An Evaluation of the Redistributive Effects of a Tax Reform in the Dominican Republic through Microsimulation Models with Behavioral Responses

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Abstract

This paper employs microsimulation methods to assess redistributive effects of the implementation of two separate fiscal reforms in the Dominican Republic, one altering the personal income tax and another altering value added taxes. For the former, behavioral responses are estimated through a discrete choice labor supply model with formal and informal hour points in the choice set and through the calibration of elasticities of hours with respect to remuneration and with respect to non-labor income. For the latter, the AIDS model is employed to estimate price elasticities of 12 consumption groups. In both reform scenarios, results highlight the role of informal markets as a progressivity driver, as it serves as a tax burden mitigation mechanism for households in the poorest quintiles, allowing that, when all households are made worse-off after a tax reform, relative tax burdens remain progressive.

JEL: H22, H24, J22

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1 Introduction

In 2012, the Dominican Government approved the National Development Strategy (END in Spanish) in which it stated its goal of increasing the country's tax revenue as a percentage of the Gross Domestic Product (GDP) from 13.1% in 2012 to 19.0% in 2020. However, the only significant tax hike implemented during this period was an increase from 16% to 18% of the standard value-added tax (VAT) rate. As a result, in 2019 the ratio of tax revenue to GDP stood at only 13.4%. There is currently a widespread public perception that a long-overdue fiscal reform is coming in the near future. This has been confirmed by current administration officials, who have only disclosed the *guiding principles* of the upcoming reform, which include an increase in government revenue and a focus on distributive equity. The increase in revenue is expected to be generated through an increase in taxes.

Before a reform of this kind is implemented, policymakers must be aware of its efficiency and redistributive implications. The presence of highly informal labor markets and of informal markets of goods and services as well as other sources of heterogeneity in the tax system adds a series of complications to this analysis. A set of tools that are specifically designed to address this heterogeneity are microsimulation models (MSMs). MSMs allow the simulation of the effects of a policy on a sample of economic agents (individuals or households) at the individual level. This policy simulation consists of evaluating the economic consequences brought by new policy measures on a vector of indicators of the activity or welfare for each individual agent in a sample and possibly their behavior **Bourguignon and Spadaro (2006, p. 2)**. To my knowledge, these types of models have not been applied in the context of tax reforms in the Dominican Republic.

In this paper, I explore the redistributive implications with behavioral responses of two different tax policy measures that are not assumed to occur simultaneously: first, an increase in the personal income tax rate of 5 percentage points for each personal income tax bracket, including the exempted bracket in the baseline, and second, an elimination of all tax exemptions on goods and services in the VAT, except for the health and education consumption categories. For the personal income tax section, I first develop a discrete choice labor supply model like the one developed by **Van Soest (1995)** based on the assumption that utility maximizing agents choose from a set of formal and informal working hour points, where the utility is defined over net income and leisure time. Once I simulate the tax policy change, the individual faces a new net income level in their utility function, from which behavioral responses within the formal and informal hours set and welfare changes can be derived. Second, I adopt the calibration approach in **Spadaro (2005)** by using calibrated values for the elasticity of a proxy of hours with respect to remuneration and with respect to

non-labor income in order to obtain post-reform income measure changes.

For the VAT reform simulation, I first take into account informality in goods and services markets by employing the methodology in **Bachas et al. (2020)**. I then develop an Almost Ideal Demand System (AIDS) for the households in the sample from which I gather the price elasticities of 12 consumption groups and proceed to the simulation exercise.

I find that, as expected, all household quintiles will be negatively impacted by the simulated reforms, although in varying degrees. I find that the model specified by **Van Soest (1995)**, which is commonly used in the European microsimulation literature, fails to fit the Dominican survey data. I suggest that in developing countries labor supply choices might not be based on leisure preferences but rather imposed based on market structure and deficiencies, which trivializes the discrete labor supply model. In the calibration approach, I find that the predominance of informal employment in the poorest quintiles mitigates the impact of a personal income tax reform. I also find that when elasticities are high, inequality is worsened. Finally, I find that informality, and not existing exemptions, in the markets of goods and services is the main driver of progressivity in the Dominican VAT system.

This paper is structured as follows. Section **2** presents the literature review of utilized microsimulation models. Section **3** introduces the Dominican tax system. Section **4** shows the specification, estimation and microsimulation results from the discrete choice model and the calibration approach. Section **5** shows the specification, microsimulation estimation and results of the AIDS model and the simulation of the VAT tax reform. Lastly, Section **6** concludes.

2 Literature Review

Microsimulation models (MSMs) are widely used in the evaluation of policy changes in tax-benefit systems. These models allow simulating the effects of said policies at the level of the samples' observational units or in relevant aggregations, thereby taking into account the heterogeneity of the economic agents. MSMs have been in use since the early 1980s following the rise of large and detailed datasets on individual agents and the increases in computing power **(Bourguignon and Spadaro, 2006)**. Depending on the inclusion of behavioral responses to the simulated policy changes, **Bourguignon and Spadaro (2006)** classify these models into arithmetical MSMs, when behavioral responses are ignored, and behavioral MSMs, when some form of agent responses are included. Typically, behavioral responses take the form of changes in agents' labor market supply when the reform introduces changes in the personal income tax-benefit system or changes in agents' demand of goods and services, when the reform is implemented through the indirect tax system.

MSMs, and particularly those that center around personal income, are predominant in developed countries, with examples such as the FASIT for Sweden, Espasim for Spain, CBOLT and TAXSIM for the United States and EUROMOD for the European Union and the United Kingdom, among others. In Latin America, as in developing countries in general, these models are less common. **Absalon and Urzua (2011)** point to the fact that fiscal and social reforms in Latin America are subject to pronounced political swings, which generates constant variation to an already non-generous tax-benefit system. **Urzúa (2012)** surveys Latin American research on microsimulation models and points to five leading studies that embody full-size microsimulation models for five countries: Brazil, Chile, Guatemala, Mexico and Uruguay[1]. The models developed for these countries range from simulating reforms in personal income tax rates and social security contributions to consumption tax rates by incorporating labor supply and demand of goods and services responses. More recent regional efforts include the development of LATINMOD, an integrated microsimulation model for six Latin American countries[2].

One crucial aspect of microsimulation models in the context of tax reforms is the modelling strategy of the behavioral response. This may be done through the estimation of a structural econometric model for the households in the sample or though the calibration of a behavioral model with some predetermined structure **Bourguignon and Spadaro (2006, p. 13)**. An application of the latter approach can be found in **Spadaro (2005)**.

One estimation method commonly employed in the personal income tax microsimulation literature is to incorporate behavioral responses through discrete choice models of labor supply. These models treat labor supply as a discrete variable consisting of only a few alternative values, as opposed to the continuous modelling of labor supply. This model was first developed by **Van Soest (1995)**. Important illustrations were provided by **Hoynes (1996)** and **Keane and Moffitt (1998)** in the context of labor supply and welfare program participation. Other contributions include the examination of the labor market behavior of married women in the UK **(Duncan and Weeks, 1997)** and the evaluation of the effect of tax credits on hours worked by **Blundell et al. (2000)**. More recent papers utilizing discrete choice models are **Pacifico (2009)** applied for Italy and **Labeaga et al. (2005)** and **Oliver and Spadaro (2017)** for Spain.

Van Soest (1995) notes that the main advantage of these models is that they allow for all kinds of nonlinearities and non-convexities in the budget set while also being computationally tractable, which makes them desirable in the analysis of tax and benefit policies. However,

[1] **Nogueira et al. (2011)**, **Larrañaga et al. (2011)**, **Castanon-Herrera and Urzua (2011)**, **Absalon and Urzua (2011)**, **Amarante et al. (2007)** and **Amarante et al. (2011)**.

[2] **Centro Estrategico Latinoamericano de Geopolitica (2018)**.

Creedy and Kalb (2005) point to the fact that one disadvantage of the model is that the usual formulae for poverty and inequality measures cannot be applied directly because these models do not identify a particular level of hours worked for each observational unit after a policy change but rather results in a probability distribution over the discrete values (or more specifically hours, if these constitute the choice set) used. Nonetheless, this disadvantage can be circumvented by utilizing the product of the relevant probabilities, by using the approach of expected income sampling approach **(Gerfin and Leu, 2003)** or by treating all possible outcomes of each observational unit as different observations **(Creedy and Scutella, 2004)**.

