Is the Belgian income tax system inefficient ? An inverted optimal taxation approach.

Author : Antoine GERMAIN

Thesis Director : Prof. François MANIQUET

Thesis Joint Director : Prof. Nicola PAVONI

Reader : Prof. Jean HINDRIKS

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Université catholique de Louvain - Economics School of Louvain - Place Montesquieu 3, 1348 Louvain-La-Neuve
Université de Namur – Economics School of Namur – Rempart de la Vierge 8, 5000 Namur
Università Commerciale Luigi Bocconi• Via Roberto Sarfatti, 25 • 20136 Milano - Italy

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Master Thesis

Is the Belgian income tax system inefficient ? An inverted optimal taxation approach.

Antoine Germain*

under the supervision of Prof. F. Maniquet† and Prof. N. Pavoni‡

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Abstract

The present thesis investigates the Pareto efficiency of Belgian labor income tax system. More precisely, we use the Saez (2002) model to retrieve social preferences from the existing tax-benefit system and we check whether the implicit marginal social welfare weights are positive along the income distribution. The estimation is run on a subpopulation of childless singles with a recent dataset for several relevant labour supply elasticity scenarios. The results suggest that either the labour income tax-benefit system is inefficient or participation elasticities are much smaller than what the literature has documented.

*Bocconi/ESL. antoine.germain@student.uclouvain.be

†CORE, UCLouvain.

‡IGIER and IFS. Department of Economics, Università Bocconi.

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1 Introduction

There exist secular debates in our societies regarding the way tax policies and social assistance should be designed. The rather large diversity of opinions on these matters seems to suggest that most of them could not be easily reconciled. Economists have tried to study these phenomena for a long time but some developments in public economics have paved the way for a fruitful treatment of these topics.

In particular, the optimal taxation theory founded after the seminal contribution of Mirrlees (1971) has brought a considerable amount of results of primary relevance to these issues (see e.g. Diamond (1998), Guesnerie (1995), Saez (2001)). The traditional approach in that field consists in deriving an optimal tax schedule for a utilitarian planner that observes pretax earnings rather than productive skills under budget and incentive-compatibility constraints. Nonetheless there has been a growing dissatisfaction with this utilitarian approach[1] from which several departures have been attempted (Piketty & Saez, 2013).

Still the most common approach in that literature remains the computation an optimal tax formula as the result of a maximization of some social welfare function for a distribution of skills. However this leads to an optimal tax prescription whose practical relevancy has often been limited, because the distance between observed and optimal tax systems seems prohibitive. For example Sadka (1976) and Seade (1977) showed in a Mirrleesian setup that the optimal marginal tax rate on the highest income should be zero if the income distribution is bounded - which of course far from observed policies (Diamond, 1998).

Besides, a recent body of that literature following Bourguignon and Spadaro (2012)[2] has raised a dual approach that eases the study of existing tax systems rather than their idealized versions. It consists in flipping the common reasoning to raise the following question: once we know the distribution of skills, for which social welfare function is the status-quo tax system optimal?

In practice, this requires to invert an optimal tax formula to retrieve the marginal

[1]The utilitarian approach : (a) provides policy prescriptions but neglects fairness principles on which peoples' opinions (Alesina & Giuliano, 2011) and tax policies are typically based ; (b) assumes an arguably unrealistic homogeneity of preferences that exempts from the difficult issue of interpersonal utility comparisons. For (a), Saez and Stantcheva (2016) suggest a generalization of the planner's objective while Fleurbaey and Maniquet (2018) adapt the social welfare function to several fairness principles. With respect to (b), Fleurbaey and Maniquet (2006), Jacquet et al. (2013), Kroft et al. (2020), Lockwood and Weinzierl (2015) have all incorporated heterogeneity along several dimensions

[2]There has been a *pre-history*, i.e. a literature before Bourguignon and Spadaro (2012) exploring a related approach among which we may mention Ahmad and Stern (1984), Amiel et al. (1999), Choné and Laroque (2005), Christiansen (1977), Christiansen and Jansen (1978), Decoster and Schokkaert (1989), Drèze and Stern (1987), Madden (1995), Mera (1969), Moreh (1981), Pfingsten and Schneider (1994), Ross (1984), Stern (1977).

social welfare weights[3] at each income level. Diamond (1998), Jacquet et al. (2013), Saez (2001, 2002) have all proposed formulas that can be fruitfully inverted provided that one can estimate taxpayers' behavioral responses, which are commonly captured by the labour supply elasticities[4]. This inversion yields a pattern for marginal social welfare weights conditional on these elasticities, which is of primary curiosity as it reflects the social preferences embodied in the actual tax system.

Then, one can study these weights and check whether they satisfy two desirable properties : they are (a) positive and (b) decreasing everywhere. Indeed this non-negativity requirement on weights is a necessary condition for the Pareto efficiency of the underlying tax system as it implies that the tax-deduced social welfare function is non-decreasing with the level of skills[5]. The second condition echoes the fact that the tax system values the redistribution from high- to low-earners such that it reflects to some extent the fairness of that system[6].

The present thesis pursues this inverse-optimum approach, thereby following Bourguignon and Spadaro (2012), to evaluate the Pareto efficiency of the social preferences induced from the Belgian income tax-benefit system. It is important to recall that the Pareto efficiency is a normative criterion that the vast majority of economists consider as desirable for a tax system. In fact when it is not met, it implies that one could improve the condition of at least one individual while leaving all the others unaffected. Therefore we shall also deem it desirable as it relies on a unanimity principle[7].

However one should also note that we do not need to assume that the government is optimizing a social welfare function to design its tax-benefit system in order to study whether that system is efficient. Indeed our analysis is mainly positive[8] as it aims at identifying whether or not the current tax system is efficient. Then, as pointed out by Stantcheva (2016) in her thoughtful comments on Lockwood and Weinzierl (2016), in-

[3]The marginal social welfare weight on an individual reflects the value that the society attaches to giving an additional euro to her. Therefore the variation of these weights across individuals measures the society's tastes for redistribution. Moreover it corresponds in part to the first derivative of the social welfare function in a Mirrlesian setup. See Saez and Stantcheva (2016) for a brilliant exposition.

[4]These quantities reflect the changes in the amount of labour supplied by workers when their wages increase, such that an optimal tax formula typically prescribes that the tax rate should increase when these elasticities decrease.

[5]Equivalently, Bourguignon and Spadaro (2012), Laroque (2005), Werning (2007) showed that the non-negativity condition implies that the tax rate does not exceed the Laffer bound, i.e. the revenue-maximizing tax rate of the Laffer curve.

[6]However it is known since the beginning of the inverse-optimum approach that (b) is sensitive to the different cardinalization of utility used by the researcher. In the remainder of this thesis, we put aside these fairness considerations to concentrate on efficiency.

[7]Nonetheless it must be recalled that this criterion is silent when it comes to compare two efficient situations (see Maniquet (2012) for a discussion) such that our approach is complementary to the literature on fairness in optimal taxation (see Fleurbaey and Maniquet (2018) for a review).

[8]It could also become normative as a direct consequence of the positive analysis is the search for a Pareto-improving tax reform. An epistemological review of the combinations of positive and normative aspects in economics can be found in Maniquet (2018)

ferring normative implications from positive policies[9] can only be done under a set of crucial hypotheses. First, the government should design its tax-benefit system as the Mirrleesian theory predicts, that is using an optimal tax formula. Second, public policies should adequately reflect people's opinions[10]. Third, the government should use the same labour supply elasticity estimates as the econometrician. Hence a failure to obtain well-behaved implicit social preferences implies either that common assumptions on their shape are improper, or that (at least) one of these three hypotheses is wrong - which in both cases entails useful information.

