Fairness and Income Redistribution: an Analysis of the Latin American Tax System*

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Abstract: This paper assesses the effects of income redistribution policies on "responsibility-sensitive" fairness levels in major Latin American countries. In doing so, the following items are analyzed: i) the fairness rule described in Bossert (1995), Konow (1996), and Cappelen & Tungodden (2007) and; ii) the redistribution mechanism (taxation policy) proposed by Ooghe & Peich (2010). The results indicate that taxation does not have a significant effect on Latin American fairness indicators. This behavior can be explained, among other factors, by the fiscal design used, which utilizes high rates associated with the effort variables and fails to equalize unequal opportunities.

Keywords: Theory of Justice, Redistribution.

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1 Introduction

Although the recent literature indicates a close relationship between wealth distribution and economic efficiency,[1] this argument is hardly taken into consideration by public policymakers. Usually, in democratic societies, redistribution and social security policies are formulated to meet the ethical outcry for justice, often represented by a more equal income distribution.

This school of thought can be found in government's conventional optimal size models. Influenced by the seminal work of Mirrlees (1971), redistribution and social spending have been considered to be closely related to income inequality. For Meltzer & Richard (1981), for instance, the central planner maximizes the median voter's utility by observing the assymmetry of income distribution. Therefore, the lower the median voter's income compared to the mean voter's, the stronger the redistribution policy (*selfish redistribution*) to be adopted.

Following this reasoning, the effectiveness of a redistribution policy[2] could be verified by the comparison of inequality levels before and after tax and transfers (henceforth pretax and post-tax). This is summarized in Figure 1, where pretax (in blue) and post-tax (in gray) Gini coefficients of inequality are plotted for a set of selected countries.[3] As depicted, the tax and government transfer systems significantly reduce the concentration levels in developed countries (40%, on average. From 47.6 to 28.2). In Latin American countries, however, the effect is virtually zero.

FIGURE 1 HERE

A possible conclusion of this analysis is that, at least in developed countries, these public policies enhance social justice. It is assumed that the social norm of justice, used as a parameter for the design of the redistribution policy, is the strict equality. Nevertheless, recent developments show that individual and social perceptions about inequality are much more relevant for the central planner's decision-making process than is the income concentration level.

For further understanding, imagine that individual results are determined by "responsibility" and "non-responsibility" factors (Roemer, 1998). In other words, some of the individual income is regarded as a result of effort (e.g., investment in human capital, migration decisions and hours worked every

[1] See Galor & Zeira (1993) and Banerjee & Newman (1993), among others.

[2] Hereafter, the term "redistribution policy" will summarize government actions associated with social spending, income transfers and taxation.

[3] This information is available from Latin American Economic Outlook 2009, pg. 122: http://www.oecd.org.

week, i.e., responsibility variables), while the remainder is conditional on circumstances, such as family background, race, sex, place of birth, among others.

So, let us assume that only those inequalities related to circumstantial or non-responsibility variables are socially undesirable. According to these arguments, the egalitarian rule is relegated to the background, prompting the emergence of "responsibility-sensitive" concepts.[4] The responsibility-sensitive principle posits that economic and social policies should only interfere with inequality caused by circumstances, rendering individuals accountable for the consequences of their personal decisions.

In fact, as pointed out in Alesina & Angeletos (2005) and Bénabou & Tirole (2006), the magnitude of the government's social action does not depend only on the level of inequality, as suggested by the models of Mirrlees (1971) and Meltzer & Richard (1981), but on the composition of this inequality. In brief, as suggested by Roemer (1998), inequality can presumably be decomposed into effort and circumstantial (luck) factors, in a such a way that redistribution policies will be larger, the larger the social belief that income derives from luck.

In this respect, the comparison of pretax and post-tax Gini coefficients (Figure 1) does not necessarily mean that redistribution policies are fairer or less fair. That is, in the case of developed countries, the reduction in inequality observed after government intervention could possibly maintain or even increase the level of injustice.

An indicative sign of the actual impact of the redistribution policy of developed countries on the level of justice is available in Ooghe & Peich (2010). In sum, those authors demonstrate that in countries where effort is seen as key to the definition of individual income, the perception about inequality (and, therefore, the redistributive design used) differs from that of countries where luck is believed to play a central role. Thus, it is possible to identify sets of countries with clear-cut definitions of fair taxation.

The case of Latin American countries is more noteworthy as redistribution does not even affect income concentration. Hence, it can be unfair both in the strict equality and responsibility-sensitive perspectives. Some studies have already investigated, either directly or indirectly, the levels of fair and unfair income concentrations in these countries.[5] However, little attention has been paid to the role of the design of redistribution policies in the promotion of a fairer society. The available studies investigate the role of fiscal policy on

[4] In fact, not even modern egalitarians such as Rawls (1971), Dworkin (1981) and Arneson (1989) use strict equality as a benchmark.

[5] See Barros et al. (2009).

conventional concentration levels (cf. Goñi et al., 2008).

Therefore, the aim of the present study is to assess the impact of redistribution policies on the responsibility-sensitive fairness level of major Latin American countries. The investigation includes Argentina, Brazil, Chile, Colombia, Mexico and Uruguay. The analysis will be carried out as follows:

1) pretax and post-tax fairness indicators will be calculated for each country;

2) the design of fiscal policy will then be evaluated based on a mechanism that takes into consideration individual differences in effort and circumstances.

For the first item, the fairness rule described in Bossert (1995), Konow (1996), and Cappelen & Tungodden (2007) will be used. The assessment of the redistribution mechanism, item 2, will follow the theoretical model of Ooghe & Peich (2010). This approach is consistent with modern egalitarianism, which admits that the income of agents results both from factors beyond their control and from partially controllable factors.[6]

Finally, the paper is organized into two parts. Each one contains a theoretical and an empirical section. Section 2 presents the results for pretax and post-tax fairness measures. Section 3 asseses the fiscal policy of the selected countries. Section 4 concludes.

2 Mensuring Fairness Levels

The (un)fairness levels will be assessed in two steps. The first one, subsection 2.1, establishes an individual fairness rule, z_i, based on responsibility criteria. Subsequently, the rules calculated for each country are compared with the current income distribution (subsection 2.2).

The empirical analysis discusses two concepts of income: pretax and post-tax. Subsection 2.2 seeks to answer the following two basic questions: **1) how far from fair distribution are the investigated countries?**; **2) does the redistribution system of these countries allow reducing the distance between the observed income and the fairness rule?**

2.1 Individual Fairness Levels

Consider a society A, containing $N = \{1, ..., n\}$ individuals. Each individual $i \in A$ is characterized by a pair (y_i^A, z_i^A), where y_i^A is the observed income

[6]The consideration of partially controllable variables is a generalization of the concept proposed by Roemer (1998). Further details can be found in Section 3.

and z_i^A is the fair income. Bearing in mind an egalitarian society, the fairness parameter will be $z_i^A = \mu(A)$, with $\mu(A) = n^{-1} \sum_i y_i^A$. In other words, deviations of the observed income from the mean income of distribution, $u_i^A = y_i^A - z_i^A$, will be regarded as unfair.

As highlighted earlier, the main problem with this criterion is that it does not contemplate merit differences among individuals, given that the mean income is taken as a single rule. This way, some unjust judgments could ensue, i.e., two people can have different income levels because one of them strives more.