Studies incorporating behavioral responses in an indirect rather than direct tax reform are less common in developed countries. **(Decoster and Verwerft, 2011)**. For consumption taxes, and particularly VAT microsimulation, the existence of MSMs is rare, and more so when accounting for behavioral responses. In order to address this gap in the literature, **Siemers (2014)** develops a basic general VAT-MSM, applicable to the European Union member states, or countries with similar consumption tax systems and applies it to the case of Germany. However, since developing countries, and particularly Latin American countries, rely heavily on indirect taxation for government revenue collection, the ex-ante analysis of indirect taxation reforms is more common.

A method for incorporating behavioral responses in indirect tax reforms consists of obtaining elasticities for consumption goods and services and taking them into consideration when altering relative prices in the economy through a tax reform. A method commonly used for obtaining said elasticities is to estimate a system of demand equations. The first estimation of a system of demand equations stemming from consumer preferences theory was developed by **Stone (1954)**. Further contributions were introduced by **Theil (1965)** and **Barten (1969)**, who proposed the Rotterdam system, and by proposals such as the indirect Translog model by **Christensen et al. (1975)**, who introduced further flexibility to the functional forms. Currently, the demand system more widely used in empirical work is the Almost Ideal Demand System (AIDS), developed by **Deaton and Muellbauer (1980)**, which satisfies a set of desirable characteristics. Particularity, the AIDS provides an arbitrary first-order approximation to any demand system, offers an exact aggregation over consumers without depending on parallel linear Engel curves, satisfies the axioms of choice and, lastly, allows for the homogeneity and symmetry properties to be tested by linear parameter restrictions **(Deaton and Muellbauer, 1980)**.

Notable early applications of the AIDS to the tax reform literature find their roots in authors such as **Decoster and Schokkaert (1990)** for the Belgian indirect tax system, **Nichèle and Robin (1995)** for indirect tax reform alternatives for France. Since developing countries, and particularly Latin American countries, rely heavily on indirect taxation

for Government revenue collection, the ex-ante analysis of indirect taxation reforms and, therefore, the application of demand systems in said empirical analysis are to be expected.

Recent works that utilize AIDS preferences for Latin America have been authored by **Asano et al. (2004)**, who analyze the optimal commodity taxes for Brazil, and by **Figueroa and Peña (2017)**, who examine the implications of an increase of VAT on poverty, inequality and welfare for Guatemala, El Salvador and Honduras. Further empirical applications for Latin America, such the work of **Oliva (2008)** for Ecuador and **Abramovsky et al. (2015)** for Mexico, utilize the Quadratic Almost Ideal Demand System (QUAIDS), developed by **Blundell et al. (1997)**. QUAIDS differ from AIDS in that the former allows Engel curves to be quadratic, therefore allowing goods to be necessities at one level of income and luxuries at another level.

3 Tax Incidence in the Dominican Republic

Dominican Republic's tax system depends considerably on taxes on goods and services, which comprise 56.7% of the total tax revenue (Table **1**). In particular, internal and external Value Added Taxes (VAT) represent 35.0%. One-third of the tax revenue corresponds to taxes on income, profits and capital gains, where Business Income Tax (BIT) and Personal Income Tax (PIT), generate 15.7% and 9.7%, respectively.

Table 1: Tax Revenue in the Dominican Republic

	2019 (Millions of DOP)	% of Total
Taxes on Income, Profits and Capital Gains	**194,280.7**	**31.8**
Corporate Income Tax	*96,181.4*	*15.7*
Personal Income Tax	*59,447.7*	*9.7*
Other Taxes	*38,651.6*	*6.3*
Property tax	**29,564.5**	**4.8**
Taxes on Goods and Services	**346,896.6**	**56.7**
General Taxes on Goods and Services	214,324.0	35.0
Internal VAT	*120,605.6*	*19.7*
External VAT	*93,718.4*	*15.3*
Taxes on Specific Goods and Services	114,491.4	18.7
Taxes on International Trade and Transactions	40,168.9	6.6
Green Taxes	**7834.5**	**0.1**
Other Taxes	**1.6**	**0.0**
Total Tax Revenue	**611,746.8**	**100.0**

Source: Ministry of the Dominican Republic

The PIT (Table **2**) presents a progressive and graduated scale, in which individuals with annual income below 416,220 DOP[3] are exempted. Income up to 624,329 DOP is taxed by a marginal tax rate of 15.0%, followed by a marginal 20.0% rate for up to 867,123 DOP annual income, and a marginal 25% rate for all income above this threshold. Individuals are taxed separately from businesses. The latter are taxed by the BIT, which is set at a flat rate of 27.0%. The tax system guarantees certain exemptions and discounts to certain sectors that fall under the Government's development plan (such as tourism, export-processing zones and firms located in border provinces, among many others) at both the individual and, more predominantly, the business income level[4]. However, it does not consider any significant tax benefits dependent on family structure or specific demographic characteristics[5].

Table 2: Personal Income Tax Brackets

Annual Income Brackets	Tax Rate
Up to 416,220 DOP	Exempt
From 416,221 DOP up to 624,329 DOP	15.0% on income over 416,221 DOP
From 624,330 DOP up to 867,123 DOP	31,216 DOP and 20.0% on income over 624,330 DOP
Over 867,124 DOP	79,776 DOP and 25.0% on income over 867,124 DOP

Source: Department of Internal Revenue of the Dominican Republic

The main VAT rate on goods and services is 18.0%, while there is also a limited set of goods that are taxed at a reduced rate of 16.0%. In addition, a large list of goods and services are exempt from the payment of VAT. Goods and services on this list are those considered of primary need (e.g. live cattle, meat, fish, dairy, house utilities, health services, funeral services, etc). It must be noted that the withholding agents for the VAT are the units of production from which the final products are bought. Tax law allows taxpayers to deduct from their gross tax the amounts of VAT paid to local and external suppliers. Lastly, excise taxes on specific goods and services amount to 18.7% of total tax revenue. These consist of differentiated tax rates and specific excise-duties for mineral oil, alcohol products, tobacco,

[3]Equivalent to just over 7,200 US dollars in 2020.

[4]The Ministry of Finance of the Dominican Republic estimates that tax expenditure from PIT and BIT are 0.78% of GDP **(Ministry of Finance of the Dominican Republic, 2019)**

[5]There are indeed social program in place that benefit the poorest households. However, participating in these programs depend on the initial poverty status and not on income level nor its evolution. These programs lack an exit strategy.

telecommunication services, insurance services and electronic transfers.

As in many other developing countries, tax evasion is prevalent in the Dominican tax system. In 2018, the Department of Internal Revenue (DGII in Spanish) estimated that income tax evasion is higher than 60% while VAT evasion is close to 43% **(Acosta, 2018)**. Income tax avoidance is facilitated by the presence of high informality levels in the labor market[6]. In 2020, 58.9% of workers 15 years or older were participating in the informal sector.

4 Personal Income Tax Reform

4.1 Discrete Choice Model

4.1.1 Specification

In this section, I derive the labor supply model based on discrete choices for single individuals. In this model, individuals derive utility from household income y and leisure time L, which is denoted as $L = T - h$ where T is total time available and h is hours of work. The associated utility function that individuals seek to maximize is:

$$U = U(y, h; X) \tag{4.1}$$

where X are demographic characteristics. Utilizing the notation in **Labeaga et al. (2005)**, the associated constraint is given by:

$$y = wh + \mu - T(h, w, \mu, X) \tag{4.2}$$

where $T(h, w, \mu, X)$ represents tax payment net of benefits that tends to depend on hours, wages, non-labor income and demographic characteristics, and μ is non-labor income. Therefore, the economic agent's problem is:

$$Max_h\, U(y, h, X) \;\; s.t. \;\; y = \mu + wh - T(\mu, w, h, X) \tag{4.3}$$

(Keane and Moffitt, 1998), **Blundell et al. (2000)** and **Labeaga et al. (2005)** estimate the parameters of this function following the flexible quadratic utility function. Single individuals tend to decide the amount of hours they allocate to work independently, while

[6]The informality status of the employment is measured by the Central Bank of the Dominican Republic as the ENCFT administrators. The entity's definition of informality considers legal status of the production unit, access to social security, existence of written or oral contract, existence of other in-work benefits, domestic workers retirement or health insurance plans status and household workers payment status.

couples allocate their working hours simultaneously. Therefore, the utility function specified in (4.4) contemplates singles exclusively. It is worth noting that the literature on discrete choice labor supply models tends to include both singles and couples specifications, which are estimated separately[7].

$$U(y,h,X) = \alpha_{yy}y^2 + \alpha_{hh}h^2 + \alpha_{yh}yh + \beta_y(X)y + \beta_h(X)h \tag{4.4}$$