This inverse-optimum procedure was used *inter alia* by Blundell et al. (2009) to compare the German and the British tax system for lone mothers and by Bourguignon and Spadaro (2012) who provide pieces of evidence against a Paretian French income tax system. Besides, this approach is not restricted to the study of Pareto-improving tax reforms as the implicit social preferences can be used to evaluate the welfare costs of US business cycles (Lockwood & Weinzierl, 2016) or to bring to light Dutch political parties' tastes (Jacobs et al., 2017). Another recent[11] application (Hendren, 2020) constructs a measure for the Kaldor (1939) - Hicks (1940) efficiency criterion to compare income distributions across countries.

In our view, the case of Belgium is of particular interest as it is a country that traditionally combines relatively generous demogrant transfers with a relatively high level of taxation (see OECD (2016)). Moreover it is characterized by a progressive but rapidly increasing tax scheme such that a rather large fraction of the labour force hits the highest income bracket. In addition to that, the taxes and benefits regulations in Belgium are often numerous and complex, such that the holistic viewpoint offered by the optimal taxation theory is welcome.

In order to retrieve marginal social welfare weights induced by the Belgian income tax-benefit system, we invert the Saez (2002) model and then we perform the estimation using the MEqIn dataset which contains survey data on Belgian households in 2016. The computations are run for the subpopulation of childless singles and are presented as a function of labour supply elasticity scenarios which have been constructed on a thorough review of the relevant literature.

Our results extend those obtained in the cross-country comparisons of Bargain, Dolls,

[9] In other words, inferring the tax-deduced social preferences as the actual preferences of the government and the voters.

[10] Lockwood and Weinzierl (2016) argue that income taxation has a leading place in public debate such that the discrepancy between voters' expectations and actual tax system should be small. Thus an interesting political economics undertaking would be to compare our results with empirical and survey data on social preferences (in the spirit of Singhal (2008)). See Gaertner and Schokkaert (2012) for a review of the empirical social choice literature.

[11] Recent work also includes Bargain and Keane (2010), Lorenz and Sachs (2016), Petersen (2007) for the Irish, the German, and the Danish case, respectively. Bargain, Dolls, et al. (2014) and Spadaro et al. (2015) propose an international comparison.

et al. (2014) and Spadaro et al. (2015)[12] by enlarging the scope of benefits considered while having a more robust inference at the bottom of the income distribution. In particular both studies have obtained unrealistic estimates for the employment rate in Belgium such that their marginal social welfare weights are likely to be biased.

Our study amends the literature in a number of ways. First, our approach confirms that the Belgian planner values redistribution from earners to non-earners. Second, we found that either the Belgian labour income tax-benefit system is inefficient or the participation elasticity of low-income workers is smaller than commonly estimated by the literature. In particular we found that, for reasonable values of remaining parameters, the extensive elasticity of low-income workers must be smaller than 0.14 for the tax-benefit system to be Pareto efficient. Third, we document that in some instances the variance of labour supply elasticities across income groups can be more important than their mean level in the determination of marginal social welfare weights.

Section 2 presents the relevancy of Saez (2002) for our purposes. Section 3 details the empirical strategy and provides an in-depth review of the literature on labour supply elasticity to build relevant scenarios. Section 4 discusses the results, their limitations, and performs various robustness checks while section 5 concludes.

2 The model

2.1 Motivations

We have opted for the inversion of the optimal tax model *à la* Saez (2002) rather than the continuous models of Diamond (1998), Saez (2001) or Jacquet et al. (2013)[13]. While they all have in common to express optimal tax formulas as a function of estimable elasticities in a second-best setting, our choice is motivated by at least three arguments.

First, Diamond (1998) and Saez (2001) originally capture labour supply reactions along the intensive margin only, while Saez (2002) and Jacquet et al. (2013) embed both hours-of-work responses and labor market participation decisions. This is particularly relevant because the empirical labour economics literature has stressed the importance of the participation elasticites (see for example Heckman (1993)) in labour supply decisions. Moreover these two models allow the labour supply elasticity to vary with income, and numerous pieces of evidence[14] suggest that participation elasticities are typically higher at the bottom of the income distribution for singles.

[12]These studies found some pieces of evidence supporting that Belgium might have experienced non-concave social welfare function that would rationalize the relatively high tax burden supported by low-income workers. Both of these studies were performed in a European context, thereby restricting the range of country-specific taxes and benefits considered.

[13]Doing so, we follow Bargain, Dolls, et al. (2014), Bargain and Keane (2010), Blundell et al. (2009), Spadaro et al. (2015) amongst others.

[14]Among them we may mention Bargain, Dolls, et al. (2014), Decoster et al. (2010b), Eissa and Liebman (1996), Immervoll et al. (2007), Juhn et al. (1991), Meghir and Phillips (2010)

Second, inverting the Saez (2002) model requires less assumptions than the inversion of a continuous model of optimal taxation. Indeed Bourguignon and Spadaro (2012) and Jacobs et al. (2017) typically assume a stronger restriction on the utility function[15] to estimate the distribution of unobserved productivities from actual earnings when they invert Diamond (1998) and Jacquet et al. (2013) models, respectively. In order to avoid that, Lockwood and Weinzierl (2016) invert the continuous model of Saez (2001) and assume that the *virtual*[16] income density corresponds to the actual earnings distribution. On the contrary the discrete model of Saez (2002) only depends on the assumption that there is no income effect[17].

Third, any dataset is in essence discrete. Hence if one opts for a continuous model, one has to use kernel-smoothing techniques (Bourguignon & Spadaro, 2012) or one should approximate the income distribution with statistical laws (typically a Pareto distribution as done in Jacobs et al. (2017) and in Hendren (2020)) in order to match the data. Conversely in the Saez (2002) the researcher has to define the number of income brackets to consider. Therefore the continuous approach is likely to be more promising with large dataset (such as administrative dataset) while discrete models could be more convenient for survey data, which reinforces our program.

Nonetheless these perks have to be tempered with the increased arbitrariness implied by this partitioning of the data into a discretionary number of income brackets[18]. Moreover selecting the Saez (2002) reduces our scope to a one-dimensional heterogeneity (which is arguably unrealistic as discussed above). However Hendren (2020) showed that the inverse optimum approach fails when there remains heterogeneity conditional on income[19]. Therefore in accordance with the existing literature we will focus on a homogeneous subpopulation, namely childless singles, when performing the estimation of the inverted optimal taxation model (see section 3.1).

2.2 The Saez (2002) inverted model

Consider the case where there exists a unit mass of agents with heterogeneous and unobserved productive skills distributed following $\psi(i)$ and a finite set of possible (gross) earnings level $z_0 = 0 < z_1 < z_2 < .... < z_N$.

Individual i chooses her occupation $n = 0, 1, ..., N$ and her disposable income c_n through a standard utility maximization program (UMP) :

$$\max_{n} u_i(c_n; n) \qquad \text{s.t. } c_n = z_n - T(z_n) \tag{1}$$

[15]Namely, isoelastictiy with respect to labour supply.

[16]In the Saez (2001) model, the virtual earnings density corresponds to the one that would be obtained if the tax code was linearized locally. Therefore assuming that the *virtual* corresponds to the *actual* income density only makes sense if individuals actually face a linear tax schedule.

[17]In the next subsection, we prove this claim and we provide empirical support for that assumption.

[18]Bearing that in mind, we will select the largest number of income brackets provided that the number of observations in each category is sufficient for a meaningful inference.

