment and how this affects inequality.

Appendix A: Proofs of propositions

Proof of Proposition 1:

The value of the indirect utility of a voter working in the informal sector at t_0 is $V^0(t_0)$, which is constant for a given society (η, k). However $V^w(t_w)$ is increasing in w. Applying the envelope theorem to V^w with respect to w : $\frac{\partial V^w}{\partial w} = (1 - t_w) > 0$. There exist a unique cut-off point $\widetilde{w}$, implicitly defined by $V^0(t_0) = V^{\widetilde{w}}(t_{\widetilde{w}})$. The $\widetilde{w}-$voter is indifferent between t_0 and $t_{\widetilde{w}}$. All voters with earnings ability $w < \widetilde{w}$ $(w > \widetilde{w})$ prefer t_0 to t_w (prefer t_w to t_0). This unique cut-off point lies necessarily between w_1 and w_2 in Figure 2 ∎

Proof of Proposition 2:

a) Preferences satisfy the single-crossing property: by looking at Figure 1 we can see that preferences over the tax rate are decreasing (not in a strict sense) in w. If the median is such that he prefers the highest income tax rate (t_0) all voters to the left of the median also prefer t_0 to any other tax rate. If the median preferred income tax rate is smaller than the highest income tax rate, which means that he is working in the formal sector, then any proposal of a higher income tax rate will be defeated by the median preferred income tax rate by a coalition of high earnings voters. Analogous for smaller income tax rates.

b) Preferences satisfy the single crossing property and voters have an unambiguous preferred income tax rate given their type. We know that for any $w < \widetilde{w}$, $t(w) = t_0$, and for any $w \geq \widetilde{w}$, $t(w) = t_w$. This proves the second part of the proposition ∎

Proof of Proposition 3:

The proof is done in two steps:

1. The location of $\widetilde{w}$ and m.

   Assume that $m < \eta$ when $k \to 0$, then, $\widetilde{w} > m$. Assume that $m = \mu > \eta$ at $k = 1$, then, $\widetilde{w} < m$. For the particular distribution function $F(w) = w^k$ this is satisfied for η sufficiently small. At $k = 1$, $\eta = 0.38$ solves $V^0 = V^w$, or equivalently $\beta(t^0) + \eta = \frac{1}{2}$. For $\eta < 0.38$ the median voter wage is higher than $\widetilde{w}$ at $k = 1$.

2. Here we prove that the functions $\widetilde{w}(k)$ and $m(k)$ crosses only once for η sufficiently small. Which is equivalent to prove that $V^0(k)$, the value of the indirect utility of a informal sector worker, cross only once $V^m(k)$, the value of the indirect utility of the median when working in the formal sector.

   Uniqueness comes from the fact that $V^0(k) - V^m(k)$ is a contraction. This is true if for $k' > k$ and $\alpha \in (0, 1)$,

$$\left|V^0(k') - V^0(k) - (V^m(k') - V^m(k))\right| < \alpha(k' - k) \tag{3}$$

Since both $V^0(.)$ and $V^m(.)$ are strictly increasing in k, we have:

$$\left|V^0(k') - V^0(k) - (V^m(k') - V^m(k))\right| < V^0(k') - V^0(k)$$

A sufficient condition for (3) to be satisfied is $V^0(k') - V^0(k) \leq (k' - k)$ which is equivalent to $\frac{d\beta}{dk}(t_0, k) \leq 1$. For f differentiable on k, $\frac{\partial \beta}{\partial k} = t_0 \int_{w^*}^1 w \frac{\partial f}{\partial k} dw$. Since $t_0 < 1$, the condition for (3) to be satisfied is:

$$\int_{w^*}^1 w \frac{\partial f}{\partial k} dw \leq 1$$

Note that if distribution functions are ranked by FSD: $\int_0^1 w \frac{\partial f}{\partial k} dw = 0$ (same mean for two different distribution functions). This implies that $\int_0^x w \frac{\partial f}{\partial k} dw + \int_x^1 w \frac{\partial f}{\partial k} dw = 0$, for $k' > k$ this is equivalent to:

$$\Rightarrow \int_x^1 wf(k')\,dw - \int_x^1 wf(k)\,dw = \int_0^x wf(k)\,dw - \int_0^x wf(k')\,dw \tag{4}$$