4.1.2 Data and estimation

In order to estimate the parameters in (4.4), it is necessary to establish the discrete choices available to each individual in the finite set $h \in \{h^1, h^2, ...h^K\}$ that fulfills the observability rule[8]. For each of the alternative number of hours in the choice set h, an associated counterfactual net labor income level is assigned. In my estimation, I depart from the literature by distinguishing between informal and formal hours of work and adding these distinct employment type as different choices. Therefore, the new finite set becomes $h \in \{h_f^1, h_f^2, ...h_f^K | h_{in}^1, h_{in}^2, ...h_{in}^K\}$, where f denotes formal employment and in denotes informal employment. This distinction is important because counterfactual net labor income levels depend of the tax structure, as show in (4.2), which in turn depend on the agent's employment type. Only in formal employment the individual is required to pay personal income tax[9], therefore, net income, y, associated with the finite choice set is:

$$y \in \{wh_f^1 - T(\mu, w, h_f^1, X), wh_f^2 - T(\mu, w, h_f^2, X), ...wh_f^K - T(\mu, w, h_f^K, X) \mid wh_{in}^1, wh_{in}^2, ...wh_{in}^K\}$$

[7]The specification commonly employed for couples is the following:

$$U(y,h_m,h_f,X_m,X_f,X) = \alpha_{yy}y^2 + \alpha_{hmhm}h_m^2 + \alpha hfhfh_f^2 + \alpha_{yhm}yh_m + \alpha_{yhf}yh_f + \alpha_{hmhf}h_mh_f + \beta_y y + \beta_{hm}h_m + \beta_{hf}h_f$$

where h_i and $X_i, i = m, f$ are hours and demographic characteristics of the member i in the couple, commonly, male and female members of the couple.

[8]The observability rule is given by:

$$\begin{aligned} h &= h^1 \; if \; h \leq h_1^B \\ &= h^2 \; if \; h_1^B \leq h_2^B \\ &\vdots \\ &= h^{K-1} \; if \; h_{K-1}^B < h \leq h_{K-1}^B \\ &= h^K \; if \; h > h_{K-1}^B \end{aligned}$$

[9]Although more prevalent in formal employment, both formal and informal labor can come with non-wage benefits. These sources of labor income are not accounted for in my estimation.

Likewise, leisure, l, for each alternative within the choice set is defined as 168, which is the number of hours available to any individual each week, minus the number of work hours:

$$l \in \{168 - h_f^1, 168 - wh_f^2, ...wh_f^K | 168 - wh_{in}^1, 168 - wh_{in}^2, ...168 - wh_{in}^K\}$$

Stochastic terms that are assumed to be generated by extreme value distributions are added in order to estimate the model. Therefore, I seek to estimate a multinomial logit model[10], which is the the discrete choice model that results from the assumption of an extreme value distribution.

The choice probability for agent i under these assumptions is derived by:

$$Pr[h_i = h^j, X] = Pr[U*_{i^j} > U*_{i^k} \; \forall k \neq j, k \in 1, 2, ..., K] \tag{4.5}$$

$$Pr[h_i = h^j, X] = \frac{exp[U*(y_{i^j}, T - h^j; X]}{\sum_{k=1}^{K} exp[U*(y_{i^k}, T - h^k; Z)]} \tag{4.6}$$

where $U* = U(.) + \epsilon_{hi}$.

With the independent errors hypothesis, the likelihood function to be estimated by maximum likelihood ϕ of each model can be written for singles as:

$$ln\phi_s = \sum_{i=1}^{N} \sum_{k=1}^{K} d_k[lnPr(h_i = h^{ki}, X_i)] \tag{4.7}$$

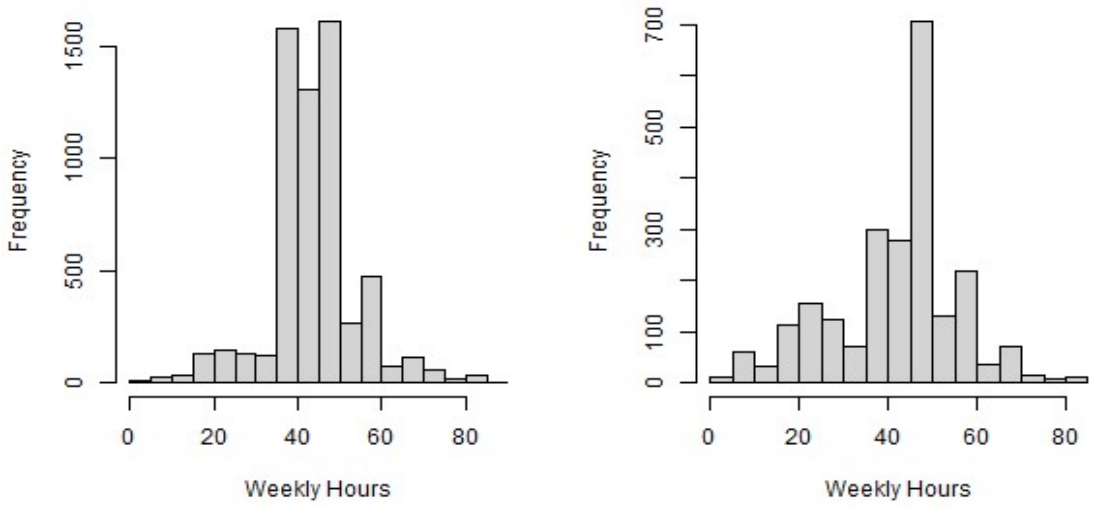
To apply this empirical strategy, I exploit the National Continuous Survey of Labor Force (ENCFT in Spanish) of 2019. This survey is carried out by the Central Bank of the Dominican Republic. This is a quarterly survey launched in 2016 designed to substitute the National Labor Force Survey (ECFT, in Spanish), which had been conducted since 1991, as the leading employment survey in the country. It contains living conditions and family composition data of households, and employment, education and earnings data of a working age member of the households. In order to obtain stable estimates, the ENCFT is conducted through an overlapping panel of households with 80% of households being mutual in two consecutive quarters, and 20% being mutual in the same quarter of two consecutive years. This means that the observational units (households) are not constant throughout quarters.

From this survey, I gather monthly income, demographic and labor supply information for single individuals. I further limit the sample to exclude self-employed and unemployed

[10]Specifically, I estimate a conditional logit model since only alternative-specific independent variables are included, as opposed to individual-specific variables **(McFadden, 1977)**.

individuals, as well as students and those younger than 15 and older than 65[11]. The remaining sub-sample consists of 18,852 single men and women. In order to select the intervals of hours choices to be included in the finite set h, in Figure **1** I show histograms of weekly working hours for singles in the formal and informal labor markets and in non-participation status. I use the total number of hours across the first and second occupation, if any, per individual.

Figure 1: Weekly hours of work of formal (left) and informal (right) single workers



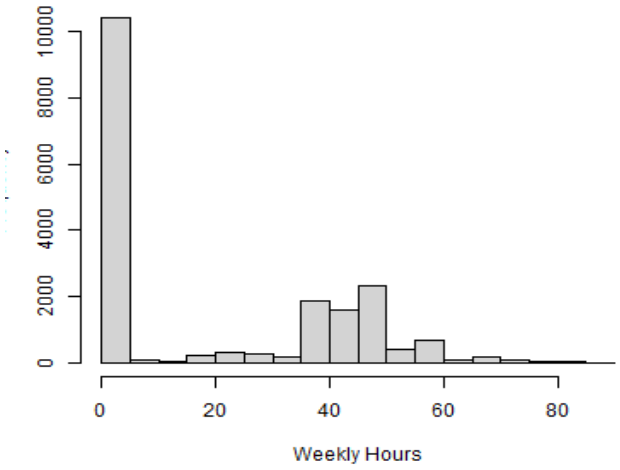
Source: ENCFT, own calculations

When compared to developed countries, the labor force in the Dominican Republic consists of fewer part-time workers. Regardless of formality status, most workers are concentrated in the full-time interval and exhibit a large proportion of higher than 40 hours work weeks. Informal workers show a slightly higher proclivity to work part-time[12]. Figure **2** shows the weekly working hours distributions for the whole sub-sample, including non-participants, who amount to 50.9% for the sub-sample. I take into account the actual working hours in the sub-sample to establish the following discrete set $h_f \in \{15, 40, 50, 60\}$ of formal working hours and $h_{in} \in \{15, 40, 50, 60\}$ of informal working hours and $h_0 = 0$ for non-participation. Both h_f and h_{in} correspond to the intervals: $< 5, 6-35, 36-45, 46-55, > 56$. Each individual's choice set is comprised by the union of the h_f, h_{in} and h_0 sets, resulting in 9 different alternatives.

[11]In 2019, 72.5% of people over 65 were not working. Future estimation efforts can include a higher age cutoff.