[19]Intuitively, this is due to the fact that two different individuals at the same earning level could have different welfare weights in such a setting. See Hendren (2020)-Appendix D for a discussion at length.

It must be noted that $T(z_n)$ stands for the net tax supported by the individual, which is the difference between all labour income taxes she pays and all the benefits that she receives. Therefore it can - and it will - be the case that this amount takes negative values for some n. As a consequence, our analysis can only give results on the tax-benefit system - and not solely the labour tax code itself - as taxes and transfers are fully integrated in the framework.

The indirect utility function is denoted by v_i and is such that the individual earns c_n^* given her optimal occupation choice $n \in \{0, 1, ..., N\}$. For a tax schedule $T(z)$ and this UMP we denote by $h_n(c_0, c_1, ..., c_N)$ the fraction of individuals that choose occupation n. The problem for the Mirrleesian government reads :

$$\max_{T(z)} \int_i \omega_i G[v_i] d\psi(i) \quad \text{s.t.} \sum_{n=0}^{N} h_n T(z_n) = E$$

where G() is an increasing transformation of utilities, ω_i corresponds to the Pareto weight on individual i and E denotes the exogenous government budget constraint. This is a standard constrained maximization problem that one can solve with the method of Lagrange multipliers[20].
The Lagrangian for the government's problem is :

$$\mathcal{L} = \int_i \omega_i G[v_i] d\psi(i) + \lambda \left[\sum_{n=0}^{N} h_n T(z_n) - E \right]$$

where λ is a standard Lagrange multiplier on the government budget constraint.
The first-order condition with respect to $T(z_n)$ reads :

$$\int_i \omega_i G'[v_i] \frac{\partial u_i(c_n; n)}{\partial c_n} d\psi(i) = \lambda \left[h_i - \sum_{j=0}^{N} T(z_j) \frac{\partial h_j}{\partial c_n} \right]$$

This can be rearranged to get the Saez (2002) first-order condition for the optimum:

$$(1 - g_n) h_n = \sum_{j=0}^{N} T(z_j) \frac{\partial h_j}{\partial c_n} \tag{2}$$

$$\text{with } g_n = \frac{1}{\lambda h_n} \int_{i \in \text{job } n} \omega_i G'(v_i) \frac{\partial u_n(c_n; n)}{\partial c_n} d\psi(i) \tag{3}$$

where g_n denotes the marginal social welfare weight averaged among the individuals of occupation n. It is of interest to note that equation (3) implies that g_n corresponds to the euro value in terms of public fund of giving an additional euro to one individual of group n.

[20] See Mas-Colell et al. (1995)(p.956-964) for a theoretical exposition of the method of Lagrange multipliers.

It is typically assumed that there is no income effect so that the aggregate labour supply only displays substitution effects[21]. In other words, this essentially means that workers do not decrease the amount of labour they supply when wages increase. This is a widespread assumption in both the theoretical and the empirical optimal taxation literature (see e.g. Atkinson (1996), Diamond (1998)). Moreover Bargain, Dolls, et al. (2014) find that the income elasticity with respected to hours worked in their sample is virtually zero in most countries, including Belgium in 1998. This provides some micro-foundations for that assumption that we will keep for the remainder of this thesis, which has two important consequences for our analysis.

First, an increase for all income brackets by a constant amount R does not affect the occupational choice distribution such that we have $h_j(\underline{c}+R) = h_j(\underline{c})$ for any row vector R. Hence $\sum_n \frac{\partial h_j}{\partial c_n} = 0$ and summing (2) over all income groups results in a useful normalization :

$$\sum_{n=0}^{N} g_n h_n = 1 \tag{4}$$

Second, when both extensive and intensive labour supply responses are considered such that the occupation choice of an individual lies between n, $n+1$, $n-1$ or being unemployed $n = 0$, we can write $h_n(c_n - c_0; c_n - c_{n-1}; c_{n+1} - c_n)$ and (2) implies the optimal tax formula in proposition 1.

Proposition 1. (Saez, 2002) When both extensive and intensive labour supply responses are considered and income effects are assumed away, the optimal tax formula reads :

$$\frac{T(z_n) - T(z_{n-1})}{c_n - c_{n-1}} = \frac{1}{h_n \nu_n} \sum_{j=n}^{N} h_j \left[1 - g_j - \xi_j \frac{T(z_j) - T(z_0)}{c_j - c_0} \right] \quad \text{for } n = 1, ..., N \tag{5}$$

where ξ_n denotes the extensive elasticity and ν_n is the intensive elasticity :

$$\xi_n \equiv \frac{c_n - c_0}{h_n} \frac{\partial h_n}{\partial c_n - c_0} \qquad \nu_n \equiv \frac{c_n - c_{n-1}}{h_n} \frac{\partial h_n}{\partial c_n - c_{n-1}} \tag{6}$$

Proof. [22] If the premise holds we have $h_n(c_n - c_0; c_n - c_{n-1}; c_{n+1} - c_n)$. and (2) reduces to:

$$(1 - g_n) h_n = T_n \frac{\partial h_n}{\partial c_n - c_0} + T_0 \frac{\partial h_0}{\partial c_n - c_0} - T_{n+1} \frac{\partial h_{n+1}}{\partial c_{n+1} - c_n} - T_n \frac{\partial h_n}{\partial c_{n+1} - c_n} + T_n \frac{\partial h_n}{\partial c_n - c_{n-1}} + T_{n-1} \frac{\partial h_{n-1}}{\partial c_n - c_{n-1}}$$

[21] It must be noted that Bourguignon and Spadaro (2012) also invert a model that embeds income effects, such that the inverse optimum approach does not hinge crucially on that assumption.
[22] Freely adapted from Saez (2002). In this proof we use $T_n = T(z_n)$ for notation convenience.

Observing that $\frac{\partial h_{n+1}}{\partial c_{n+1}-c_n} = -\frac{\partial h_n}{\partial c_{n+1}-c_n}$ we can write:

$$(1-g_n)h_n = (T_n - T_0)\frac{\partial h_n}{\partial c_n - c_0} - (T_{n+1} - T_n)\frac{\partial h_{n+1}}{\partial c_{n+1} - c_n} + (T_n - T_{n-1})\frac{\partial h_n}{\partial c_n - c_{n-1}}$$

Using the definitions of elasticities in (6) and rearranging one gets:

$$\frac{T_n - T_{n-1}}{c_n - c_{n-1}} = \frac{1}{\nu_n h_n}\left[h_n\left(1 - g_n - \frac{T_n - T_0}{c_n - c_0}\right) - \frac{T_{n+1} - T_n}{c_{n+1} - c_n}\nu_{n+1}h_{n+1}\right]$$

Letting $\gamma_n = \frac{T_n - T_{n-1}}{c_n - c_{n-1}}\nu_n h_n$ we identify a first-order linear difference equation. Solving forward with the transversality condition that $\gamma_{N+1} = 0$ we get :

$$\gamma_n = \sum_{j=n}^{N} h_j\left(1 - g_j - \frac{T_j - T_0}{c_j - c_0}\right)$$

which proves that equation (2) implies (5) if the premise holds. □

This tax formula is particularly useful as it expresses the optimal tax as a sufficient statistic[23] of estimable elasticities. Moreover observe that if $\xi_n = 0$ we obtain a tax formula which is the discrete equivalent of the Mirrlees (1971) - Diamond (1998) formula. It must also be noted that the optimal tax rate on 0-earners in this setting amounts to $T(z_0) = \frac{1}{h_0}[E - \sum_{j=1}^{N} h_j T(z_j)] = -c_0$ and it is non-positive.