Owing to this limitation, one proposes replacing the conventional measures of inequality with indicators based on responsibility-sensitive criteria. To do so, it is necessary to replace the fairness rule based on perfect equality. The first step is to assume that the economic outcome of each agent i results from responsibility factors, x_i^R, and from non-responsibility factors, x_i^{NR}, i.e.: $y_i = f(x_i^R, x_i^{NR})$.

Following Bossert (1995), Konow (1996), and Cappelen & Tungodden (2007), it is assumed that each agent i has a merit (or affirmation) level. This pattern is determined by the mean distribution of a hypothetical income, where all other individuals have a responsibility level equal to i.

The function that defines the affirmation of individual i, $g(x_i^R; \cdot)$, is given by:

$$g(x_i^R; \cdot) = \frac{1}{n} \sum_j f(x_i^R, x_i^{NR}).$$

Thus, the fair rule will be:

$$z_i = \frac{g(x_i^R; \cdot)}{\sum_j g(x_j^R; \cdot)} \sum_i y_i. \qquad [2.1]$$

Note that (2.1) sets the non-responsibility factors, measuring the ratio between the effort of individual i to the effort of other individuals. So, z_i denotes the fraction of overall income individual i should get, given his/her proportional level of effort.

From an empirical perspective, $f(x_i^R, x_i^{NR})$ can be estimated from the following log-linear specification:

$$\log y_i = \beta x_i^R + \gamma x_i^{NR} + \epsilon_i. \qquad [2.2]$$

However, some remarks about (2.2) are deemed necessary. First of all, it is not always possible to have non-responsibility variables, especially, information on family background. Therefore, the error term (ϵ_i) which would theoretically stand for brute luck includes both responsibility and non-responsibility factors.

Because of that, Devooght (2008) uses a normative criterion where ϵ_i is included in the set of compensation variables (x_i^{NR}). To do that, he substitutes (2.2) into (2.1), obtaining:

$$z_i = \frac{\exp(\beta x_i^R)}{\sum_j \exp(\beta x_j^R)} \sum_j y_j. \qquad [2.3]$$

Parameter (2.3) is built upon the following view on fairness: population groups are defined according to their responsibility variables, and any within-group inequality is deemed unfair. In other words, if one considers hours worked as the only responsibility variable, x_i^R, all individuals who work for the same number of hours must have the same income level. Outside this pattern, any income inequality will be unfair (c.f. Devooght, 2008, Almås, 2008, and Almås et al., 2010).

Another relevant problem concerns how to determine the factors within and without the realm of individual responsibility. According to Roemer (1998), the categorization into compensation and responsibility variables is not clear in a few cases. As a rule of thumb, only extrema are accepted: either the characteristic is fully under the control of agents or there exists no control whatsoever. To get around this problem, as in Almås et al. (2010), robustness checks will be used to assess the results of distance measures in different sets of responsibility variables (x_i^R).[7]

2.2 Results

As underscored previously, the aim of this subsection is to measure the distance between the observed income and the fair rule. Two concepts of income, pretax and post-tax, are used. Each concept of income has one fairness rule. The starting point for the design of rule (2.3) is the estimation of earnings equation (2.2). Due to the lack of variables x_i^{NR}, this procedure will be performed in two steps. In the first one, (2.2) is inferred only with variables x_i^R, with the later use of parameter and residual values for construction of indicator (2.3).

The set of responsibility variables will be: a) the individual's schooling years; b) hours worked every week and; c) a proxy for experience built upon information on the age of individuals. The dependent variable will be the logarithm of real personal income from all jobs, pretax and post-tax. The

[7] Section 3 results do not have this problem since they are based on the concept of partial responsibility (cf. Ooghe, 2010).

data sources, as well as the detailed information about the variables, are summarized in Appendix A1.

Some descriptive statistics for this dataset are displayed in Table 1. Roughly speaking, note that most of the country samples comprise employed, married and male individuals who work more than 30 hours per week. Most of them are young ($\text{Age}_1+\text{Age}_2 > 50\%$), and have poor qualification ($E_1+E_2 > 50\%$).

TABLE 1 HERE

The results for the first step of the estimation of (2.2), only for pretax income, are shown in Table 2.[8] In general, the parameters related to hours worked and education are significant. Interestingly, the importance of unobservable variables is greater for Brazil, since R^2-adjusted amounts to nearly 9%. This behavior can be interpreted in many ways. One can say that, as the construction of the fairness rule assumes that unobservable factors (error term) are the non-responsibility variables, a small R^2-adjusted implies that these factors have a heavier weight on Brazilian earnings, compared to those of other countries, especially Argentina (R^2-adjusted=27%). In other words, pretax income in Brazil depends much more on variables related to origin, color and family background than on factors associated with effort. An alternative explanation is that the quality of education, the major explanatory variable, is lower in Brazil than in the other countries.

TABLE 2 HERE

The comparison of fairness rules with observed pretax and post-tax incomes is the key goal of this subsection. After all, how far apart are these distributions? Does the redistribution system of these countries allow reducing the distance between the observed income and fair income?

Figures 1 through 4 give the first answers to these questions. They show the Cumulative Distribution Functions (CDFs) for the logarithm of observed income (pretax and post-tax) and their respective fairness rules. For space restriction, only the results for Argentina and Brazil are displayed. The visual analysis indicates that there is no significant change in the distance between the observed income distributions (pretax and post-tax) and the fairness rules.

FIGURES 2, 3, 4, AND 5 HERE

The distances between these distributions will be formally quantified using the metric entropy measure developed by Granger et al. (2004). This

[8]The remaining results were omitted due to space restrictions.

indicator is normalized between 0 and 1. Where 0 indicates that the distributions are identical. Maasoumi et al. (2007) assert that this tool is adequate for assessing the distance across distributions and the "goodness of fit" in nonlinear regression models. With respect to its use in studies on income distribution, there is at least one advantage over the distance measures proposed by Cowell (1980): the possibility to establish the statistical significance of the distances using nonparametric simulation methods.

Therefore, the analysis will be carried out as follows: 1) the distances between pretax and post-tax incomes and their respective fairness rules are calculated by entropy

$$S_\rho = \frac{1}{2}\int_{-\infty}^{\infty}\left[\sqrt{f(y)} - \sqrt{g(y)}\right]^2 dy,$$

where $f(y)$ and $g(y)$ are the marginal densities of the observed income and of the fair income, respectively; 2) the statistical significance of the distances is determined using a hypothesis test, where $H_0 : S_\rho = 0$ and; 3) after calculating the distances between the two concepts of income and the fairness rules, the procedure is repeated to compare pretax and post-tax fairness rules. Thus, it is possible to check whether the redistribution system significantly changes the fairness patterns.

The inference of distance indicators is summarized in Table 3.[9] In the comparison across countries, Colombia and Brazil are those with the largest distance between observed and fair incomes. As to the results for pretax and post-tax incomes, which provide an insight into the impact of redistribution policies, the sharpest reduction in the indicator S_ρ was observed in Chile, around 3%, followed by Argentina and Uruguay. All distances are significant at 1%, which indicates that the differences shown in Figures 2 through 4 are rather impressive.

TABLE 3 HERE

Nonetheless, the comparison of distances between pretax and post-tax fairness rules points out that there is no significant difference in any of the countries. This result indicates that redistribution policies do not reduce unfairness in the set of investigated countries.