[12]The current sub-sample excludes self-employed individuals. Since most individuals that are self-employed belong to the informal sector, by excluding them, the sub-sample goes from a majority of informal workers (55%) to a minority (27%). Appendix **A** shows the weekly working hours histogram that includes all informal workers.

Figure 2: Weekly hours of work of single workers



Source: ENCFT, own calculations

As mentioned previously, in order to estimate the discrete choice model, counterfactual labor income levels at alternative working hour points are required. To obtain these figures, I start by computing the weekly gross hourly wage of the observed choice by dividing weekly gross labor income by the observed weekly working hours. I then compute the counterfactual gross labor income by multiplying the gross hourly wage by the number of alternative working hours. Net labor income is calculated by applying the personal income tax laws to the gross labor income. This last step provides the fundamental difference between formal and informal hour choices. Net labor income for the informal hours is equal to gross labor income while net labor income for the formal sector is equal to gross labor income minus the mandatory social security contribution of 6.91% of labor income and the personal income tax burden, if the individual's gross labor income surpasses the official exemption benchmark. In my sub-sample, the average gross weekly wages in the formal sector is 4,179.4 DOP, compared to 2,118.5 DOP in the informal sector. After applying the corresponding personal income tax burden in addition to the social security contribution, the formal sector average weekly net wage amounts to 3,849.2 DOP.

For the purpose of assigning alternative labor income levels to individuals with non-participation status, and therefore with unknown potential wages, I estimate a classical Heckman selection model to correct for sample selection **(Heckman, 1979)** and input the predicted wages to non-participants labor income's counterfactual. The estimation output of this model is shown in Appendix **B**.

Lastly, I obtain estimates of the parameters of the utility function for (4.4) by optimizing (4.7). As the demographic variables in vector X, I include the number of children, age and secondary education of the individual. In Table **3** I report the results. All independent variables are significant. However, the sign of the marginal utilities are unusual when compared to those in the related literature. Whereas in most applications to Europe the resulting marginal utility of income increases at a decreasing rate and is almost always positive, my estimates do not identify concavity. This results in that the sign of the estimated coefficients produce higher utility levels when leisure hours increase without being offset by utility losses from net wage reductions, given the negative sign in $netwage$ and $netwage^2$. As a consequence, predicted values are predominantly incorrect as they favor non-participation in over 90% of individuals. One potential reason is that the current specification lacks regressors that represent advantages to the formal sector. However, this is not sufficient to explain the findings, because of the prevalence of non-participation instead of informality[13].

These results point to the fact that the specification commonly employed in the discrete choice labor supply literature, which is heavily European, might not be appropriate for a developing country in which individuals' labor supply choices are not based on leisure preferences but rather imposed based on market structure and deficiencies. Factors beyond leisure and net income seem to influence labor supply choices and are not accounted for in European specifications.

The step following the estimation of the coefficients is the microsimulation stage in which predicted choices are reevaluated for a set of new tax policy measures that would affect net labor income for formal workers. This would alter all individual's labor income counterfactual, who would therefore adjust their working hours choices to a certain extent. However, since I do not obtain reliable coefficients for the reasons set out in the previous paragraph, this step is omitted.

4.2 Calibration

4.2.1 Specification

I employ the calibration methodology developed by **Spadaro (2005)**. The author proposes a microsimulation model that incorporates behavioral responses to changes in the tax-benefit system through household productivity. This model integrates gross labor income, non-labor income, tax-benefit laws as they apply to households and a set of arbitrary elasticities, along

[13]I estimate two additional models. In the first one, I exclude non-participation from the choice set. In the second model, I include a proxy of fixed costs of working as an independent variable, as in **Van Soest (1995)**. In both estimations, the individual's predictions predominantly favor the choices with the least amount of working hours, demonstrating that the deficient identification persists.

Table 3: Estimation results for the discrete choice labor supply model. Single females and single males

	Dependent variable:
	Hours choice
Netwage	-0.001^{***}
	(0.0001)
Netwage^2	-0.000^{***}
	(0.000)
Leisure	-0.578^{***}
	(0.010)
Leisure^2	0.002^{***}
	(0.00004)
Netwage*Leisure	0.00002^{***}
	(0.00000)
Netwage*Children	-0.00000
	(0.00001)
Netwage*Age	-0.00001^{***}
	(0.00000)
Netwage*Sec Educ	0.0003^{***}
	(0.00002)
Leisure*Children	-0.005^{***}
	(0.001)
Leisure*Age	-0.001^{***}
	(0.00004)
Leisure*Sec Educ	0.010^{***}
	(0.001)
Observations	18,852
Log Likelihood	$-30{,}597.500$

Notes: *p<0.1; **p<0.05; ***p<0.01

$Netwage$ is net wage; $Leisure$ is defined as the hours available to any given individual in a week $(24 * 7 = 168)$ minus the number of weekly work hours; $Children$ is the number of children in the household; Age is age of the individual; $SecEduc$ is secondary education.

with the productivity variable w that comes from the proposed theoretical model of effort supply. This model establishes the household maximization problem as:

$$Max_{c,e}\, U(c, e, N) \;\; s.t \;\; c = we + m - T(N, we, +m) \tag{4.8}$$

where c is consumption with price fixed at one, e is supply of effort with price w which is the remuneration of abilities (ROA), m is non-labor income and N is the size of the household. $I(\cdot)$ represents the tax benefit system in place. Assuming the usual properties of the utility function are satisfied, this function can be inverted, allowing for the value of w to be recovered from observed gross income, corresponding taxes and benefits and disposable income. By replacing the budget constraint in the maximization problem in (4.8) with a non-linear budget constraint, the inversion of the optimal problem can be implemented **Spadaro (2005, p. 605)**. This linearization is performed by changing the constraint to:

$$c = m_v + we(1 - t_{marg}) \tag{4.9}$$

where m_v denotes the virtual non-labor income and t_{marg} is the effective marginal tax rate.[14]

The effort supply e follows a Cobb-Douglas parametric specification:

$$e = N\phi w_v^{\alpha} m_v^{\beta} \tag{4.10}$$

where ϕ is a constant, α is the elasticity of e with respect to ROA, β is the elasticity of e with respect to non-labor income, and w_v is the virtual ROA[15]. The indirect utility function associated with (4.11) is:

$$V(w_v, m_v, N) = \frac{N\phi w_v^{1+\alpha}}{1+\alpha} + \frac{m_v^{1-\beta}}{1-\beta} \tag{4.11}$$

Spadaro (2005) notes that the result of the inversion procedure following this specification is:

$$w = \left[\frac{y}{N\phi(1 - t_{marg})^{\alpha} m_v^{\beta}}\right]^{\frac{1}{1+\alpha}} \tag{4.12}$$

Given that in the Dominican case there are no transfers that depend on income level and only the marginal tax rate affects t_{marg}, there is no concern about the the effective marginal

[14] Virtual income is defined as the non-labor income that the individual would get if her earnings were zero and she could stay on the virtual linearized budget **Piketty and Saez (2012, p. 16).**

[15] $w_v = w(1 - t_{marg})$

tax rate being 1 and rendering w incalculable.

4.2.2 Microsimulation results

In this section, I show the impact of an increase in the marginal tax rate of 5 percentage points in each personal income tax bracket, including the exempted bracket in the baseline, that is, the marginal tax rates go from 0, 15%, 20% and 25% to 5%, 20%, 25% and 30%. I present a low-reaction scenario followed by a medium-reaction scenario.

I exploit the 2019 ENCFT data for a total of 11,140 households. I follow **Spadaro (2005)** assignment of elasticities, which are $\alpha = 0.1$ and $\alpha = 0.3$ for the low-elasticity and medium-elasticity scenario, respectively, and $\beta = -0.2$ and $\beta = -0.4$ for each respective scenario. Concurrently, ϕ is assigned values of 2.7 and 2.5, respectively[16]. These elasticities, except for ϕ were selected by the author as to follow the microeconometric literature on labor supply mainly for European countries, which undoubtedly is of dubious validity for other countries. As seen in section **4.1**, it is not surprising that frameworks that hold for certain developed countries might not be the most appropriate for different contexts. However, in order to establish an upper bound of behavioral responses for the Dominican case, I continue with the calibrated approach.

Since the Dominican personal income tax system is designed at the individual level and does not incorporate deductions based on family composition or expenditure types, I perform the analysis at the individual level and then aggregate it to the household level for income distribution effects. I start by assigning the correspondent marginal tax rate to each individual in the baseline scenario according to the personal income tax brackets associated with their income level, as well as their social security contribution. As in section **4.1**, informality is taken into account and informal individuals are not assigned neither tax burdens nor social contribution allocations.