Now we isolate g_n in (5) to get the inverted optimal tax formulae (Bourguignon & Spadaro, 2012) for $n = 1, ..., N-1$:

$$g_n = 1 - \xi_n\frac{T(z_n) - T(z_0)}{c_n - c_0} - \nu_n\frac{T(z_n) - T(z_{n-1})}{c_n - c_{n-1}} + \frac{1}{h_n}\sum_{j=n+1}^{N} h_j\left[1 - g_j - \xi_j\frac{T(z_j) - T(z_0)}{c_j - c_0}\right] \tag{7}$$

$$g_N = 1 - \xi_N\frac{T(z_N) - T(z_0)}{c_N - c_0} - \nu_N\frac{T(z_N) - T(z_{N-1})}{c_N - c_{N-1}} \tag{8}$$

One can observe that the marginal social welfare weight for some group decreases with its extensive and intensive elasticities. Moreover an increase in the tax burden lying on that group also decreases the weight attached to it, *ceteris paribus*. Finally a fall in a group's relative size h_n implies that h_j increases for some $j \neq n$ such that both effects have a positive impact on g_n.

[23] The use of sufficient statistics in public economics have been recently reviewed by Chetty (2009)

3 Empirical estimation

3.1 Strategy

Equations (8) for g_N and (7) for g_n with $n = 1, .., N-1$ combined with the normalization in (4) allow us to derive the g_n schedule recursively for $n = 0, ..., N$ through the observations $T(z_n), c_n, \xi_n, \nu_n, h_n$ for each n.

It is worth noting here the issue that might arise from the fact that earnings are essentially collected by the individuals while taxes and (even more) benefits hinge upon households. Hence we shall follow Bargain, Dolls, et al. (2014), Blundell et al. (2009), Bourguignon and Spadaro (2012), Spadaro et al. (2015) in restricting our inverted procedure on a sub-sample of childless singles. This is also coherent with the fact that the aggregation of heterogeneous households sizes into a single social welfare function raises the difficult question of welfare comparison between a single individual and two persons living in couple, for which a normative stance would be required. Moreover childless singles are often subject to the quintessence of a tax-benefit system, while lone parents and couples enjoy additional tax rebates and/or (child) benefits. Hence for our purposes it seems relevant to start by analyzing the system for that subgroup.

We used the MEqIn dataset which contains survey data on after-tax and disposable incomes for a sample of Belgian households in 2016. We aggregated these variables in six groups such that $N = 5$: a group 0 composed by 0-earners and five earnings quintiles among those reporting a strictly positive amount[24]. Of course one has that the larger the number of groups, the better the identification, but this has to be compensated by the fact that the number of observations in each group must be sufficient for inference.

We thus obtained the c_n as the mean level of disposable income in each group. Similarly we get the mean net earnings by group, from which we reconstructed the z_n by applying the fiscal rules applicable for childless singles through a gross/net earnings simulator that applies the official rules for the calculation of the Belgian income tax[25]. That we observe c_n and that we reconstruct z_n exempts from using a microsimulation tool to estimate the benefits received by each households as we compute the net tax $T(z_n) = z_n - c_n$. This contrasts with other studies (e.g. Bargain, Dolls, et al. (2014)) which had to decide which benefits to include in the microsimulation to recover the c_n, and that step was crucial in the context of an international comparison. In that respect we believe that our strategy allows to capture a larger scope of the Belgian tax-benefit system while exonerating from errors and approximations implied by microsimulation.

We further restricted the sample to exclude those whose returns from property (land and capital) exceed 10 percent of their disposable income. Moreover we excluded from the sample students as defined by those spending more than 10 hours per week studying. These two additional restrictions aim at identifying those whose behavioral responses to changes in the income tax-benefit system only depend on these changes, such that mean

[24] The separation in quintiles is chosen so as to minimize the arbitrariness discussed above.

[25] The link is : https://www.attentia.be/fr/outil/corporate/outils-de-simulation

elasticities within-group are meaningful. Indeed a *rentier* whose labour income is relatively small is likely to display significantly different behavioral responses after an income tax increase than a full-time worker who earns her living with her wage.

Finally the gross/net earnings simulator was run for a childless individual using the tax system applicable on the 1^{st} August 2016 in Belgium. This date coincides with the end date of the MEqIn data collection which started in February 2016. We have considered that no individual had experienced a specific tax exemption because of sickness or disability. Moreover, for historical reasons, there exist two tax systems applicable in Belgium depending on the status : either *factory worker* or *salaried worker*. We have computed the gross earnings for each status and then we took the weighted[26] average to get z_n. Observe also that all of our analysis only relates to labour income taxation, thereby ignoring bequest, capital, or commodity taxes[27].

The next table summarizes the sample statistics for our selection[28]. Aside from the relevant quantities for estimation h_n, c_n and z_n, we also report the effective 'marginal' tax rates (EMTR) and the effective participation tax rates (EPTR) faced by group n for $n = 1, ..., 5$. The former is computed by $\frac{T(z_n)-T(z_{n-1})}{z_n-z_{n-1}}$ while the latter is $\frac{T(z_n)-T(z_0)}{z_n-z_0}$[29]. This is a good exercise to check whether our sample yields an inference on taxes that comparable to what other studies have found with different samples.

Table 1: Sample statistics for childless singles, by quintiles

Group	#obs	h_n	c_n	z_n	EMTR	EPTR
G0	75	0.38	1025.24	0.00		
G1	25	0.13	1176.35	577.29	0.74	0.74
G2	25	0.13	1480.12	1813.21	0.75	0.75
G3	24	0.12	1775.96	2778.95	0.69	0.73
G4	25	0.13	2282.08	3586.44	0.37	0.65
G5	24	0.12	3213.77	6387.01	0.67	0.66
$\sum$	198	1				

We obtained the U-shaped pattern in EMTR that was also found in Immervoll (2004). Moreover our EMTR and EPTR estimates are very close to what Bargain, Dolls, et al. (2014) found for Belgium and confirm the high implicit taxation on low-income earners. These figures rationalize the fact that it is costly in Belgium to leave unemployment because the in-work support does not compensate for the exhaustion of means-tested benefits. Of course our estimates are a crude simplification of actual EMTR and EPTR facing Belgian childless singles as we aggregate them into 5 categories. This hides the

[26] We have attached a weight of 60 percent to the *salaried workers* which corresponds to their share in the population. It must be noted that the two regimes differ by a maximum of 77 euros per month in the case of the quintiles definition.

[27] See Golosov et al. (2003) for capital and indirect optimal taxation.

[28] The units for c_n and z_n are euros per month.

[29] Therefore it is natural that the two rates must coincide for $n = 1$

fact that some households experience a 100 percent marginal tax rate (as shown by Maniquet and Neumann (forthcoming-a)). A thorough investigation of the tax burden in Belgium can be found in Decoster et al. (2010a) or in OECD (2016)

3.2 Labour supply elasticities

Many reviews on the estimation of labour supply elasticities exists (see e.g. Bargain and Peichl (2016), Blundell and MaCurdy (1999), Evers et al. (2008)) but most studies ignore childless singles, despite their growing relative importance, and concentrate on couples and lone parents. In addition to that, few studies have been performed on Belgian data. Nevertheless pinning down the labour supply elasticity is of primary importance in our task as an optimal tax prescription is highly sensitive to the elasticity estimate used. For example Diamond and Saez (2011) obtain an optimal marginal top tax rate for the U.S. of 73 percent if the labour supply elasticity is .25 but this rate goes down to 54 percent if the elasticity is .57 .