To check the robustness of results, two structures are used for the set of responsibility variables. This procedure, suggested by Almås et al. (2010),

[9]Entropy measures are calculated as follows: i) the condtional Rosenblatt-Parzen density is computed via cross-validation; ii) a grid restricted to the interval [-0.25,0.25] is built with 501 points; iii) the Rosenblatt-Parzen kernel estimator is assessed in this grid; iv) the entropies are calculated based on the previous steps. The hypothesis tests are run using bootstrap simulation with 999 replicates.

measures the sensitivity of results to different sets of responsibility variables. Hence, besides the results including all variables (Table 3), two sets of variables (x_i^R) are used: a) Unfair1, with only the hours worked variable; b) Unfair2, with hours worked and age. The results are displayed in Table 4.

TABLE 4 HERE

The results show that the responsibility cut does not affect the results obtained in Table 3 in a significant fashion. Note that: a) Colombia and Brazil still have the largest distances; b) the redistribution mechanism reduces the distances and; c) pretax and post-tax fairness rules are still statistically identical.

In sum, the results indicate that redistribution policies do not have a significant effect on responsibility-sensitive inequality indicators. These results, coupled to the evidence shown in Figure 1, indicate that the Latin American redistributin mechanism is unfair both in the perspective of strict equality and of modern fairness rules. Therefore, the study seeks to investigate the fiscal mechanism of these countries The analysis is conducted in the next section.

3 Fair and Efficient Taxation

The previous section results demonstrated that the redistribution mechanism of Latin American countries does not have a significant effect on responsibility-sensitive unfairness levels. This section assesses the fiscal systems of these countries in light of fairness.

Subsection 2.1 summarizes the model of Ooghe & Peich (2010). The focus will be on key equations and comments. Derivations, Lemmas and Propositions will be omitted because of space restrictions.

3.1 Model

Summary: The model leads to two basic propositions: **(I)** the tax rate associated with non-controllable characteristics must be higher compared to those in which control is partial; **(II)** the overall effect of the non-controllable characteristics on post-tax income must be zero. That is, the redistribution mechanism should be such that, once redistribution takes place, non-controllable characteristics have no relationship at all with net income. This one should thus vary due only to different effort levels or to the other characteristics controlled by the agents.

Base: Let y be the gross income. That is, income before tax. Consider J to be a finite set of characteristics. If y is a function of a vector of characteristics x, with $x \in \Re^J$, then

$$y = \beta_0 + \sum_{j \in J} \beta_j x_j. \qquad [3.1]$$

Where each specific characteristic, x_j, is determined by the combination of effort, $e \in \Re^J$, and circumstance, $\theta \in \Re^J$. This combination involves a degree of control ϕ_j, which takes on value zero if the characteristic denotes pure effort and value one if it denotes pure circumstance. So, for each $j \in J$:

$$x_j = \phi_j e_j + (1 - \phi_j)\theta. \qquad [3.2]$$

Where $\phi \in (0,1)^J$ is a vector of weights that is the same for all individuals. Assume that each characteristic x_j is taxed such that the post-tax income c is less than or equal to the gross income y

$$c \leq y - t_0 - \sum_{j \in J} t_j x_j. \qquad [3.3]$$

In this case, $t_0 \in \Re$ controls the overall level of net income and $t_j \in \Re^J$ is the tax rate associated with characteristic x_j. Also consider a quasi-linear preference structure:

$$U(c, e, \gamma, \delta) = c - \sum_{j \in J} \frac{\delta_j}{\exp(\gamma_j)} \exp\left(\frac{e_j}{\gamma_j}\right). \qquad [3.4]$$

That is, individual utility is a function of net income c, of effort e, and of two new parameters: $\gamma \in \Re^J$ associated with the disutility of effort and; $\delta \in \Re^J$ is a vector of control for the degree of convexity of the effort cost, supposedly the same for all individuals. The resulting optimal effort choices and indirect utility can be observed in Lemma 1 of Ooghe & Peich (2010, p. 5).

Central Planner: Consider F to be the multivariate distribution of circumstances and G to be the multivariate distribution of preferences. The social planner chooses rates t_0 and t_j which maximize social welfare subjected to the budgetary constraint given by:

$$t_0 + \int\int \Big(\sum_{j \in J} t_j x_j^*\Big) dF(\theta) dG(\gamma) \geq R_0. \qquad [3.5]$$

Where

$$\theta \sim N(\mu^\theta, \Sigma^\theta), \quad \gamma \sim N(\mu^\gamma, \Sigma^\gamma). \qquad [3.6]$$

In addition, R_0 is an exogenous revenue per capita demand, x_j^* is the expression for the characteristic derived from optimal effort and $\Sigma^\theta = \sigma_{ij}^\theta$ and $\Sigma^\gamma = \sigma_{ij}^\gamma$ are matrices, $i \times j$. With regard to aggregate welfare, the planner considers efficiency under Pareto and fairness under selective egalitarism. This is represented by a Kolm-Pollak function, where aggregate wefare is defined as a sum of individual exponential, concave and increasing functions.

In this structure, direct welfare does not depend on circumstance θ, so the welfare differentials between individuals with the same preference and with the same effort result from diifferentials in post-tax income c. In addition, Pigou-Dalton transfers increase aggregate welfare. These considerations are summarized in Lemmas 2 and 3 (Ooghe & Peich, 2010, pp. 7–8).

Finally, if all individuals are subjected to the same circumstances, then all of them obtain the same laissez-faire welfare level defined by $(t_0, t) = (R_0, 0)$. In this case, deviations of $t = 0$ reduce welfare.

Result: The social planner's problem lies in choosing fiscal design (t_0, t) to maximize welfare, subjec to budgetary constraint. I.e.

$$max_{t_0,t} - \frac{1}{r} \ln \int \int \exp[-rv(t_0, t; \alpha, \beta, \gamma, \theta)] dF(\theta) dG(\gamma). \qquad [3.7]$$

Subject to budgetary restriction (3.5), with $r > 0$ inequality aversion parameter, R_0 exogenous (per-capita) revenue requirement, indirect individual welfare $v(\cdot)$, and distributions F and G are presented in (3.6).

Based on Proposition 1 (Ooghe & Peich, 2010, p. 8), one obtains the laissez-faire result if the planner does not worry about compensation $(r \to 0)$ or if the circumstances are homogeneous $(\Sigma \to 0)$. In this case, in the optimum, $(t_0, t) = (R_0, 0)$. Two specific cases are also discussed: (i) Mirleees: the result is defined by an exogenous characteristic (income); (ii) Akerlof: endogenous and exogenous (non-controllable) characteristics are considered. The second case is especially interesting as it provides testable hypotheses that do not depend on the degree of control or on inequality aversion.