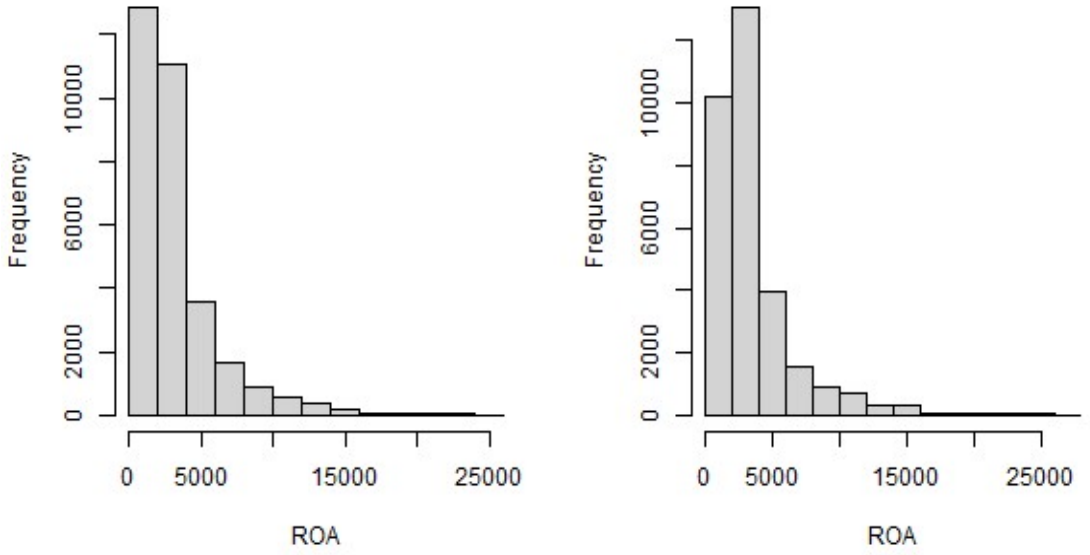
I obtain the productivity distribution of the sample given by (4.12). In Figure **4**, I show the productivity distribution in the low-elasticities and the medium-elasticities scenarios. It is clear to see that higher elasticities conduct to a slightly more equal distribution of ROA at its initial levels.

Behavioral simulation results after the personal income reform is implemented are reported in Table **4** for adult equivalent[17], where I show the average percentage change

[16] **Spadaro (2005)** calibrates ϕ as to normalize to 1 the effort supply of a single employee who works full-time and earns the minimum wage by using an algorithm of utility maximization. I omit this step and proceed with using the author's calibrated values. In order to ensure that the results are not too dependent on this strong assumption, in Appendix **C** I perform a robustness check that bootstraps 60 values of phi from 0.1 to 6.

[17] (Adult equivalent = square root of household size)

Figure 3: Distribution of ROA rate for low (left) and medium (right) elasticities



Source: ENCFT, own calculations

in gross income, disposable income and net taxes for the low-elasticities scenario. As a result of the reform, gross income does not change significantly. The poorest gross income quintile only registers an increase of 0.1% of this figure, while the fifth quintile's increases by 0.3%. The change in disposable income is also higher in absolute value for the fifth quintile (-3.0%) than for the poorest quintile (-0.1%). The reason disposable income is not affected proportionally for all quintiles when the reform adds 5 percentage points to all working individuals' tax burdens is because of informality in the labor market, which allows just over half of the individuals, specially those in the poorest quintiles, to avoid paying taxes. The scenario with medium-elasticities presented in Table **5** shows a similar trend. However, decreases in disposable income are diminished by virtue of the slightly higher gross income responses in this scenario, but this increase in gross income is not enough to offset the tax increase. Appendix **D** shows that in a scenario with no informality, that is, when all workers are subject to personal income tax and social security contributions, the average change in disposable income is closer to the 5 percentage point increments in the personal income tax rates reform, as expected. Again, when agents respond more actively to the new tax rates, as in the scenario with higher elasticities, the decline in disposable income is mitigated.

One obvious conclusion that arises from this analysis is that the effect of a tax reform that seeks to eliminate the exempted personal income tax bracket that currently covers most

individuals[18] is mitigated by the existence of informality.

Table 4: Redistribution performance of tax reform: low-elasticities scenario. Expressed in values per adult equivalent (adult equivalent = square root of household size)

Quintile	Avg. Change in Gross Income	Avg. Change in Disposable Income	Avg. Change in Net Tax
1	0.0005	−0.005	-
2	0.002	−0.018	-
3	0.002	−0.022	0.002
4	0.003	−0.024	0.027
5	0.003	−0.030	0.118

Source: ENCFT, own calculations

Table 5: Redistribution performance of tax reform: medium-elasticities scenario. Expressed in values per adult equivalent (adult equivalent = square root of household size)

Quintile	Avg. Change in Gross Income	Avg. Change in Disposable Income	Avg. Change in Net Tax
1	0.001	−0.004	-
2	0.005	−0.016	-
3	0.006	−0.018	0.002
4	0.007	−0.020	0.027
5	0.008	−0.025	0.122

Source: ENCFT, own calculations

Following **Spadaro (2005)**, I pay attention to the concerns of the statistical representativity of the ENCFT sub-sample and perform a bootstrapping analysis by replicating my computations for 1000 alternative subsamples generated randomly with replacement from the original distribution. In Table **6** and Table **7**, I report the results. These show that the recovered standard errors for the change in disposable income aggregated by adult equivalent are very small, and that the upper and lower band of the 95% confidence intervals is very similar to the average changes in the original sub-sample.

Lastly, Table **8** shows inequality indices on per adult equivalent disposable income in different scenarios: baseline, post-reform with low elasticities and post-reform with medium

[18]In the pre-reform scenario, only 91% of wage-earners in the sample earn enough to pay personal income tax.

Table 6: Bootstrap standard errors and confidence intervals for simulations results: low-elasticities scenario

Quintiles	Avg. Change in Disposable Income	Std. Error	95% Lower	95% Upper
1	−0.004	0.00001	−0.004	−0.004
2	−0.017	0.00001	−0.018	−0.017
3	−0.022	0.00001	−0.022	−0.022
4	−0.025	0.00001	−0.025	−0.025
5	−0.030	0.00001	−0.030	−0.030

Source: ENCFT, own calculations

Table 7: Bootstrap standard errors and confidence intervals for simulations results: medium-elasticities scenario

Quintiles	Avg. Change in Disposable Income	Std. Error	95% Lower	95% Upper
1	−0.004	0.00001	−0.004	−0.003
2	−0.015	0.00001	−0.015	−0.015
3	−0.019	0.00001	−0.019	−0.019
4	−0.021	0.00001	−0.021	−0.021
5	−0.026	0.00001	−0.026	−0.026

Source: ENCFT, own calculations

elasticities. Clearly, when the tax reform is implemented the Gini index points to more inequality in the economy, which is slightly worsened if the scenario that is taken into account is that of medium elasticities. Two values of α (a parameter of inequality aversion) are evaluated for the Atkinson index[19]. When there is a high aversion to inequality ($\alpha = 0.1$, both elasticities scenarios perform equally poorly in regards to post-reform equality. When there is low aversion to inequality ($\alpha = 0.99$, the scenario that entails the least erosion of equality is the one with low elasticities.

Table 8: Inequality index for different scenarios calculated on per adult equivalent disposable income

Scenario	Gini	Atkinson (a = 0.01)	Atkinson (a = 0.99)
Baseline	0.536	0.005	0.467
Low Elasticities	0.551	0.006	0.476
Medium Elasticities	0.552	0.006	0.481

Source: ENCFT, own calculations

5 Value-Added Tax Reform

5.1 Specification

In this section, the AIDS model is derived. The starting point of the AIDS is individuals' expenditure function which in turn is used to derive flexible share equations is:

$$\ln m = \ln E(p, U) = \ln \alpha(p) + U\beta_0 \prod_i p_i^{\beta_i} \tag{5.1}$$

where U is the utility level and p_i is the price of good i, and

$$\ln \alpha(p) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij}^* \ln p_i \ln p_j \tag{5.2}$$

where α, β and γ are parameters. For m to be linearly homogeneous in p, the following restrictions must be satisfied:

$$\sum_i \alpha_i = 1; \sum_i \beta_i = 0; \sum_i \gamma_{ij} = 0 \; \forall j \tag{5.3}$$

[19]This index measures the proportion of income that could be sacrificed without social welfare loss if income were to be equally distributed.