Moreover it is known in the literature as a source of disagreement among economists as there are significant discrepancies in estimation results across studies (Bargain & Peichl, 2016). Indeed in macroeconomics labour supply elasticity was often calibrated after a general equilibrium model and estimates used to be much larger than what microeconometric studies had found[30]. However recent studies (Chetty, 2012; Chetty et al., 2011; Jäntti et al., 2015; Keane & Rogerson, 2012) suggest that this micro-macro gap might be smaller than previously thought and it seems now widely accepted in the profession that labour supply elasticity cannot be considered anymore as a unique deep structural parameter[31].

Given our purpose and these two arguments we think that the most convincing strategy would be to run our empirical analysis using different elasticity scenarios rather than computing a single estimate from our sample[32]. That way, if some pieces of evidence suggest Pareto inefficiency of the Belgian tax-benefit system even in the case of an extreme scenario, our conclusions would gain in robustness. In addition to that it seems rather implausible that a Mirrlesian government - if it exists- would pinpoint exactly the true elasticity parameters when designing its tax-benefit system, such that presenting results as a function of elasticities could also give hints about the government's beliefs.

In order to construct accurate scenarios we now provide a survey of relevant labour supply elasticity estimates for Belgian singles which significantly updates Bargain and Peichl (2016). The pertinent point estimates obtained in the literature are reported in

[30] In the eighties this was considered as serious difficulty for the field in which the Lucas (1976)'s critique was gaining ground. Hansen (1985) found an elegant solution.

[31] Attanasio et al. (2018) study the aggregate implications of the heterogeneity in labour supply responses at the micro level.

[32] Moreover, relying on cross-sectional variation in hours worked and income in our sample would neglect the endogeneity of wages (Bargain & Peichl, 2016). Indeed it is the case that unobservable personality traits (e.g. hardworking person, etc.) can be correlated with productivity and wages as well as with preferences for work . This violates the exogeneity restriction of the OLS estimator and the Gauss-Markov theorem fails, such that estimates could be biased.

table 2.

It is to be noted that many studies differentiate the labour supply elasticity between males and females. Of course this is of primary relevance in the presence of children or in the case of a couple but it is less obvious for childless singles. We ignore this gender distinction on labour supply elasticity in the remainder of this thesis. This is consistent with the cross-country review of Bargain and Peichl (2016) which shows that estimates for childless singles are usually smaller and display less gender-variation than those for lone parents or couples.

Furthermore most papers only compute extensive and intensive elasticities as a mean level for their whole sample, thereby ignoring the fact that the bottom and the top of the income distribution might display significantly different behavioral responses. In our case, as described above, the model allows without loss of generality our elasticity estimates to be a function of income level (see equations (5) and (6)).

There exists an empirical literature supporting decreasing participation elasticities with income, as initiated by Eissa and Liebman (1996) who found larger extensive responses for less-educated lone mothers and single females using a U.S. tax reform in 1986. Chetty (2012) and Bastani et al. (2020) report such a decreasing pattern with income of extensive elasticities for the U.S. and Sweden, respectively, using quasi-experimental setups. For Belgium an empirical literature based on the discrete-choice approach (see Van Soest (1995)) also substantiates larger extensive and intensive elasticities for the bottom of the income distribution (Bargain, Dolls, et al. (2014) as well as Decoster et al. (2010b)[33], but with a much smaller variance than the former).

[33] For Decoster et al. (2010b) : Except for single females. It must be noted that, for that study, their estimates are run on singles, whether or not they are childless.

Table 2: Labour supply elasticity estimates for Belgium, relevant studies

Study	**Data used**	**Selection**	**Extensive elasticity**	**Intensive elasticity**
Bargain, Dolls, et al. (2014)	PSB 1998	Childless singles	0.35	0.16
Bargain, Orsini, et al. (2014)	PSB 2001	Single woman	0.25	0
	PSB 2001	Single man	0.23	0.03
Capéau et al. (2016)	EU-SILC 2007	Single woman	0.3327	0.1257
	EU-SILC 2007	Single man	0.2895	0.0944
Dagsvik et al. (2011)	NRD 2001	Single man	0.11	0.2
	NRD 2001	Single women	0.07	0.13
Decoster et al. (2010b)	MIMOSI 2009 run on BCSS/KSZ	Single males	0.184	0.239
	MIMOSI 2009 run on BCSS/KSZ	Single females	0.237	0.336
Jäntti et al. (2015)	LIS 1992	All	0.011	/
Vandelannoote and Verbist (2016)	EUROMOD using BE-SILC 2012	Single male	0.22	0.31
	EUROMOD using BE-SILC 2012	Single female	0.36	0.42

Note : PSB is *Panel Survey on Belgian Households*. EU-SILC stands for *European Survey on Income and Living Conditions*. NRD stands for National Register Data. LIS stands for *Luxembourg Income Survey*. MIMOSI and EUROMOD are microsimulation tools. BCSS/KSZ is an administrative data warehouse. Studies performed on Belgian data but reporting results only for couples or lone parents were excluded from the list.

Based on these facts and on the literature review we have constructed 9 elasticity scenarios that we report below in table 3.

Concerning the participation responses our review shows that most point estimates are between .2 and .35. Moreover as discussed above the extensive elasticities tend to be much larger for the bottom of the distribution. Nonetheless Dagsvik et al. (2011) report a point estimate close to .1. Therefore it seems that a pattern assigning .2 for the first group and .1 for the others is a reasonable[34] lower-bound. Furthermore the mean of the estimates for extensive elasticities is around .27 such that we construct a mid-case pattern assigning .35 and .25 for the first two quintiles, respectively, while setting .2 for the other quintiles.

With respect to the intensive elasticity the literature reports values either between .3 and .42 or between .1 and .2. Accordingly we construct a high-case pattern assigning an intensive elasticity of .4 to the first quintile and .3 to the other groups, while the low-case pattern sets .18 and .1 analogously.

Scenario A can be conceived as a benchmark model as it is extracted from the only paper specifically studying *childless* singles in Belgium (Bargain, Dolls, et al., 2014).

Table 3: Labour supply elasticity scenarios for quintiles

Scen.	Elasticity	Group 1	Group 2	Group 3	Group 4	Group 5	Remark
A	Extensive	0.43	0.53	0.25	0.38	0.15	benchmark/
	Intensive	0.43	0.2	0.13	0.07	0.1	benchmark
B	Extensive	0.43	0.53	0.25	0.38	0.15	benchmark/
	Intensive	0.18	0.1	0.1	0.1	0.1	low-case
C	Extensive	0.43	0.53	0.25	0.38	0.15	benchmark/
	Intensive	0.4	0.3	0.3	0.3	0.3	high-case
D	Extensive	0.35	0.25	0.2	0.2	0.2	mid-case/
	Intensive	0.18	0.1	0.1	0.1	0.1	low-case
E	Extensive	0.2	0.1	0.1	0.1	0.1	low-case/
	Intensive	0.43	0.2	0.13	0.07	0.1	benchmark
F	Extensive	0.2	0.1	0.1	0.1	0.1	low-case/
	Intensive	0.18	0.1	0.1	0.1	0.1	low-case
G	Extensive	0.2	0.1	0.1	0.1	0.1	low-case/
	Intensive	0.4	0.3	0.3	0.3	0.3	high-case
H	Extensive	0	0	0	0	0	intensive-
	Intensive	0.43	0.2	0.13	0.07	0.1	only
I	Extensive	0.43	0.53	0.25	0.38	0.15	extensive-
	Intensive	0	0	0	0	0	only

Note: the last column shows the combination of extensive/intensive patterns to yield a scenario.

[34]By reasonable, we mean that, given the current state of labour supply elasticity literature, it would not make much sense to consider scenarios with smaller quantities.