(i) The Mirlees case: It is the simplest one. Suppose that product y is a function of only one characteristic: wages x_1, with $y = x_1 = \phi_1 e_1 + (1 - \phi_1)\theta_1$. The first-order condition system is reduced to

$$-\phi_1(1 - \phi_1)\delta_1 \frac{t_1}{1 - t_1} - r(\phi_1 \delta_1)^2 t_1 \sigma_{11}^\gamma + r(1 - \phi_1)^2 (1 - t_1) \sigma_{11}^\theta = 0.$$

Thus, tax rate t_1^* levied on earnings x_1:

(a) Is between extrema, $0 < t_1^* < 1$;

(b) Decreases with elasticity δ_1, ranging from full taxation, in the case of perfect inelasticity of effort ($t_1^* \to 1$ if $\delta_1 \to 0$) to taxation in the case of perfect elasticity of effort ($t_1^* \to 0$ if $\delta_1 \to \infty$);

(c) Increases with inequality aversion r, ranging from non-taxation if the planner is inequality-neutral ($t_1^* \to 1$ if $r \to 0$) to partial taxation if the planner is worried only about inequality ($t_1^* \to \kappa$ if $r \to \infty$), where

$$\kappa = \frac{(1-\phi_1)^2\sigma_{11}^\theta}{(\phi_1\delta_1)^2\sigma_{11}^\gamma + (1-\phi_1)\sigma_{11}^\theta}.$$

(d) Increases with the heterogeneity of circumstances σ_{11}^θ, ranging from non-taxation if all experience the same circumstances ($t_1^* \to 0$ if $\sigma_{11}^\theta \to 0$) to full taxation if circumstances are rather heterogeneous ($t_1^* \to 1$ if $\sigma_{11}^\theta \to \infty$);

(e) Decreases with the heterogeneity of preferences σ_{11}^γ, ranging from partial taxation if all have the same preferences ($0 < t_1^* < 1$ se $\sigma_{11}^\gamma \to 0$) to zero taxation if preferences are rather heterogeneous ($t_1^* \to 0$ if $\sigma_{11}^\gamma \to \infty$);

(f) Decreases with the degree of control ϕ, ranging from full taxation if gains cannot be controlled ($t_1^* \to 1$ if $\phi_1 \to 0$) to non-taxation if gains are totally controllable ($t_1^* \to 0$ if $\phi_1 \to 1$).

The last item addresses the contribution of Ooghe & Peichl (2010) to the literature.

(ii) The Akerlof case: Suppose that there are two characteristics, earnings $x_1 = \phi_1 e_1 + (1-\phi_1)\theta_1$ and an exogenous characteristic $x_2 = \theta$. Admit the product as $y = x_1 + \beta_2 x_2$. The first-order condition system is reduced to

$$-\phi_1\delta_1\frac{t_1\xi}{1-t_1} - r(\phi_1\delta_1)^2 t_1\sigma_{11}^\gamma + r(1-\phi_1)(1-t_1)(1-\phi_1)\sigma_{11}^\theta + (\beta_2 - t_2)\sigma_{21}^\theta = 0.$$

$$(1-t_1)(1-\phi_1)\sigma_{21}^\theta + (\beta_2 - t_2)\sigma_{22}^\theta = 0$$

Where $\xi = (1-\phi_1) + \beta_2$. Note that t_1^* satisfies items (a)–(f) described in the previous case. Moreover, in the limiting case of perfect correlation of circumstances ($(\sigma_{21}^\theta)^2 \to \sigma_{11}^\theta\sigma_{22}^\theta$), t_1^* is reduced to zero and all taxation will occur via t_2^* , provided that the latter is a perfect signal of earnings ability and can be taxed at zero cost.

The second first-order condition is the most interesting for the aims of this study, which can be rewritten as

$$(\beta_2 - t_2) + \left(\frac{\sigma_{12}^{\theta}}{\sigma_{22}^{\theta}}\right) \times (1 - t_1)(1 - \phi_1) = 0 \qquad [3.8]$$

In general, equation (3.8) shows that the total marginal effect of θ_2 on net output c should equal zero in a fair tax system. Based on Lemma 1, (3.8) can be rewritten as:

$$x_1^* = \phi_1 \delta_1 (\ln(\beta_1 - t_1)\phi_1) + (1 - \phi_1)\theta_1$$
$$x_2^* = \theta_2$$

Which implies $\sigma_{12}^{x^*} = (1 - \phi_1)\sigma_{12}^{\theta}$ and $\sigma_{22}^{x^*} = \sigma_{22}^{\theta}$. Using these formulas, one gets the empirical counterpart for theoretical formula (3.8):

$$(\beta_2 - t_2) + \left(\frac{\sigma_{12}^{x^*}}{\sigma_{22}^{x^*}}\right) \times (1 - t_1) = 0.$$

Note that neither the degree of control nor inequality aversion r need to be observed to test them.

3.2 Empirical Model

Let w denote the vector of covariables, which can be decomposed into $w = (w_j)_{j \in J}$, where w_j is the covariable for characteristic j in J. If "·" represents the vectorial product, then the pretax income regression will be

$$y = b_0 + b \cdot w + \epsilon$$
$$y = b_0 + \sum_{j \in J} b_j w_j + \epsilon \qquad [3.9]$$
$$y \approx \beta w$$

Defining $\beta_0 \approx b_0$, $\beta \approx 1$ and $x \approx ((b_j w_j)_{j \in J}, \epsilon)$ the vector of characteristics, including the unobservable ones, the rate (or subsidy, if negative) is equal to

$$\tau = y - c = t_0 + tx \qquad [3.10]$$

Note the necessity for a two-step strategy to estimate t_0 and t. First one estimates (3.9), obtaining prediction $\hat{x} \approx ((\hat{b}_j w_j)_{j \in J}, \hat{\epsilon})$. Afterwards, one estimates (3.10), replacing x with $\hat{x}$ and correcting standard errors. The estimations can follow a simple OLS strategy.

In this case, one obtains the estimates for the implicit rates so as to test prediction **(I)**, presented at the beginning of the section. To test prediction **(II)**, consider the categorization of the set of observable characteristics into non-controllable (N) and partially controllable (P) characteristics. Admit the unobservable error term as a separate and independent characteristic. Consider (3.9), now decomposing x into

$$(x_N, x_P, x_U) = \left(\sum_{j \in N} b_j w_j, \sum_{j \in P} b_j w_j, \epsilon \right).$$

In this case, (3.8) is reduced to

$$(1 - t_N) + \left(\frac{\sigma_{PN}^{x^*}}{\sigma_{NN}^{x^*}} \right) \times (1 - t_P) = 0.$$

Two hypotheses are then obtained:

(i) Weak hypothesis: If $\sigma_{PN}^{x^*} / \sigma_{NN}^{x^*} \approx -1$, then $t_N \approx t_P$;

That is, if $\sigma_{PN}^{x^*} / \sigma_{NN}^{x^*}$ is greater than -1, the rate associated with non-controllable characteristics is higher than that which is associated with partially controllable characteristics. Note that $\sigma_{PN}^{x^*} / \sigma_{NN}^{x^*}$ corresponds to a_1 in regression:

$$x_P = a_0 + a_1 x_N + \eta. \qquad [3.11]$$

One can also define

$$FM = (1 - t_N) + \left(\frac{\sigma_{PN}^{x^*}}{\sigma_{NN}^{x^*}} \right) \times (1 - t_P), \qquad [3.12]$$

as a fairness measure. i.e.: the total marginal effect of non-controllable characteristics on the net outcome. In a fair fiscal design, this measure is equal to zero.

(ii) Strong hypothesis: $FM = 0$.

To estimate the fairness measure, consider

$$c = (\beta_0 - t_0) + (1 - t_P) x_P + (1 - t_N) x_N + (1 - t_U) x_U. \qquad [3.13]$$

Substituting (3.11) into (3.13) and assuming $a_1 = \sigma_{PN}^{x^*} / \sigma_{NN}^{x^*}$:

$$c = (\beta_0 - t_0) + (1 - t_P)(a_0 + a_1 x_N + \eta) + (1 - t_N)x_N + (1 - t_U)x_U,$$

$$c = (\beta_0 - t_0) + (1 - t_P)a_0 + [(1 - t_P)\sigma^{x^*}_{PN}/\sigma^{x^*}_{NN} + (1 - t_N)]x_N + (1 - t_U)x_U + (1 - t_P)\eta. \quad [3.14]$$

Where $(\beta_0 - t_0) + (1 - t_P)a_0$ is the constant and the term between square brackets, $(1 - t_P)\sigma^{x^*}_{PN}/\sigma^{x^*}_{NN} + (1 - t_N)$, associated with x_N, is the fairness measure. Again, note the necessity for a two-step procedure. First, one estimates (3.9) to get $\hat{x} = (\hat{x}_N, \hat{x}_P, \hat{x}_U)$. Afterwards, one estimates (3.14) using $(\hat{x}_N, \hat{x}_U)$, which provides the estimate for the fairness measure.