From FSD the RHS of (4) is strictly positive.[10] Since $\int_0^x wf(k)\,dw < x$, necessarily $\int_0^x wf(k)\,dw - \int_0^x wf(k')\,dw < x$ with $x < 1$. The ranking of distribution functions then satisfies $\int_x^1 w \frac{\partial f}{\partial k} dw \leq 1$ for all $x \in [0,1]$. This proves that there exist two types of equilibria: one where the median works in the informal sector in relatively unequal societies, the second for $k's$ sufficiently large where the median works in the formal sector. If we assume the particular distribution function $F(w) = w^k$ where distribution functions are ranked by Generalized Lorenz Dominance even if (4) is not satisfied still $\frac{d\beta}{dk}(t_0, k) < 1$.

$$\frac{\partial}{\partial k}\beta(t_0, k) = \frac{t}{k+1}\left[\left(\frac{k}{k+1}\left(1 - (w^*)^{k+1}\right)\right) + \left(-(w^*)^{k+1}\ln w^*\right)\right] < 1$$

It can be easily checked that $\frac{t}{k+1} < 1$, $\left(\frac{k}{k+1}\left(1 - (w^*)^{k+1}\right)\right) < 0.5$ (since $\overline{k} = 1$) and $-(w^*)^{k+1}\ln w^* < 0.37$ for all k and $w^* \in (0,1)$. ■

Proof of Corollary 2:

The general condition for β being increasing in k is:

$$\frac{\alpha}{1 + \alpha\left(\frac{w^* f(w^*)}{F(w^*)}\right)} < \frac{tF(w^*)\int_{w^*}^1 w \frac{\partial f}{\partial k} dw}{|\frac{\partial F}{\partial k}| w^*} \tag{5}$$

[10] Remember that from the equality tax-base gain: $\int_x^1 wf(k')\,dw - \int_x^1 wf(k)\,dw > 0$.

where w^* is defined implicitly by $(1-t)\,w^*\,(F(w^*))^{\alpha}-\eta=0$. Note that, for a given $t>0$, still the set of informal sector workers is formed by all voters with $w<w^*$. Since the LHS of (5) is increasing in α and the RHS is strictly positive for $t>0$, we need the elasticity of informal sector employment to be sufficiently small.

If $F(w)=w^k$, the indifferent voter is $w^*(t;k)=\left(\frac{\eta}{1-t}\right)^{\frac{1}{k\alpha+1}}$. All voters with earnings ability below w^* work in the informal sector. The redistribution level becomes:

$$
\begin{aligned}
\beta(t;k,\alpha) &= t\mu\left(1-\left(\frac{\eta}{1-t}\right)^{\frac{k+1}{k\alpha+1}}\right) \\
\frac{\partial\beta}{\partial k} &= t\frac{\partial\mu}{\partial k}\left(1-\left(\frac{\eta}{1-t}\right)^{\frac{k+1}{k\alpha+1}}\right)-\left(\frac{1-\alpha}{(k\alpha+1)^2}\right)\left(\frac{\eta}{1-t}\right)^{\frac{k+1}{k\alpha+1}}\ln\left(\frac{\eta}{1-t}\right) \qquad (6)
\end{aligned}
$$

The second expression of the RHS of (6) is strictly positive for $\alpha<1$, and it cancels out at $\alpha=1$.

For β concave there is a unique t_0 for each society (k,η). There is, then, a unique $\widetilde{w}$ for each society (k,η). At this point the extension of Proposition 3 is straightforward. When $k\to 0$, we have that the median works underground ($\widetilde{w}>m$). At $k=1$, the median wage equals $\frac{1}{2}$. Take the case where $\frac{\eta}{F(w^*(t_0))^{\alpha}}+\beta(t_0,1)<\frac{1}{2}$. We still have that $\widetilde{w}(k)$ crosses only once $m(k)$ and that at $k<\widetilde{k}$, the median works in the informal sector, the equilibrium tax is t_0 and provided the first statement of this corollary: redistribution is increasing in equality.