4 Results

4.1 Discussion

In table 4 we present the results of our empirical estimation as a function of elasticity scenarios.

Table 4: Marginal social welfare weight by group, as a function of elasticity scenarios, for quintiles.

Scenario		A	B	C	D	E	F	G	H	I
n	h_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n
Group 0	0.38	2.88	2.64	2.85	2.17	1.90	1.67	1.87	1.40	2.47
Group 1	0.13	**-0.81**	**-0.41**	**-0.42**	**-0.19**	**-0.16**	0.24	0.23	0.40	**-0.21**
Group 2	0.13	**-0.91**	**-0.67**	**-0.85**	0.16	0.37	0.61	0.43	0.67	**-0.58**
Group 3	0.12	0.07	0.16	**-0.17**	0.30	0.48	0.57	0.24	0.75	0.32
Group 4	0.13	0.45	0.43	0.69	0.76	0.97	0.95	1.21	1.15	0.30
Group 5	0.12	0.51	0.51	0.11	0.42	0.61	0.61	0.21	0.80	0.71

Note : Values in bold indicates a marginal social welfare weight strictly negative

A first observation is that our results are qualitatively similar to those obtained by Bargain, Dolls, et al. (2014), Spadaro et al. (2015) for Belgium. In particular our estimates confirm that the Belgian tax-benefit system assigns a relatively high marginal social welfare weight to the group of zero-earners, which rationalizes the relatively generous social assistance program in Belgium reflecting that redistribution from earners to non-earners is valued.

A notable difference between these previous studies and ours lies in the size of the group 0 which is $h_0 = .38$ in our sample while it fluctuates from 7 to 20 percent in other studies. We consider our estimate to be more relevant as the group of zero-earners is the complement of the employed labour force such that the sum of h_0 and the employment rate should be around 1. The employment rate oscillated between 60 to 65 percent (depending on the demographic subgroup considered) in Belgium in 2016 which suggests that our inference at the bottom of the income distribution is more robust than the cross-country studies cited above.

Our estimates display negative marginal social welfare weights for the first group in scenario A, B, C, D, E and I. Another way to read this result is that the only ways for the marginal social welfare weight to be positive for group 1 are either the absence of participation responses (scenario H) or the lower-bound scenario for extensive elasticities (in F and G). This suggests that either participation responses are much lower than what most of the literature has documented or the government maximizes a non-Paretian social welfare function.

The importance of labour supply responses along the extensive margin in our results cannot be underestimated and is apparent in scenario I : even in the case where intensive responses are null (close to what Bargain, Orsini, et al. (2014) have estimated) one gets negative weights on the first two groups. Conversely when one ignores participation responses (scenario H) the Pareto inefficiency result no longer holds. Of course, none of these two scenarios are plausible empirically but solely of theoretical interest.

A peculiarity apparent in our findings lies in the fact that scenario E conveys a negative social weight for group 1 while it is positive in scenario G. Both scenarios adopt the lower-bound pattern for extensive elasticity such that the only difference lies in the intensive elasticity profile. In fact the hours-of-work responses are also similar for group 1 while their mean level across groups are larger in the G scenario (0.32 versus 0.19). This is counter-intuitive as in general larger elasticities are associated with smaller social weights *ceteris paribus*. The explanation lies in the variance rather than the mean : scenario E display a dramatic decrease in hours-of-work responses as income increases while scenario G postulates a smoother decline. This is a new finding with respect to the literature which suggests that the cross-sectional variance of labour supply elasticities can be even more important than their mean level in the determination of marginal social welfare weights. This should incentivize future research in empirical labour economics to account for differential responses depending on income rather than reporting a mean level for a whole sample.

It is also interesting to note that we estimate a marginal social welfare weight for the fifth group close to zero in scenario C. Our inference at the top of the income distribution is likely to be biased for at least two reasons. First, the variance of disposable income and of earnings is much larger in that group, rationalizing the fact that the income distribution is skewed to the right. Second, our analysis only focuses on income taxation, and *rentiers* have been excluded from the sample, while most of the tax burden for the top of the income distribution lies in capital taxation. Both of these facts imply that in our framework we are underestimating the taxes paid by high-earners, and hence overestimating their marginal social welfare weight (Stantcheva, 2016).

Now a natural extension of these results could be to wonder which elasticities or which tax level yield a Pareto efficient tax-benefit system in our framework. That is, if we fix all the parameters to the benchmark model (scenario A) where groups 1 and 2 carry negative social weights, which changes induce a Paretian system[35] ?

Setting all others parameters constant in the benchmark, it appears by *tâtonnement* that the participation elasticities should be lower than .14 and .22 for groups 1 and 2, respectively, in order to yield positive weights everywhere. Conversely we could not find any intensive elasticity profile with positive values for which the tax-benefit system is efficient, *ceteris paribus* (see scenario I).

Similarly if the government wants to get a Pareto efficient tax-benefit system, it can

[35] Of course these quantities should be taken with the appropriate cautiousness because they rely on a benchmark-deviation analysis. In reality, the *ceteris paribus* is likely to fail such that these quantities should be seen as a hint about the magnitude rather than about the actual design of a Pareto-improving tax reform.

either decrease the taxation lying on group 1 and 2 or increase the taxes lying on the others. However only in the former case one will get a Pareto-improving tax reform. If elasticities correspond to the benchmark, by *tâtonnement* we get that one reform that would achieve this objective yields a reduction of taxes of at least 180, 493 and 163 euros per month for groups 1, 2 and 3 respectively.

These inefficiency results rationalize the relatively high tax burden supported by low-income workers in the Belgian tax-benefit system. Maniquet and Neumann (forthcoming-a) show that Belgium is one of the countries applying a 100 percent marginal tax rate on the lowest income, given that an increase in labour income is fully replaced by an increase in social benefits below some threshold[36]. For these low-earners[37] the financial incentives to work are too small and the optimal taxation theory predicts that relaxing the tax burden on these groups would be beneficial both for the government's revenue and for these households - under the hypothesis that labour supply elasticity are not extreme.

Thus our analysis suggests that there is room for a Pareto-improving tax reform[38]. These results come from the fact that participation responses are crucial in the design of optimal tax system as it is know at least since Saez (2002) and Laroque (2005). Nonetheless it is beyond the scope of this paper to identify precisely the mechanism(s) that the government should introduce for such reform to be successful. Indeed recall that all the analysis is run on a tax-benefit system and not solely on the tax code itself. The appropriate policy mix should be based on complementary studies exploring the labour market effects of social assistance design[39].

4.2 Robustness

The strength of our approach lies in the fact that our only modelling assumption was the absence of income effects, for which we have provided empirical foundations. Moreover our results are presented as a function of labour supply elasticity scenarios which are based on a thorough review of the relevant literature. In addition to that our sample contains observations on disposable income and after-tax income which exempt from microsimulation. The gross earnings were then inferred at the group level by applying the official rules of the tax code with the Attentia simulator[40].

[36]This 100 percent result is computed through the OECD tax-benefit calculator and it holds for childless singles as well as for at least five other types of households : singles with one or two children, and couples with zero, one or two children (see Maniquet and Neumann (forthcoming-b)).

[37]Sometimes referred to as *working poor* although a definition of poverty is missing in our framework.

[38]The study of Pareto-improving tax reform has a long tradition in economics. See for example Wibaut (1987) based on his PhD thesis for a study of Pareto-improving directions in the Belgian tax system written at the CORE, UCLouvain. The methods used there differ significantly from ours, of course, but this thesis can be ascribed to the same tradition.