3.3 Results

This subsection will test two basic predictions of the model developed by Ooghe & Peich (2010), namely: **(I)** the tax rate associated with characteristics 'non control' should be greater than those which are 'partial control'; **(II)** the total effect of non-controllable characteristics on the post-tax income should be zero. To achieve that, the tests described in (3.12) and (3.14) will be used. That is, the strong and weak hypotheses about the effect of non-controllable characteristics on partially controllable characteristics and on income.

The logic of these predictions is straightforward: aside from income level, the tax rate must include individual characteristics. Individuals with "privileged" non-controllable characteristics have to pay a higher rate. In addition, the rates associated with this set of characteristics should be higher than those associated with partially controllable characteristics. This imposition indicates that variables related to effort and merit should not be overtaxed.

For example, if a country is characterized by gender, men ("privileged" non-controllable characteristic, by supposition) should pay a higher rate than should women. The guarantee that all differences associated with non-controllable characteristics will be equalized is given by prediction II.

The first step to the empirical analysis is the estimation of implicit rates related to each characteristic. Equations (3.9) and (3.10) were inferred from a two-stage OLS strategy. The dependent variable is the equivalent family income.[10] The following are regarded as partially controllable characteristics: hours worked, education, being married and employment. The set of non-controllable variables includes age and sex.

[10] Note that the logarithm of income is not used. Detailed information about the construction of variables can be obtained in Appendix A.2.

The estimation results are shown in Tables 5 and 6, first and second stages, respectively. The first-stage estimates are used to obtain the predicted values for controllable characteristics and for the residual, i.e., $\hat{x} \approx ((\hat{b}_j w_j)_{j \in J}, \hat{\epsilon})$. For instance, the "Educ" variable in Table 6 is constructed from parameters related to E_1, E_2 and E_3 obtained in Table 5. That is, for Argentina: Educ$= -551.58 \times E_1 - 392.56 \times E_2 - 316.87 \times E_3$.

TABLES 5 AND 6 HERE

That being said, the results in Table 6 represent the implicit rates associated with each characteristic. A visual inspection indicates that **Prediction I** is not observed in any of the investigated countries. That is, the rates related to non-controllable characteristics are not always higher than the others. This behavior is represented in Figure 6.

FIGURE 6 HERE

First, note that Brazil, Colombia and Mexico are the countries with the highest overall rates.[11] These countries also have the highest rates associated with partially controllable characteristics. In general, one perceives that the implicit rates associated with non-controllable characteristics are always higher than the others.

To confirm the results suggested in Figure 6, a hypothesis test based on the estimation of (3.11) and (3.12) is used. The null hypothesis consists of $\sigma^{x^*}_{PN}/\sigma^{x^*}_{NN} < -1$. That is, non-controllable characteristics have higher implicit rates than partially controllable ones. The results in Table 7 indicate that this hypothesis cannot be rejected in any of the selected Latin American countries.

TABLE 7 HERE

In view of this evidence, the first prediction of the theoretical model is rejected. Furthermore, the behavior of the implicit rates allows stating that: i) the Latin American tax system "punishes" merit, since partially controllable characteristics, such as, education and hours worked, have higher tax rates. This conclusion holds for all the countries, but it is most remarkable for Brazil, Colombia and Mexico; ii) as the rates associated with non-controllable characteristics do not follow prediction I, one may suggest that the tax system cannot reduce unequal opportunities in these countries.

[11] Appendix A3 decomposes rate τ into three components: income tax, social security payments and benefits. The analysis is conducted for the set of non-controllable and partially controllable variables.

To confirm the non-equalization of circumstances in these countries, the study uses a test for the second prediction. That is, for checking the effect of non-controllable characteristics on the post-tax income. The estimation method is once again based on two stages, using the results predicted in (3.9) ($\hat{x} \approx ((\hat{b}_j w_j)_{j \in J}, \hat{\epsilon})$), and on the later estimation of (3.14).

TABLE 8 HERE

Table 8 shows the fairness indicator based on the taxation system. Bearing in mind that fair taxation corresponds to $FM = 0$ (H_0 of this new test). $FM's$ distant from zero indicate that the country is not worried about compensating for non-controllable characteristics. That is, the higher the FM, the larger the unfairness. Once again, the results show that the tax system of Latin American countries does not fit into the fairness rules established by Ooghe & Peich (2010). Just as in subsection 2.2, Brazil and Colombia have the highest levels of unfairness.

Just to have some idea about the magnitude of these indicators, from the evidence provided in Ooghe & Peich (2010), using a similar estimation method, France and Luxembourg followed the theoretical predictions of model ($FM = 0$). The highest rate was that of the USA, $FM \approx 0.42$. The other countries had $FM's$ between 0.15 and 0.25.

Therefore, Latin American countries are noteworthy not only because of their high income inequalities, but also because of the remarkable unfairness of their tax systems. Of the investigated countries, only Uruguay and Chile had similar levels to those of the USA.

4 Final Remarks

The main objective of this study was to measure the impact of redistribution policies on the level of distributive fairness of a set of Latin American countries. As redistribution has no impact on income concentration levels, a responsibility-sensitive unfairness measure was used.

The first results indicated a significant distance between the observed income (pretax and post-tax) and the respective fairness rule. That is, the level of unfairness of the countries is statistically significant. In this context, Brazil and Colombia were the most unfair countries. The taxation policy reduced the distance for the fairness pattern, however, the statistical tests showed that the movement is not statistically relevant. In short, as with income concentration levels, the redistribution policy does not cause any impact on the distributive fairness of the investigated countries.

Based on these findings, the study suggested assessing the fiscal system of these countries. At that stage, the study investigated the whys and wherefores of redistributive inefficiency. Using a fair and efficient taxation model, the conclusion is that the taxation system violates two basic principles of fairness. Partially controllable characteristics, associated with effort, are overtaxed. In addition, the effect of non-controllable variables on net income is not zero. In brief, the tax system punishes merit and does not equalize the differences in circumstances.

The magnitude of unfairness of the Latin American tax system becomes more evident when it is compared to the results obtained by Ooghe & Peich (2010). The Brazilian unfairness indicator, for instance, is almost three times higher than that of the USA. The fairest countries, Uruguay and Chile, have similar levels of unfairness to those observed in developed countries.

Finally, the explanations for the ineffectiveness of redistribution policies in Latin American countries should be recalled. According to Goñi et al. (2008), three factors need to be mentioned: (i) too low a volume of resources gets collected and transferred; (ii) tax collection is regressive; and (iii) transfers are poorly-targeted. The evidence provided herein allows including another factor: the design of the fiscal policy does not contemplate the different levels of effort and does not equalize the different levels of circumstances.