Proof of Proposition 6:

a) Separation argument from Grandmont Intermediate Preferences theorem. Informal workers all share the same preferences. Their consumption is maximized at $T^{eq}=(t_0,\tau_0)$. The utility of a median working in the formal sector is $V^m=\frac{1-t}{1+\tau}m+\frac{\beta(t,\tau)}{1+\tau}$. Consider $T\neq T^{eq}$, assume without loss of generality that $\frac{1-t_m}{1+\tau_m}-\frac{1-t}{1+\tau}>0$. Since $V^m(t_m,\tau_m)>V^m(t,\tau)$, the following inequality holds: $m\geq\left(\frac{\beta(t,\tau)}{1+\tau}-\frac{\beta(t_m,\tau_m)}{1+\tau_m}\right)/\left(\frac{1-t_m}{1+\tau_m}-\frac{1-t}{1+\tau}\right)$, which implies that for all $w>m$, $V^w(t_m,\tau_m)>V^w(t,\tau)$. So, any tax-mix $T\neq T^{eq}$ would be defeated by the most preferred tax-mix of the median by a coalition of the median and high income voters. Similar argument for $\frac{1-t_m}{1+\tau_m}-\frac{1-t}{1+\tau}<0$, the median and low income voters (including no contributors for which $\eta<m$) would support $T^{eq}=(t_m,\tau_m)$ against any other tax-mix such that $\frac{1-t_m}{1+\tau_m}-\frac{1-t}{1+\tau}<0$.

b As in the previous section $V^0(t_0,\tau_0)$ is fixed and $V^w(t_w,\tau_w)$ is increasing in w. Then there exist a unique $\widetilde{w}$ such that $V^0(t_0,\tau_0)=V^{\widetilde{w}}(t_{\widetilde{w}},\tau_{\widetilde{w}})$. Whenever the median is better off working in the informal sector ($m<\widetilde{w}$) the equilibrium tax-mix is $T^{eq}=(t_0,\tau_0)$. Otherwise, $T^{eq}=(t_m,\tau_m)$.

Appendix B: Figure

Figure 3: Case when $k < \widehat{k}(\eta)$ and $F(w) = w^k$.
$\widehat{k}(\eta) : \frac{\widehat{k}}{\widehat{k}+1}\left(1 - \eta^{\widehat{k}+1}\right) = \eta.$

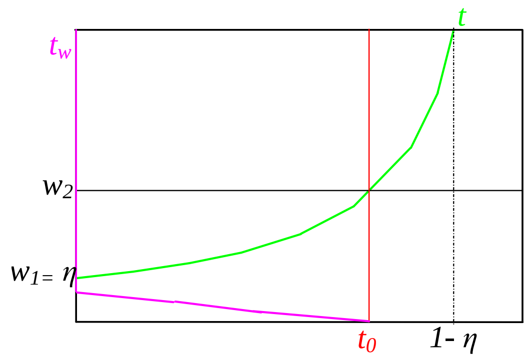

Figure 3: The $(t_0, 0)$ equilibrium case.

Note that when $k < \widehat{k}(\eta)$ the equilibrium income tax is either t_0 or $t_m = 0$.

Appendix C: Tables

Numerical Simulations Tables

The shadow areas on the tables separates the equilibrium of the form $T^{eq} = (t_0, \tau_0)$, which is the equilibrium tax-mix for all k lower than the one given by that shadow area. For all k higher than the one given by the shadow area (included) the equilibria is of the form $T^{eq} = (t_m, \tau_m)$.

T1: $\lambda = 0.8$, $\eta = 0.1$			
k	t	τ	β
0.1	0.691	0	0.045
0.2	0.698	0	0.085
0.3	0.704	0	0.123
0.4	0.710	0	0.157
0.5	0.716	0	0.189
0.6	**0.461**	**0**	**0.161**
0.7	0.393	0	0.154
0.8	0.303	0	0.130
0.9	0.148	0	0.69
1	0	0	0

T2: $\lambda = 0.8$, $\eta = 0.2$			
k	t	τ	β
0.1	0.558	0	0.035
0.2	0.564	0	0.057
0.3	0.569	0	0.083
0.4	0.574	0	0.107
0.5	0.579	0	0.130
0.6	0.583	0	0.151
0.7	**0.116**	**0**	**0.044**
0.8	0	0	0
0.9	0	0	0
1	0	0	0

T3: $\lambda = 0.8$, $\eta = 0.3$			
k	t	τ	β
0.1	0.456	0	0.020
0.2	0.460	0	0.039
0.3	0.464	0	0.057
0.4	0.468	0	0.074
0.5	0.471	0	0.090
0.6	0.475	0	0.105
0.7	0.479	0	0.120
0.8	0.482	0	0.134
0.9	0.485	0	0.147
1	**0**	**0**	**0**