[39]For example recent work in labour economics have been concentrated on unemployment insurance duration (Kolsrud et al., 2018) and waiting period (Cockx et al., 2020). Blundell and Shephard (2012) showed how one can obtain Pareto-improving tax reforms in an optimal taxation framework using a structural labour supply model.

[40]In fact, the same procedure was done with 5 different simulators and - unsurprisingly - each yields the very same outcome.

Now the first weakness of the Saez (2002) model is that the number of income brackets considered in discretionary. We set $N = 5$ in order to have a sufficient number of observations in each bracket. Thus one might wonder whether our results are robust to a larger set of brackets. Bargain, Dolls, et al. (2014) obtained qualitatively similar results in a deciles and quintiles specification, with the former case adding some noise in the estimates[41].

In order to check that we have run again the very same procedure[42] and have separated those reporting non-zero earnings in eight income brackets of equal size, that is in *octiles*. In appendix A.1 we present the resulting sample statistics and our estimation of marginal social welfare weights as a function of labour supply elasticity scenarios which have been amended to match $N = 8$[43].

Conversely to what we aimed for, the sample statistics show that the h_n differs for each group, ranging from 6 to 11 percent[44]. The reason is that there is bunching at some earnings thresholds such that the program is not able to create groups of equal sizes. Indeed the data is collected through a survey and the respondents are reporting the closest thresholds to their earnings rather than their actual earnings. For example, two people actually earning 2040 and 1980 per month are reporting the earnings level of 2000. One should note that these inequalities in h_n could actually be controlled for with a larger sample size.

This unevenness of income brackets in the $N = 8$ case could have some consequences for the estimation of marginal social welfare weights. Indeed as it is apparent in equation (7) a decrease in group's relative size h_n implies an increase in g_n, for $n = 1, ..., N - 1$, *ceteris paribus*. This means that, in addition to the earnings and elasticities inequalities, the h_n inequality will also drive the variation in marginal social welfare weights across income groups. This is an undesirable feature of the model such that a partitioning that neutralizes the variation in h_n seems more relevant. This reinforces the specification that we set up for the quintiles case.

Moreover the sample statistics in the octiles case show that the EMTR supported by the first group is 135 percent. It comes from the fact that the mean disposable income in group 1 is smaller than in group 0. This estimation should not be taken too strictly for at least two reasons. First, we compute it at the group level, such that it may hide the actual experience of some individuals within the group. Second, our c_n and z_n are computed as the mean for each group such that it is influenced by extreme values. This is important because the earnings range of group 1 is larger than any other group because there is few people making less than the reservation wage.

This effective marginal tax rate above 1 is particularly problematic for our approach. Indeed rather than a bias, this induces that our inversion procedure will be totally in-

[41] Their sample contains 357 observations, versus 198 in ours.

[42] The Stata do-file which we have created to define the samples is provided in appendix B

[43] These amended scenarios are displayed in table 8.

[44] In fact this problem arises in our case $\forall N > 5$.

consistent. That can be seen from the UMP in equation (1). As the disposable income is smaller in group 1 than group 0, any utility-maximizing agent should choose to enter group 0. Hence one should see $h_1 = 0$ but this is not the case, reflecting that some agents might be *irrational*. This means that the UMP does not hold for all agents such that the inversion procedure is inconsistent.

Can it be the case that some individuals are earning more by staying out of work rather than by entering the labour market ? Of course, as the unemployment benefits can be a function of the last wage such that they may exceed the earnings that one would get by taking up a low-paid job. Now, is it irrational for low-earners not to withdraw from the labour market ? Not necessarily, as these agents could not be entitled to the upper-bound of unemployment benefits. Hence rather than demonstrating the presence of irrationality, these results underline the limitation of the approach.

As visible from table 7 in appendix A.1 we obtain marginal social welfare weights in the octiles case that significantly differ from those we had in the quintiles case (see table 4). We attribute this failure to the fact that EMTR for the first group is exceeding 1.

Our second discretionary choice was to select the income brackets such that the h_n are identical for $n = 1, ..., 5$. Rather than setting the distribution, we could use some alternative thresholds while keeping $N = 5$ to see whether our results still hold. We now turn to this sensitivity check.

In table 5 we show 3 alternative income group definitions (alpha, beta, and gamma case) with the values of the quintiles used earlier. In the appendix A.2 we provide the sample statistics for each of the three alternative definitions. We ran again the very same inverse-optimum procedures, using the labour supply elasticities reported in table 3, to get the marginal social welfare weights for each alternative.

Table 5: Overview of income group definitions

Group	Quintiles	Thresholds alpha	Thresholds beta	Thresholds gamma
G0	[0]	[0]	[0]	[0]
G1	(0,1250]	(0,1500)	(0,1200)	(0,864.7)
G2	(1250,1600]	[1500,1700)	[1200,1600)	[864.7,1300)
G3	(1600,1900]	[1700,2000)	[1600,2000)	[1300,1700)
G4	(1900,2300]	[2000,2300)	[2000,2500)	[1700,2100)
G5	(2300, $+\infty$)	[2300, $+\infty$)	[2500, $+\infty$)	[2100, $+\infty$)

Note : Quintiles were computed with -xtile- Stata command (see appendix) while thresholds were manually defined.

The case alpha is interesting as it extends the size of the first group in comparison with the quintiles definition. Conversely, the beta case shrinks the size of the first and the last groups and the gamma case reduces even more the size of group 1 to concentrate on those earnings less than 864.7 per month. This threshold corresponds to the value of the

Revenu d'Integration Sociale (RIS) in 2016, which is a minimum income guaranteed by the state. It is also below that threshold that Maniquet and Neumann (forthcoming-a) found the 100 percent tax result, which reinforce our interest in that case.

The sample statistics (see tables 9 to 11 in appendix A.2) in the alpha case display values for the EMTR and EPTR similar to the quintiles case. For the beta case, one obtains sample statistics that yield an EMTR slightly above 100 percent for the first group[45] while the EMTR also exceed 1 by far in the gamma case. This will be as problematic as above for the inversion.

For the case alpha, we obtained marginal social welfare weights qualitatively similar to what we had obtained in the quintiles definition. This is interesting because it happens despite the bias induced by the unevenness of relative group's size. Therefore it suggests that our results do not critically lie on a quantile definition of income groups as they can be obtained with a threshold definition. As predicted, we obtained inconsistent estimates for the beta and gamma cases. Again, this is due to the fact that the mean disposable income is higher in group 0 than in group 1 for these specifications such that the inversion procedure is meaningless.

In sum, these two sensitivity tests have taught us at least two lessons. First, our results are sensitive to the discretionary choices we have made, particularly because of our sample size. Indeed it happens that when the size of group 1 is too small, the mean disposable income is smaller than in group 0 such that the inverse-optimum fails. In particular, in our case the minimal range of group 1's earnings is $(0, 1250]$ euro per month for the inversion procedure to be consistent. Second, these discretionary choices were well-designed, because without it the resulting estimates are likely to be meaningless. That is, our initial specification was the best one could design with such data. Moreover our inefficiency results are not a direct consequence of our partitioning in quintiles. Rather, this division was designed such that the h_n distribution would not disturb the g_n estimation. In that respect we believe these elements robustify our empirical strategy, despite the fact that a larger sample size would have been valuable.

[45]This is of particular interest as it corresponds to the Maniquet and Neumann (forthcoming-a) result for low income.