The uncompensated demand functions can be derived from (5.1) by applying Shephard's Lemma and replacing the unobservable utility index by the indirect utility function related to m, as done by **Deaton and Muellbauer (1980, p. 313)** and following a cross-sectional modification of notation in **Henningsen (2017)**:

$$x_{it}(p_t, m_t) = \frac{m}{p}\left(\alpha_i + \sum_j \gamma_{ij} ln p_j + \beta_i \ln\left(\frac{m}{P}\right)\right) \tag{5.4}$$

where x_{it} is the consumption quantity of good i, $\gamma_{ij} = \frac{1}{2}\left(\gamma^*_{ij} + \gamma^*_{ji}\right)$ and P is is a translog price index given by:

$$\ln P = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j \tag{5.5}$$

For simplicity, expenditure equations can be expressed as budget shares:

$$s_i(p, m) = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln(m/P) \tag{5.6}$$

where $s_i = \frac{x_i}{p_i/m}$. Given the restrictions in (5.3), expenditure shares are guaranteed to sum up to one.

5.2 Data and estimation

The econometric estimation of the uncompensated demand equations in (5.6) requires replacing the observed budget shares w_i with the unobservable budget shares s_i with added disturbance terms u_i:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \frac{m}{P} + u_i \tag{5.7}$$

While (5.3) guarantees that the observed budget shares equals one and that the disturbance terms u_i sum up to zero, it follows that the covariance matrix is singular **Blanciforti and Green (1983, p. 512)**. This requires one equation to be dropped from the estimation and to be therefore calculated as a residual in the adding-up restriction. Lastly, **Deaton and Muellbauer (1980)** suggest to approximate the translog price P with the Stone index, $\ln P^S = \sum_i w_i \ln p_i$, for cases where prices are closely collinear, then the budget shares (5.6) equation becomes:

$$w_i = \alpha_i^S + \sum_j \gamma_{ij}^S \ln p_j + \beta_i^S \ln\left(\frac{m}{P^S}\right) + u_i^S \tag{5.8}$$

To estimate this model, data on household expenditures and associated prices are required. The household-level monthly expenditures were gathered from the Household Income and Expenditure and National Survey from 2018 (ENGIH, in Spanish) for 8,892 households. This survey is carried out by the Central Bank of the Dominican Republic with the purpose of gathering statistical information throughout the territory on the distribution of spending by Dominican families as well as the amount and sources of income of the population. It is conducted at the household level and it contains living condition measures along with information on monthly expenditures and labor and non-labor income sources. Expenditure data is registered at the item level and for most products the information on the place of purchase is also registered. This latter piece of information allows identifying which items were purchased in store-types that are more likely to be informal, which, following **Bachas et al. (2020)**, is an approximation of informal purchase of goods and services[20].

The consumption data obtained from this survey were aggregated in 12 consumption categories: (1) non-alcoholic food and beverages, (2) alcohol and tobacco products, (3) clothing, (4) housing and utilities, (5) furnishings, (6) health, (7) transportation, (8) communication, (9) entertainment, (10) education, (11) restaurants and hotels, and (12) diverse goods and services.

Baseline price indices at the category level are obtained from the average national Consumption Price Index (CPI) provided by the Central Bank[21].

The uncompensated demand elasticities obtained from estimating the parameters in (5.8) are shown in Table **9**. As expected, most own-price elasticities are negative. The only exception is the Clothing category. The occurrence of unusual elasticities is similar to that documented by **Oliva (2008)** and **Figueroa and Peña (2017)**, who find its roots in the cross-sectional nature of the available expenditure data, which is unable to take into account a time component in order to estimate parameters that more closely represent the behavior of a set of households. Another check on the elasticities obtained from the AIDS model is to evaluate income elasticities. The positive sign of the income elasticities in Appendix **F** indicate, as expected, that all consumption groups comprise normal goods, which means that their consumption increases as income rises.

[20] See Appendix **E**

[21] Other research papers utilize more ideal price indices, such as expenditures divided by quantities when provided by the survey, which is not provided by the ENGIH, or through pseudounit values as in **Menon et al. (2017)**.

Table 9: Price Elasticities

	1	2	3	4	5	6	7	8	9	10	11	12
1	−0.647	0.101	−0.651	−0.200	−0.272	−0.242	0.303	0.360	0.058	0.424	−0.217	0.215
2	0.922	−6.485	−2.013	0.343	0.008	3.987	−1.615	0.079	2.185	3.437	−1.610	−0.488
3	−3.620	−1.064	0.617	−0.172	0.502	1.920	−0.933	0.842	0.183	−2.128	0.333	2.434
4	−0.503	0.085	−0.067	−0.018	−0.959	0.614	0.128	0.439	0.432	0.024	−0.329	−0.772
5	−1.679	0.005	0.525	−2.406	−4.084	0.451	−0.156	−0.266	1.609	2.465	−1.194	3.498
6	−0.981	1.403	1.268	0.922	0.283	−1.936	1.794	−0.763	0.283	−0.465	0.387	−3.411
7	0.422	−0.309	−0.347	0.052	−0.062	0.944	−0.708	0.311	−0.339	−0.906	−0.541	0.029
8	2.202	0.049	0.991	1.181	−0.300	−1.370	1.063	−2.414	−2.697	0.709	1.981	−2.678
9	0.361	1.877	0.283	1.588	2.459	0.680	−1.546	−3.690	−0.500	−3.380	−1.460	1.926
10	2.769	2.295	−2.694	0.027	2.930	−0.893	−3.207	0.750	−2.624	−3.381	−0.639	3.317
11	−0.363	−0.289	0.144	−0.233	−0.374	0.255	−0.431	0.626	−0.298	−0.153	−0.454	1.053
12	0.314	−0.075	0.767	−0.572	1.045	−1.597	0.083	−0.696	0.383	0.837	0.863	−2.343

Note: numbers correspond to the following group of goods (1) Food and Beverages, (2) Alcohol and Tobacco , (3) Clothing, (4) Housing and Utilities, (5) Furnishings, (6) Health, (7) Transportation, (8) Communication, (9) Entertainment, (10) Education, (11) Restaurants and Hotels, and (12) Diverse Goods and services.

Once the elastiticities are obtained[22], I perform microsimulations through the introduction of price changes through increases in consumption tax rates, which result in new budget shares. Additionally, in order to assess the pass-through of an increase in the consumption tax rate to prices, I make further assumptions about the informal economy.

In order to both obtain ex-post prices, that is, prices after the indirect tax reform takes place, and tax burden distribution among households, I assign tax rates corresponding to the official VAT rates in the tax law to each consumption item within each of the 12 consumption categories, differentiating between products and services taxed at the 18%, 16% and those exempted. By multiplying the household expenditure on each item by its corresponding tax rate, I obtain a preliminary tax burden measure for each item for each household. This preliminary measure is adjusted to account for informality in the economy, that is, tax evasion by means of non-abiding vendors. For this, I follow **Bachas et al. (2020)**, who use the type of store in which purchases are realized as a proxy for informal, and therefore untaxed, consumption. Appendix **E** provides further details.

Ex-post prices are obtained by adjusting baseline price indices with the new tax rates while also accounting for informality in the economy as follows:

$$
\begin{aligned}
P_h^{Post} &= P_j^{Pre}\left(\frac{1+VATrate_{h,j}^{Post}}{1+VATrate_{h,j}^{Pre}}\right) \\
VATrate_{h,j}^{Pre} &= \sum_{i=1}^{P} w_{h,i}^{Pre} * (1 - Informal_{h,j}) * VATrate_i^{Pre} \\
VATrate_{h,j}^{Post} &= \sum_{i=1}^{P} w_{h,i}^{Pre} * (1 - Informal_{h,j}) * VATrate_i^{Post}
\end{aligned}
\tag{5.9}
$$

where P_j represents the price index of the group of goods j, $Informal_{hj}$ is the fraction of goods of group j that household h buys from non-abiding vendors, $VATrate_{hj}$ represents the weighted average VAT rate for household h and group j, and w_{hi} is the budget share for household h for good i.

An important assumption that has remained implicit so far is that of a complete pass-through of increased tax rates from the producers to the consumers. This approach is common in the literature.

[22]I continue to use the elasticities from the estimation of the AIDS model despite the positive sign in the Clothing category.

5.3 Microsimulation results

In this section, I first contemplate the redistributive implications of a tax reform that consists on the elimination of current VAT exemptions and reduced rates in the Dominican Republic. This implies that goods and services exempted from VAT and those taxed at 16% will now be set at the standard 18%, except for the consumption groups of Health and Education. Second, I analyze the role of informal markets in reducing the regressivity of a reform of this type.

As a result of the tax reform, the effective weighted average VAT rates by consumption group are evidently altered, as seen in Table **10**. To better illustrate the concept of an effective weighted VAT rate in the presence of informality, it is worth indicating that if all markets were formal, column 3 in this table would equal 0.18 for all consumption categories, except for the Health and Education groups. This table shows that the reform affects the rates substantially primarily for the Transportation, Diverse Goods and Services and Housing and Utilities groups. This is a result of a combination of low pre-reform rates, in the case of Transportation and Diverse Goods and Services, and lower than average informality within these groups[23].