APPENDIX

A1 – Section 2 Data: The inferences made in Section 2 are based on the following variables: a) the real income of all jobs;[12] b) years of s chooling split into four categories: E_1, low education, for individuals with up to 4 years of schooling (including the illiterate), E_2, four to eight years of schooling, E_3, nine to eleven years of schooling and, E_4 for individuals with more than nine years of schooling; c) hours worked and; d) age, summarized by six dummy variables, the first one which assumes value one if the individual is aged 26 to 35 years, Age_1, the second one for those aged 36 to 45 years, Age_2, and so on and so forth.

Household heads are those men or women older than 26 years. The available income, post-tax, is obtained from the following rule: gross income – income tax rate – social security payments + government transfers. Further details on the tax system of each country can be obtained from their official websites.

Argentina: `http://www.cnv.gov.ar`;

Brazil: `http://www.receita.fazenda.gov.br` and

[12] The income will be deflated by the consumer price index of each country and converted to U.S. dollars, from the purchasing power parity.

http://www.previdenciasocial.gov.br;
Chile: http://www.sii.cl;
Colombia: http://www.dian.gov.co;
Mexico: http://e-mexico.gob.mx;
Uruguay: http://www.uruguayxxi.gub.uy.

A2 – Section 3 Data: The model used in Section 3 considers the equivalent family income. i.e.: $y_i^E = y_i/\sqrt{n}$. Where y_i is the gross income, also expressed in terms of purchasing power parity, and n is the household size. In addition, information described in subsection A1 plus three dummy variables representing sex (male as reference), being married and employment were used.

The microdata were obtained from:

Argentina: Encuesta de Impacto Social de la Crisis en Argentina (2002);

Brazil: Pesquisa Nacional por Amostra de Domicilios (2006);

Chile: Encuesta de Caracterización Socioeconómica Nacional (2006);

Colombia: Encuesta de Calidad de Vida (2003);

Mexico: Encuesta Nacional de Ingresos y Gastos de los Hogares (2006);

Uruguay: Encuesta Nacional de Hogares Ampliada (2006).

A3 – Decomposition of the Total Rate: The results established in Section 3 considered that the available income is a function of a single τ rate. As a matter of fact, this rate can be decomposed into three parts: the tax (rate), social security payments (SS) and benefits. According to Goñi et al. (2008), the small impacts of the Latin American redistribution policy occur via benefits. This pattern also occurs in developed countries, as demonstrated by Ooghe & Peich (2010).

To decompose the results, consider that (3.10) can be rewritten as:

$$\tau = y - c = \tau_y + \tau_{ss} - B,$$

where τ_y is the rate associated with income, τ_{ss} refers to social security tax and B are the benefits. In a two-step strategy, one has:

$$\tau_y = t_{y,0} + t_y \cdot x, \quad \tau_{ss} = t_{ss,0} + t_{ss} \cdot x, \quad -B = t_{B,0} + t_B \cdot x.$$

With $x = (x_N, x_P, x_U)$. Therefore:

$$\tau = (t_{y,0} + t_{ss,0} + t_{B,0}) + (t_y + t_{ss} + t_B) \cdot x.$$

This way, it is possible to assess the impact of each component of τ, and to categorize them into non-controllable and partially controllable variables. The estimation results are summarized in Figures 7 and 8. Figure 7 shows the composition of τ with regard to the set of non control variables. Figure 8 shows the result for the partially controllable variables.

FIGURE 7 AND 8 HERE

The results confirm the hypothesis that the most important benefits for τ associated with non-controllable characteristics. Moreover, income tax has a heavier weight on partially controllable characteristics. These results are in line with the evidence provided in the literature. However, they do not have an impact on the unfairness level of the Latin American fiscal system, as the predictions of the theoretical model were not followed.

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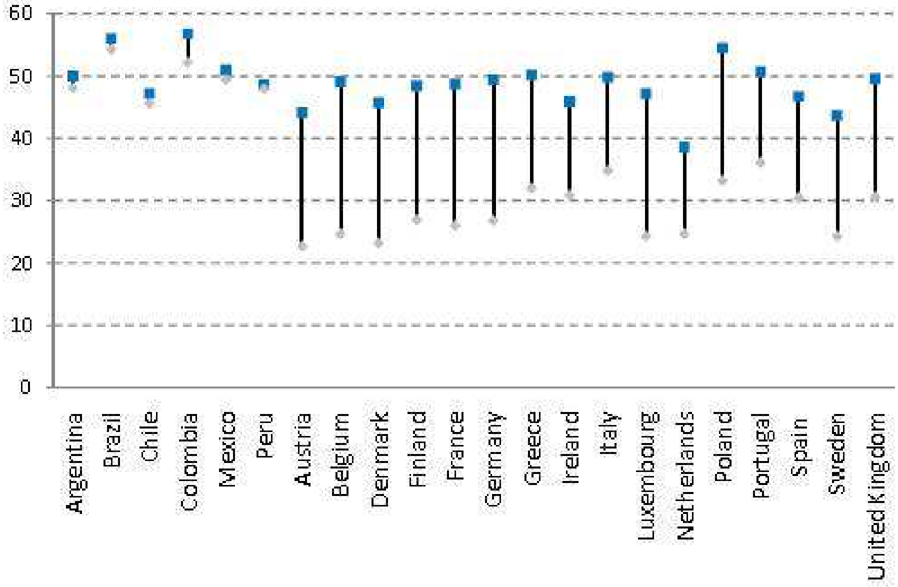

Figure 1: Pretax and Post-tax Gini Coefficient.

Table 1: Descriptive Statistics

Variables	Argentina	Brazil	Chile	Colombia	Mexico	Uruguay
Income pretax	1,636	1,403	1,765	1,192	1,675	1,540
Income postax	1,050	950	1,267	812	1,102	1,116
Hours	32	40	31	35	39	34
Employment (%)	60	76	61	66	64	70
Couple (%)	69	64	61	65	54	67
Sex (%)	60	53	68	68	55	62
Education (%)						
E_1	29	25	32	26	31	30
E_2	25	23	37	22	47	35
E_3	16	32	21	34	12	24
E_4	30	19	14	16	10	16
Age (%)						
Age_1	30	29	29	30	22	22
Age_2	29	32	34	34	31	32
Age_3	25	24	22	20	24	23
Age_4	13	11	11	10	13	14
Age_5	3	2	4	4	7	6
Age_6	1	1	10	2	3	3
Sample	3,287	46,593	1,371	2,843	39,464	1,456

Table 2: Earnings Equations: Results From First Stage Regression – Pretax

Variables	Argentina	Brazil	Chile	Colombia	Mexico	Uruguay
Hours	0.0144*	0.0040*	0.0130*	0.0125*	0.0039*	0.0127*
Age_1	0.0069	-0.4742*	0.5463	0.2107*	0.1594*	0.1820*
Age_2	0.0961	-0.2873*	0.7239*	0.6528*	0.2942*	0.2459*
Age_3	0.1937	-0.1043*	0.6722*	01867*	0.4098*	0.1674*
Age_4	0.2324*	-0.0469	0.6477	0.6546	0.3523*	-0.5632
Age_5	0.0516	0.0069	0.3641	0.4319	0.1111*	-0.0284
E_1	-0.9061*	-0.3016*	-0.8826*	-0.4504*	-1.0865*	-0.9342*
E_2	-0.5546*	-0.0142*	-0.8084*	-0.4985*	-0.9854*	-0.6532*
E_3	-0.4161*	0.2572*	-0.4010*	-0.5468*	-0.4821*	-0.4563*
Constant	6.5027*	7.5385*	11.5451*	10.2306*	8.1816*	10.9834*
Adjusted R^2	0.2732	0.0921	0.1325	0.1325	0.1430	0.1278

Note: $^*p < 0.10$.