Table 4: $\lambda = 0.9$, $\eta = 0.1$

k	t	τ	β	t/τ
0.1	0.691	0	0.045	∞
0.2	0.698	0	0.085	∞
0.3	0.704	0	0.123	∞
0.4	0.709	0.022	0.163	32.2
0.5	0.713	0.046	0.202	15.5
0.6	**0.441**	**0.229**	**0.233**	**1.89**
0.7	0.393	0	0.154	∞
0.8	0.303	0	0.130	∞
0.9	0.148	0	0.69	∞
1	0	0	0	–

Table 5: $\lambda = 0.9$, $\eta = 0.2$

k	t	τ	β	t/τ
0.1	0.558	0	0.030	∞
0.2	0.564	0	0.057	∞
0.3	0.569	0	0.083	∞
0.4	0.574	0	0.107	∞
0.5	0.579	0	0.130	∞
0.6	0.583	0	0.151	∞
0.7	**0.103**	**0.358**	**0.179**	**0.29**
0.8	0	0.081	0.034	0
0.9	0	0	0	–
1	0	0	0	–

Table 6: $\lambda = 0.9$, $\eta = 0.3$

k	t	τ	β	t/τ
0.1	0.456	0	0.020	∞
0.2	0.460	0	0.039	∞
0.3	0.464	0	0.057	∞
0.4	0.468	0	0.074	∞
0.5	0.471	0	0.090	∞
0.6	0.475	0	0.105	∞
0.7	0.479	0	0.120	∞
0.8	0.482	0	0.134	∞
0.9	**0**	**0.116**	**0.055**	**0**
1	0	0	0	–

Table 7: $\lambda = 0.95$, $\eta = 0.1$

k	t	τ	β	t/τ
0.1	0.676	0.162	0.068	4.17
0.2	0.658	0.502	0.181	1.31
0.3	0.657	0.651	0.273	1.01
0.4	0.661	0.721	0.350	0.92
0.5	0.444	1	0.454	0.444
0.6	**0.399**	**0.788**	**0.420**	**0.51**
0.7	0.356	0.441	0.313	0.81
0.8	0.291	0.132	0.182	2.20
0.9	0.159	0	0.69	∞
1	0	0	0	–

Table 8: $\lambda = 0.95$, $\eta = 0.2$

k	t	τ	β	t/τ
0.1	0.558	0	0.030	∞
0.2	0.553	0.101	0.083	5.48
0.3	0.537	0.329	0.177	1.63
0.4	0.532	0.476	0.256	1.12
0.5	0.531	0.575	0.325	0.92
0.6	0.532	0.643	0.384	0.83
0.7	**0.086**	**0.943**	**0.417**	**0.09**
0.8	0	0.559	0.246	0
0.9	0	0.205	0.096	0
1	0	0	0	–

Table 9: $\lambda = 0.95$, $\eta = 0.3$

k	t	τ	β	t/τ
0.1	0.456	0	0.020	∞
0.2	0.460	0	0.039	∞
0.3	0.464	0	0.057	∞
0.4	0.456	0.110	0.115	4.14
0.5	0.449	0.233	0.182	1.93
0.6	0.445	0.328	0.240	1.36
0.7	0.443	0.403	0.292	1.10
0.8	**0**	**0.945**	**0.435**	**0**
0.9	0	0.608	0.295	0
1	0	0.305	0.115	0

Table 10: The size of the informal sector employment, $F(w^*(t))$

	$\lambda = 0.8$			$\lambda = 0.9$			$\lambda = 0.95$		
k/η	**0.1**	**0.2**	**0.3**	**0.1**	**0.2**	**0.3**	**0.1**	**0.2**	**0.3**
0.1	0.893	0.924	0.942	0.893	0.924	0.942	0.889	0.924	0.942
0.2	0.802	0.856	0.889	0.802	0.856	0.889	0.782	0.851	0.889
0.3	0.722	0.794	0.840	0.722	0.794	0.840	0.691	0.777	0.840
0.4	0.653	0.739	0.795	0.652	0.739	0.795	0.614	0.712	0.788
0.5	0.593	0.689	0.753	0.590	0.689	0.753	0.463	0.653	0.738
0.6	0.364	0.643	0.715	0.356	0.643	0.715	0.341	0.600	0.691
0.7	0.283	0.353	0.680	0.283	0.350	0.680	0.271	0.345	0.648
0.8	0.212	0.276	0.646	0.212	0.276	0.646	0.209	0.276	0.382
0.9	0.145	0.235	0.615	0.145	0.235	0.338	0.147	0.235	0.338
1	0.100	0.200	0.300	0.100	0.200	0.300	0.100	0.200	0.300

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