Table 10: Effective Weighted VAT Rates Before and After Reform

Consumption Group	Pre-reform	Post-reform	Variation
Food and Beverages	0.892	2.390	1.497
Alcohol and Tobacco	0.514	1.217	0.703
Clothing	12.100	12.100	0.000
Housing and Utilities	6.256	12.069	5.183
Furnishings	7.646	7.668	0.022
Health	0.000	0.000	0.000
Transportation	1.099	17.273	16.173
Communication	14.493	14.493	0.000
Entertainment	11.373	15.294	3.922
Education	0.000	0.000	0.000
Restaurants and Hotels	1.812	1.812	1.812
Diverse Goods and Services	3.638	10.550	6.911

Source: ENGIH, own calculations

Table **11** shows that after the reform is implemented, the categories that gain participation are those that represent necessities, such as Health, Food and Beverages, and Transportation.

[23] See Table **22** in Appendix **E**.

In contrast, a decline in relative consumption is displayed by Education, Diverse Goods and Alcohol and Tobacco. Evidently, one would expect households to shift some proportion of their consumption to the informal market once they perceive an increase in prices through the VAT. However, in my microsimulation exercise, I assume informality remains unaltered in the post-reform world.

Table 11: Budget Shares Before and After Reforms

Consumption Group	Pre-reform	Post-reform	Variation
Food and Beverages	0.251	0.264	0.013
Alcohol and Tobacco	0.022	0.017	−0.005
Clothing	0.043	0.041	−0.002
Housing and Utilities	0.104	0.107	0.003
Furnishings	0.039	0.044	−0.004
Health	0.063	0.069	0.066
Transportation	0.111	0.116	0.005
Communication	0.035	0.034	−0.001
Entertainment	0.025	0.025	0.000
Education	0.032	0.022	−0.010
Restaurants and Hotels	0.136	0.133	−0.003
Diverse Goods and Services	0.140	0.128	−0.012

Source: ENGIH, own calculations

The resulting tax burden following the reform is presented in Table **12**, which distinguishes between expenditure quintiles. In particular, the VAT tax burden as a proportion of total expenditures is 2.2% for the poorest quintile and 4.8% for the richest quintile. Once the reform is implemented these figures become 6.0% and 10.8%, respectively. Except for the fourth quintile, which shows a smaller tax burden in terms of total expenditure than the third quintile, it is clear to see that tax burden before and after the reform shows a similar progressive trend. The same is true for the VAT burden as a share of household income. The fact that both pre-reform and post-reform scenarios follow this trend indicates that informality is the main driver of progressivity in the Dominican indirect tax system [24], since relative tax burdens between quintiles are nearly unaffected when low-rates and exemptions are absent and informality is taken into account.

To better assess this tendency, I perform another microsimulation exercise without accounting for informal markets by departing from the methodology from **Bachas et al.**

[24] I am only taking the VAT into account. Different conclusions would stem from an analysis that includes the excise taxes.

Table 12: VAT Burden by Expenditure Quintiles

Quintiles	As a share of Expenditure		As a share of Income	
	Pre-reform	Post-reform	Pre-reform	Post-reform
1	0.022	0.069	0.019	0.057
2	0.027	0.076	0.025	0.069
3	0.033	0.082	0.029	0.074
4	0.037	0.090	0.034	0.081
5	0.048	0.108	0.042	0.095

Source: ENGIH, own calculations

(2020). In Table **13**, I present the results. As hypothesized, the VAT burden in the pre-reform scenario becomes completely regressive across expenditure quintiles by going from 8.7% of the expenditures of the poorest quintile to 7.7% of those of the richest quintile. This is explained by the fact that, contrary to policy intention, the richest households benefit the most from existing exemptions when there is no informality[25]. Once the reform is implemented, this tendency persists, as seen in column 3 of Table **13**. The VAT tax burden starts at 16.7% for the poorest quintile and decreases progressively until reaching 15.7% of the expenditures of the households in the richest quintile. The reason for this is that when reduced rates are no longer in place and only exemptions in the Health and Education groups remain, the richest households benefit the most because they devote a higher proportion of their budget to these consumption groups than their poorer counterparts.

Table 13: VAT Burden by Expenditure Quintiles Without Informality

Quintiles	As a share of Expenditure		As a share of Income	
	Pre-reform	Post-reform	Pre-reform	Post-reform
1	0.088	0.167	0.073	0.138
2	0.081	0.163	0.073	0.148
3	0.079	0.163	0.070	0.145
4	0.077	0.161	0.069	0.146
5	0.077	0.157	0.067	0.138

Source: ENGIH, own calculations

[25]63.5% of expenditures by the richest expenditure quintile is exempted, whereas 53.6% of expenditures by the poorest quintile is exempted.

In Table **14** I present the average VAT burden for all households before and after the reform along with the Gini index and the Reynolds-Smolensky index[26]. The Gini index remains practically unchanged after the reform takes place in both informality scenarios, which indicates that inequality is not worsened by the change in VAT rates. The more negative Reynolds-Smolensky indices resulting from the reform , on the other hand, indicate that the indirect tax system becomes more regressive. This negative index is a common occurrence for Central American countries **(Cubero and Hollar, 2010)**.

Table 14: Redistributive Measures Before and After VAT Reform

Informality	Scenario	VAT burden	Gini Index	Reynolds-Smolensky Index
With	Pre-reform	0.033	0.352	−0.0000002288
	Post-reform	0.079	0.357	−0.0000006182
Without	Pre-reform	0.081	0.363	−0.0000009815
	Post-reform	0.163	0.362	−0.000001862

Source: ENGIH, own calculations

6 Conclusion

This paper applied three different behavioral microsimulation methods commonly used in the tax reform literature to the Dominican case. The main insight resulting from the personal income tax simulations is that theoretical models designed in the context of European generous tax-benefit systems might not apply in the context of market deficiencies that characterize developing countries and that distort the role of leisure in the specified utility function. Future efforts can be directed to developing specifications that would hold in contexts less ideal than those of developed countries.

The second insight emanating from the personal income tax reform simulation through calibration is that the predominance of informal employment in the poorest quintiles mitigates the impact of a personal income tax reform. I also find that when elasticities of hours with respect to remuneration and with respect to non-labor income are high, inequality is worsened.

[26]The Gini index measures the extent to which distribution of (in this case) consumption departs from a perfectly equal distribution. The Reynolds-Smolensky index measures how income inequality changes in terms of Gini points when a tax is introduced **(Cubero and Hollar, 2010)**.

These results hold after robustness checks through sample bootstrapping are implemented. As much as the results from the discrete choice model are dubious because of a possible unsuitable specification, the elasticities that were employed that also come from European literature might not be the most appropriate. For that reason, it is imperative to stress that the results only constitute an upper bound of possible behavioral responses. An obvious future step for the calibration approach would be to incorporate elasticities from the Latin American literature.

On the other hand, the main insight from the VAT reform simulation is that informality, and not existing exemptions, in the markets of goods and services is the main driver of progressivity in the Dominican VAT system. That means that a reform that increases VAT rates, making all households worse-off, will only significantly worsen inequality if informal market purchases are reduced for everyone or are reduced disproportionally for poorer quintiles. This suggests that if the Government combines VAT rate increases with an effort to reduce informality in the markets of goods and services, poor households would be more negatively affected by the reform.

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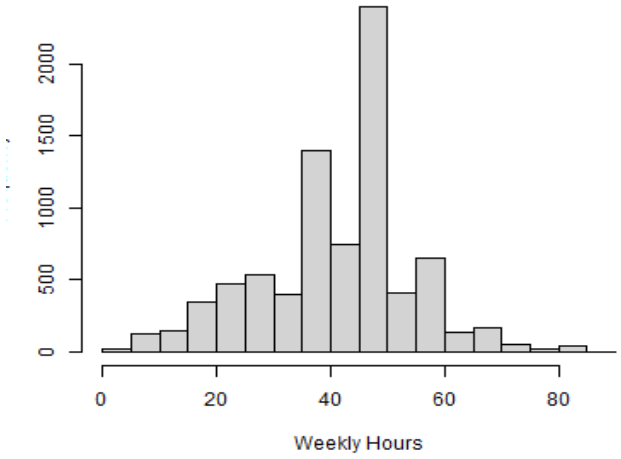
A Histogram of Working Hours of Singles with Full Informality

Figure 4: Weekly hours of work of single informal workers, including self-employed



Source: ENCFT, own calculations

B Heckman Selection Model

Table 15: Estimation results of wage regressions for singles: log of hourly wage as the dependent variable.