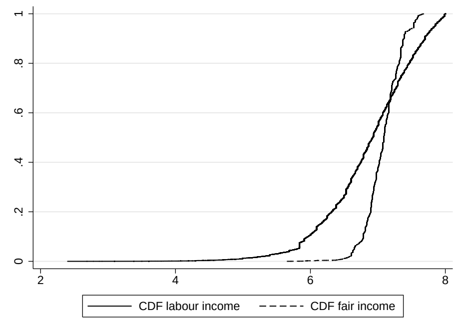

Figure 2: CDF: Fair Income and Labor Earnings – Brazil (pretax).

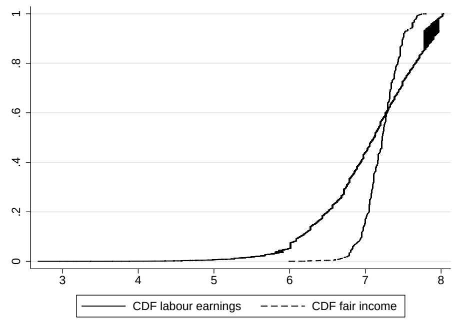

Figure 3: CDF: Fair Income and Labor Earnings – Brazil (postax).

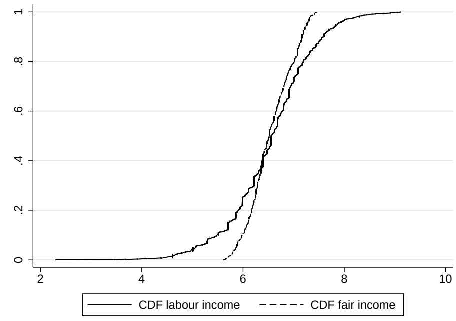

Figure 4: CDF: Fair Income and Labor Earnings – Argentina (pretax).

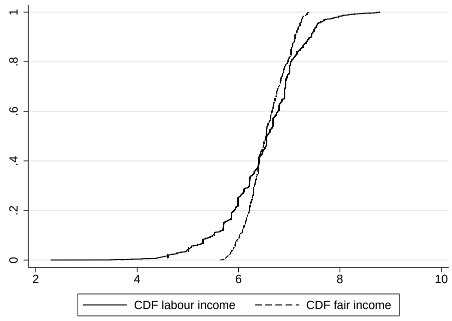

Figure 5: CDF: Fair Income and Labor Earnings – Argentina (postax).

Table 3: Unfairness Levels: S_ρ Entropy

	Pretax		**Postax**		z_i^{Pre} and z_i^{Pos}	
	S_ρ	p-value	S_ρ	p-value	S_ρ	p-value
Argentina	0.1348	0.0000	0.1311	0.0000	0.0047	0.1623
Brazil	0.3245	0.0000	0.3151	0.0000	0.0014	0.2409
Chile	0.2989	0.0000	0.2933	0.0000	0.0001	0.6485
Colombia	0.3456	0.0000	0.3398	0.0000	0.0065	0.1482
Mexico	0.1256	0.0000	0.1213	0.0000	0.0032	0.1529
Uruguay	0.1209	0.0000	0.1176	0.0000	0.0049	0.1632

Table 4: Robustness Check

	Pretax				**Postax**				z_i^{Pre} and z_i^{Pos}			
	Unfair I		**Unfair II**		**Unfair I**		**Unfair II**		**Unfair I**		**Unfair II**	
	S_ρ	p-value	S_ρ	p-value	S_ρ	p-value	S_ρ	p-value	S_ρ	p-value	S_ρ	p-value
Argentina	0.1186	0.0000	0.1240	0.0000	0.1154	0.0000	0.1237	0.0000	0.0012	0.3409	0.0015	0.3412
Brazil	0.2858	0.0000	0.2988	0.0000	0.2873	0.0000	0.3002	0.0000	0.0000	0.2982	0.0019	0.2745
Chile	0.2630	0.0000	0.2754	0.0000	0.2514	0.0000	0.2698	0.0000	0.0002	0.5486	0.0002	0.5743
Colombia	0.3041	0.0000	0.3179	0.0000	0.2908	0.0000	0.3029	0.0000	0.0009	0.2103	0.0015	0.1734
Mexico	0.1155	0.0000	0.1105	0.0000	0.1112	0.0000	0.1034	0.0000	0.0019	0.1869	0.0029	0.1620
Uruguay	0.1063	0.0000	0.1003	0.0000	0.1034	0.0000	0.0962	0.0000	0.0031	0.1672	0.0037	0.1600

Table 5: Results From First Stage Regression

Variables	Argentina	Brazil	Chile	Colombia	Mexico	Uruguay
Hours	4.20*	6.21*	2.35*	8.67*	16.86*	5.43*
Age_1	-278.89*	-1286.53*	172.97	291.96*	-576.67*	-342.09*
Age_2	-238.53*	-1129.67*	280.44	622.69	-181.8	-178.65*
Age_3	-167.43*	-708.65*	361.04	841.40*	1291.60*	-154.03*
Age_4	-69.14	-359.48*	580.99	395.72	975.20*	0.78
Age_5	-88.02	-240.24*	273.68	55.08	-334.84	-90.43
E_1	-551.58*	-2625.43*	-1252.10*	-348.05*	-15490.9*	-432.74*
E_2	-392.56*	-2304.39*	-1013.69*	-529.16*	-14276.24*	-1234.64*
E_3	-316.87*	-1835.49*	-7501.01*	-586.98*	-8815.79*	-1730.23*
Sex	-60.61*	32.61*	-53.89	23.57	-483.93*	-71.23*
Emplo	301.23*	210.06*	340.23*	900.02	270.49*	123.84
Couple	-25.25	181.43*	84.25*	97.60	48.29*	90.34
Constant	959.29*	3643.27*	1399.70*	2469.24*	2044.95*	873.52*
Adjusted R^2	0.24	0.30	0.17	0.22	0.28	0.28

Note: $^*p < 0.10$.

Table 6: Results From Second Stage Regression

Variables	Argentina	Brazil	Chile	Colombia	Mexico	Uruguay
Hours	0.0937*	0.3572*	0.2143*	0.2965*	0.2821	0.2301*
Age	0.1670*	0.3689*	0.2668	0.3539	0.2892*	0.2439*
Educ	0.2310*	0.3775*	0.2648*	0.3669*	0.4366*	0.2754*
Sex	0.3519*	0.2991*	0.2487*	0.3004*	0.3510*	0.2492*
Emplo	0.2970*	0.3863*	0.2943*	0.3495*	0.4329*	0.3091*
Couple	0.5306*	0.4885*	0.1927*	0.5146*	0.2202	0.2134*
Resid	0.2832*	0.3691*	0.2618*	0.3591*	0.5286*	0.2764*
Constant	149.29*	1250.10*	278.66*	446.97*	8847.85*	199.02*
Adjusted R^2	0.73	0.99	0.96	0.98	0.73	0.98

Note: $^{*}p < 0.10$.