Regressors	Single males		Single females	
	Coefficient	Std. error	Coefficient	Std. error
Probit selection equation				
Intercept	-6.1299^{***}	0.1200	-6.6627^{***}	0.1487
Age	0.2911^{***}	0.0048	0.2996^{***}	0.0067
Age^2	-0.0032^{***}	0.0001	-0.0035^{***}	0.0001
Urban	-0.1182^{**}	0.0364	0.0783^{*}	0.0365
NL_Income	-0.0003^{***}	0.0000	-0.0004^{***}	0.0000
East	0.4639^{***}	0.0.0421	0.1975^{***}	0.0399
Cibao	0.3627^{***}	0.0526	0.1480^{**}	0.0486
Prim Educ	0.7020^{***}	0.0769	0.7023^{***}	0.0844
Sec Educ	1.0155^{***}	0.0776	0.9873^{***}	0.0847
Univ Educ	0.8297^{***}	0.0872	1.2438^{***}	0.0866
Children	0.6892^{*}	0.3085	0.1323^{***}	0.0321
Child_O6	-0.1067	0.3763	0.1415^{*}	0.0655
Outcome equation				
Intercept	5.0318^{***}	1.5035	4.0268^{***}	0.7443
Age	-0.0705	0.0584	-0.0156	0.0285
Age^2	0.0010	0.0007	0.0003	0.0003
Prim Educ	-0.7711^{*}	0.3238	-1590	0.2082
Sec Educ	-0.7240^{*}	0.35338	-0.0097	0.2143
Univ Educ	0.0443	0.3592	0.7910^{***}	0.2218
Urban	0.3911^{**}	0.1326	-0.1185	0.0689
East	-0.0588	0.1827	0.498	0.0808
Cibao	0.2334	0.2088	0.0973	0.0943
Inv Mills Ratio	-0.8258^{*}	0.3429	-0.3520^{**}	0.1320
Sigma	3.5583	.	1.7343	.
Rho	-0.2321	.	-0.2030	.
Note:			*p<0.1; **p<0.05; ***p<0.01	

C Robustness check: ϕ

Table 16: Robustness check for ϕ: low-elasticities scenario

Quintiles	Avg. Change in Disposable Income	Std. Error	95% Lower	95% Upper
1	-0.004	0.00003	-0.004	-0.004
2	-0.017	0.0001	-0.017	-0.017
3	-0.020	0.0001	-0.020	-0.020
4	-0.023	0.0001	-0.023	-0.023
5	-0.028	0.00004	-0.028	-0.028

Source: ENCFT, own calculations

Table 17: Robustness check for ϕ: medium-elasticities scenario

Quintiles	Avg. Change in Disposable Income	Std. Error	95% Lower	95% Upper
1	-0.003	0.00002	-0.003	-0.003
2	-0.015	0.0001	-0.015	-0.015
3	-0.017	0.00005	-0.017	-0.017
4	-0.019	0.00004	-0.019	-0.019
5	-0.024	0.00003	-0.024	-0.024

Source: ENCFT, own calculations

D Redistribution Performance without Informality

Table 18: Redistribution performance of tax reform without informality: low-elasticities scenario. Expressed in values per adult equivalent (adult equivalent = square root of household size)

Quintile	Avg. Change in Gross Income	Avg. Change in Disposable Income	Avg. Change in Net Tax
1	0.0001	−0.014	-
2	0.004	−0.039	-
3	0.005	−0.044	0.004
4	0.005	−0.047	0.048
5	0.005	−0.051	0.223

Table 19: Redistribution performance of tax reform without informality: medium-elasticities scenario. Expressed in values per adult equivalent (adult equivalent = square root of household size)

Quintile	Avg. Change in Gross Income	Avg. Change in Disposable Income	Avg. Change in Net Tax
1	0.004	−0.012	-
2	0.010	−0.033	-
3	0.012	−0.037	0.004
4	0.013	−0.039	0.049
5	0.014	−0.043	0.229

Source: ENCFT, own calculations

Source: ENGIH, own calculations

E Measurement of Informal Consumption

For 31 countries, **Bachas et al. (2020)** create a criteria for determining purchases realized in the informal economy, as this information is not usually available in expenditure surveys. The authors classify expenditures by place of purchase by assigning each to one of five categories of goods: (1) non-market consumption (domestic production), (2) non-brick-and-mortar stores (public markets, street stalls), (3) corner and convenience stores, (4) specialized stores

Table 20: Informal Store Types Classifications

Bachas et al. (2020) Classification	Informal Store Types
Non brick-and-mortar stores	Parking
Non-market consumption	Households
Non-market consumption	Neighborhood councils
Non brick-and-mortar stores	Flea markets
Non brick-and-mortar stores	Street markets
Corner and convenience shops	Tailors
Non brick-and-mortar stores	Fried chicken vendors
Non brick-and-mortar stores	Milk sellers
Non brick-and-mortar stores	Chicken stalls
Non brick-and-mortar stores	Empanadas stalls
Corner and convenience shops	Tire shops
Corner and convenience shops	Shoes repairs
Corner and convenience shops	Beauty salons and barber shops
Corner and convenience shops	Secondhand clothing markets
Non brick-and-mortar stores	Street vendors
Non brick-and-mortar stores	Coal sellers
Non brick-and-mortar stores	Firewood sellers
Non brick-and-mortar stores	Fruit stalls
Service provided by an individual	Particular individuals

Source: Own classification

and (5) large stores (department stores, supermarkets). These categories are ranked in a descending order by probability of informality. There are two additional categories for services: (1) services provided by an institution and (2) services provided by an individual. Their key assumption, which they test for, Cameroon, Mexico, Peru and Rwanda, is that the smaller the retailer, the higher their probability of participating in the informal economy. This is further supported by theoretical findings, such as **Kleven et al. (2016)** and **Hsieh and Olken (2014)**.

Following **Bachas et al. (2020)** methodology, the expenditures realized in the store types in Table **20** are deemed untaxed in the empirical application to the Dominican case.

For the ENGIH 2018, after applying this methodology, I assume that 53.2% of total expenditures are conducted in the informal market. The proportion of informal expenditures is, as expected, higher in the poorests quintile of households. When measured both in quintiles of expenditures, Table **21** shows that the first quintile realizes 66.1% of its expenditures in the informal market and this proportion steadily declines and reaches 38.8% of the expenditures of the fifth quintile. These figures remain practically unchanged when measured by quintiles

of income and are consistent with **Bachas et al. (2020)** values for other countries. For instance, the informal budget share falls from 90% for the poorest decile of households to 70% for the richest ones for Rwanda, while for Mexico, these figures go from 55% to 25%. This indicates that the Dominican Republic also shows a downward-sloping informality Engel curve, that is, the budget share for informal goods and services declines with household income.

Table 21: Informal Budget Shares by Expenditure Quintiles

Quintiles	Informal Share
1	0.661
2	0.594
3	0.537
4	0.483
5	0.388

Source: ENGIH, own calculations

When considering informality by consumption group and quintiles of expenditure, as seen in Table **22** it is evident that for most consumption groups, downward-sloping informality Engel curves persist. Notable exceptions are Alcohol and Tobacco and Restaurants and Hotels, among others.

Table 22: Informal Budget Shares by Consumption Groups and Expenditure Quintiles

Groups	Quintiles				
	1	2	3	4	5
Food and Beverages	0.918	0.921	0.879	0.847	0.711
Alcohol and Tobacco	0.254	0.307	0.358	0.441	0.431
Clothing	0.309	0.302	0.271	0.248	0.207
Housing and Utilities	0.296	0.302	0.330	0.345	0.348
Furnishings	0.775	0.653	0.544	0.452	0.405
Health	0.057	0.051	0.052	0.055	0.042
Transportation	0.023	0.027	0.032	0.035	0.056
Communication	0.112	0.167	0.157	0.156	0.139
Entertainment	0.066	0.111	0.114	0.104	0.087
Education	0.174	0.310	0.349	0.342	0.277
Restaurants and Hotels	0.715	0.767	0.795	0.792	0.745
Diverse Goods and Services	0.508	0.443	0.403	0.377	0.335

Source: ENGIH, own calculations

F Income Elasticities in the AIDS Model

Table 23: Income Elasticities

Food and Beverages	0.769	Transportation	1.454
Alcohol and Tobacco	1.250	Communication	1.282
Clothing	1.086	Entertainment	1.401
Housing and Utilities	0.926	Education	1.349
Furnishings	1.232	Restaurants and Hotels	0.519
Health	1.217	Diverse Goods and Services	0.991

Source: ENGIH, own calculations