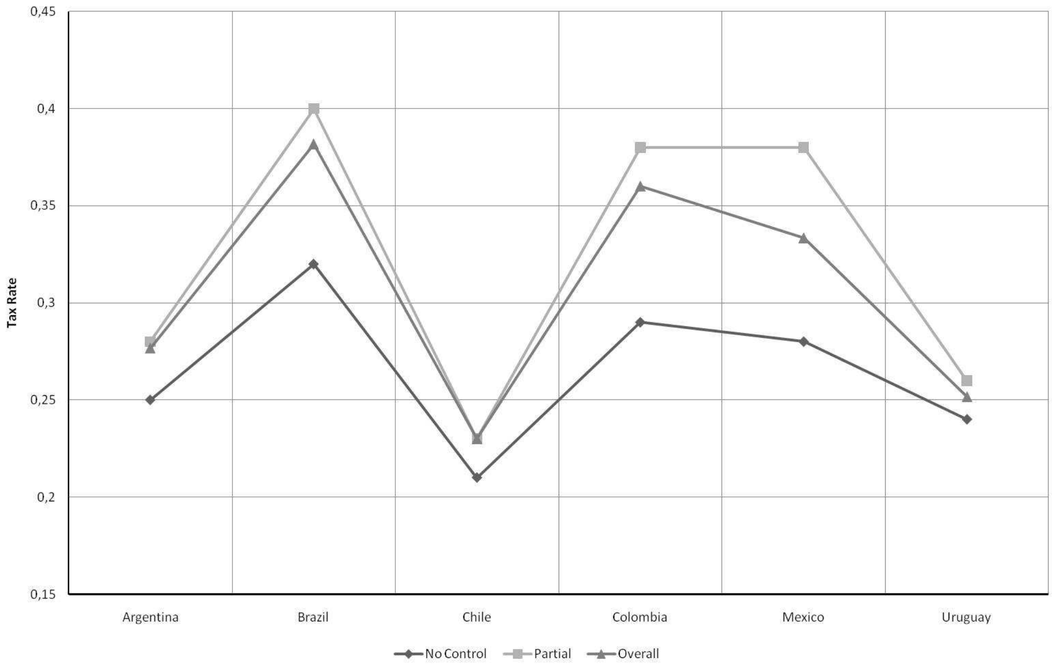

Figure 6: Implicit Tax Rate for the Different Composite Characteristics.

Table 7: Testing the Weak Hypothesis: $H_0 : \sigma^{x^*}_{PN}/\sigma^{x^*}_{NN} < -1$.

	$\sigma^{x^*}_{PN}/\sigma^{x^*}_{NN}$	p-value
Argentina	-1.6570	0.4320
Brazil	-1.2660	0.3782
Chile	-1.5250	0.3964
Colombia	-1.1111	0.2457
Mexico	-1.1853	0.2599
Uruguay	-1.3541	0.3948

Table 8: Fairness Measure – Akerlof Case

	FM	p-value
Argentina	0.5950	0.0000
Brazil	1.2010	0.0000
Chile	0.4903	0.0000
Colombia	0.9832	0.0000
Mexico	0.6815	0.0000
Uruguay	0.4240	0.0000

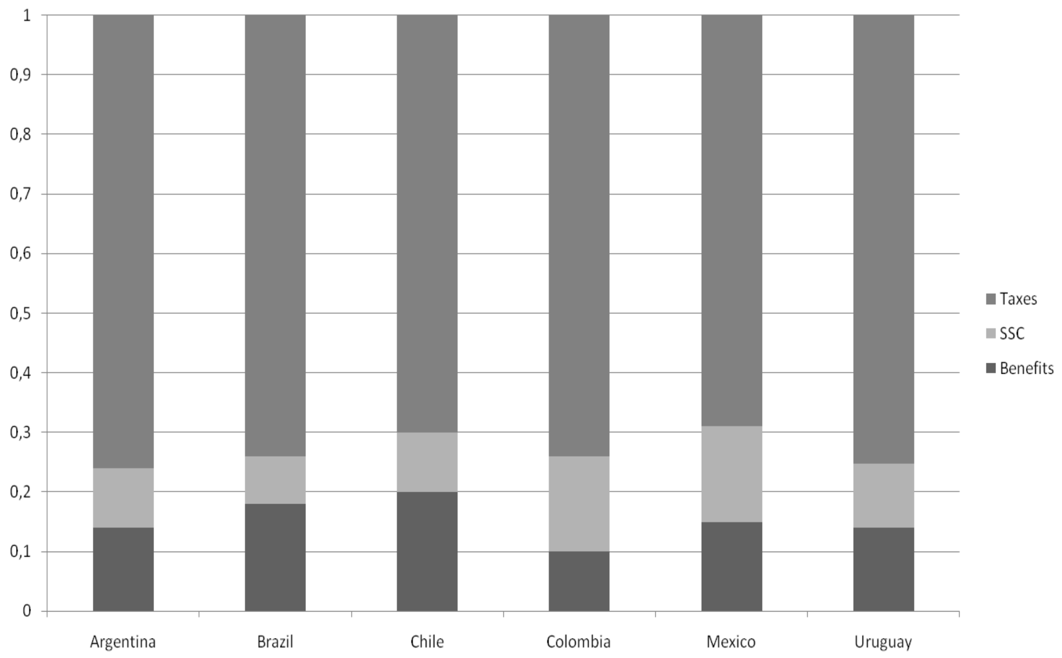

Figure 7: Decomposition Taxes Rate – Noncontrol.

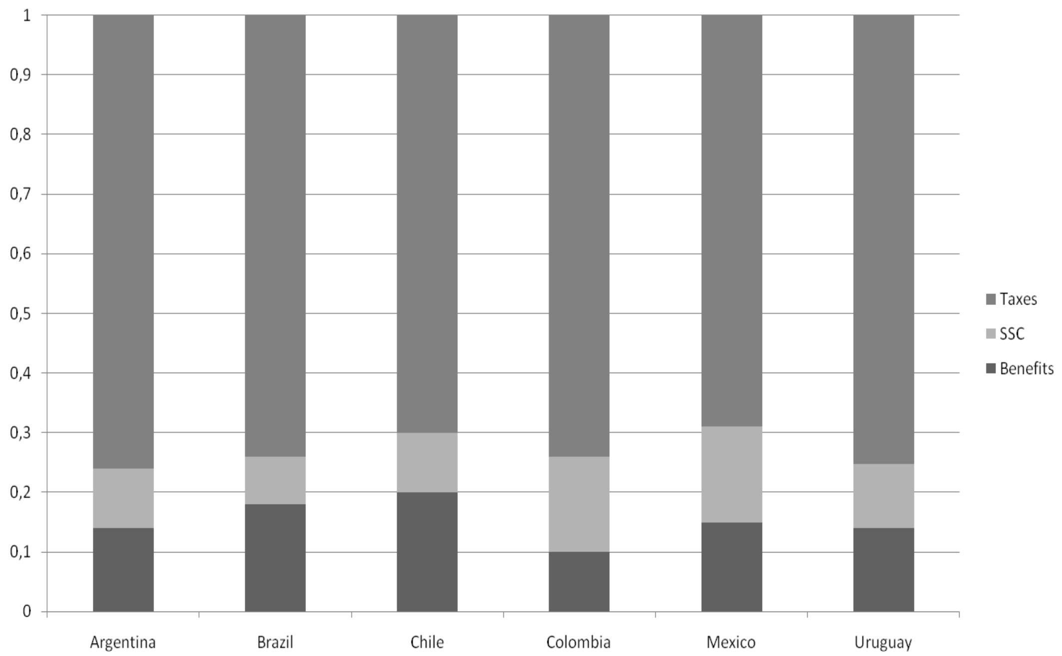

Figure 8: Decomposition Taxes Rate – Partial Control.