5 Conclusion

Our study amends the literature in a number of ways. First, the theoretical framework is based on a empirically verified hypothesis while the empirical strategy allows to capture a larger scope of taxes and benefits with a robust inference at the bottom of the income distribution despite a smaller sample size. The estimation suggests that: (a) either the Belgian labour income tax-benefit system is inefficient or the participation elasticity of low-income workers is much smaller than commonly believed; (b) the Belgian planner values redistribution from earners to non-earners; (c) the variance of elasticities across income groups can be even more determinant than their mean level for the sign of marginal social welfare weights. This last finding is particularly important as it should incentivize future research in the field to differentiate labour supply responses depending on income.

This study could be extended in various directions. Indeed we have ignored many relevant dimensions of a tax-benefit system, e.g. tax evasion, tax avoidance, the existence of a shadow economy, of high non take up rates[46], or general equilibrium effects[47]. We have considered only a static framework while labour supply reactions to tax-benefit system surely display some dynamic behavior. Repeating our analysis over several years could provide hints about *changes* in the weights attached to some groups[48] but requires a much richer panel dataset.

In addition to that starting from 2016 the Belgian government has implemented a large tax reform known as *tax shift* whose aim was to transfer partially the tax burden from labour to consumption and capital (see e.g. Valenduc (2019) for an exposition). In particular the reform strengthens the in-work support for low-incomes while reducing the tax burden for most of the income distribution[49]. The law rolled the reform out over several years such that its full effects would be enforced in 2020. Therefore it will be of primary interest to renew our analysis in the coming years to check whether inefficiencies were resolved or whether the tax-deduced social preferences have evolved.

Furthermore, given that Maniquet and Neumann (forthcoming-b) demonstrate that the 100 percent marginal tax result also holds for other household types, it would be interesting to check whether our Pareto inefficiency results can be extended to lone parents or couples *mutatis mutandis*. For the former, Blundell et al. (2009) carry out a similar procedure as ours, restricting the sample to lone mothers. For the latter Bourguignon and Spadaro (2012) argue that the relevant strategy would be to consider a unitary rep-

[46]Accounting for the existence of tax evasion, tax avoidance and the shadow economy are likely to give higher elasticity estimates. Taking into account the non-take up rates would yield higher implicit tax rates. In both cases, this would have a negative impact on marginal social welfare weights such that our inefficiency results would be strengthen.

[47]The general equilibrium effect on the estimation of g_n is unclear. See Sachs et al. (2020) for a characterization of optimal taxes in general equilibrium.

[48]Lockwood and Weinzierl (2016) and Bastani and Lundberg (2017) found significant time variation over several decades for the U.S. and Sweden, respectively. Bargain, Dolls, et al. (2014) report much more stable patterns for four European countries in the short run.

[49]Thus the reform is likely to have a positive impact on the marginal social welfare weights for the bottom of the distribution. However the reform also benefits to other income brackets such that the total effect on the bottom weights is unclear.

resentation of the household by treating the participation elasticity of the second-earner (usually quite large) as an intensive elasticity for the household. Although simple, this approach ignores intra-household decisions and bargaining. Therefore it seems more promising to us to follow the inversion procedure with models tackling the optimal taxation of couples (e.g. Kleven et al. (2009) or the more general model of Laroque and Pavoni (2017)), bearing in mind that the estimation of spouses cross-elasticities is a difficult empirical task.

Finally, Diamond and Saez (2011) postulate that results in optimal taxation theory are useful for policy recommendations as long as they meet three conditions : (1) relevancy to the problem ; (2) robustness to assumptions ; (3) implementability in practice. We hope that our discussion has convinced the reader that our results fulfill the first two properties. With respect to the third one, our study should be complemented with future research on the labour market effects of taxes and social assistance design.

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A Robustness

A.1 Groups definition by octiles

Table 6: Sample statistics for childless singles, octiles

Group	#obs	h_n	c_n	z_n	EMTR	EPTR
g0	75	0.38	1025.24	0.00		
g1	16	0.08	951.25	231.90	1.32	1.32
g2	15	0.08	1361.87	1326.18	0.62	0.75
g3	16	0.08	1510.19	1934.81	0.76	0.75
g4	21	0.11	1722.52	2643.14	0.70	0.74
g5	12	0.06	1936.67	3118.70	0.55	0.71
g6	13	0.07	2412.46	3594.64	0.00	0.61
g7	19	0.10	2386.84	4165.90	1.04	0.67
g8	11	0.06	4226.67	8813.86	0.60	0.64
$\sum$	198	1				

Table 7: Marginal social welfare weight by group, as a function of elasticity scenarios for octiles

Scenario		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
n	h_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n
Group 0	0.38	1.40	1.62	1.42	1.34	0.85	1.07	0.87	0.62	1.78
Group 1	0.08	5.23	3.80	5.06	3.47	4.28	2.85	4.10	3.45	2.78
Group 2	0.08	**-0.32**	**-0.23**	0.06	0.00	0.36	0.44	0.74	0.95	**-0.26**
Group 3	0.08	**-0.81**	**-0.59**	**-0.60**	0.25	0.48	0.70	0.69	0.78	**-0.58**
Group 4	0.11	0.05	0.14	**-0.19**	0.28	0.47	0.56	0.23	0.75	0.30
Group 5	0.06	**-0.01**	**-0.04**	**-0.29**	0.39	0.67	0.64	0.39	0.91	0.08
Group 6	0.07	**-3.01**	**-3.01**	**-9.82**	**-2.72**	**-2.56**	**-2.56**	**-9.37**	**-2.41**	0.40
Group 7	0.10	3.11	3.11	7.95	3.01	3.21	3.21	8.05	3.42	0.69
Group 8	0.06	0.58	0.58	0.28	0.50	0.67	0.67	0.37	0.85	0.74

Table 8: Labour supply elasticity scenarios for $N = 8$

Scen.	Elasticity	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
A	Extensive	0.43	0.43	0.53	0.25	0.38	0.38	0.15	0.15
	Intensive	0.43	0.43	0.2	0.13	0.07	0.07	0.1	0.1
B	Extensive	0.43	0.43	0.53	0.25	0.38	0.38	0.15	0.15
	Intensive	0.18	0.18	0.1	0.1	0.1	0.1	0.1	0.1
C	Extensive	0.43	0.43	0.53	0.25	0.38	0.38	0.15	0.15
	Intensive	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
D	Extensive	0.35	0.35	0.25	0.2	0.2	0.2	0.2	0.2
	Intensive	0.18	0.18	0.1	0.1	0.1	0.1	0.1	0.1
E	Extensive	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
	Intensive	0.43	0.43	0.2	0.13	0.07	0.07	0.1	0.1
F	Extensive	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
	Intensive	0.18	0.18	0.1	0.1	0.1	0.1	0.1	0.1
G	Extensive	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
	Intensive	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
H	Extensive	0	0	0	0	0	0	0	0
	Intensive	0.43	0.43	0.2	0.13	0.07	0.07	0.1	0.1
I	Extensive	0.43	0.43	0.53	0.25	0.38	0.38	0.15	0.15
	Intensive	0	0	0	0	0	0	0	0

Note : These scenarios are qualitatively similar to the corresponding ones in the $N = 5$ case.

A.2 Groups definition by thresholds

A.2.1 Sample statistics

Table 9: Sample statistics for childless singles, groups defined by net-of-taxes earnings thresholds (case alpha)

Groups	Thresholds	#obs	h_n	c_n	z_n	EMTR	EPTR
G0	[0.00]	75	0.38	1025.24	0.00		
G1	(0,1500)	34	0.17	1249.15	791.54	0.72	0.72
G2	[1500,1700)	20	0.10	1556.30	2144.68	0.77	0.75
G3	[1700,2000)	21	0.11	1810.00	2847.24	0.64	0.72
G4	[2000,2300)	20	0.10	2293.10	3541.21	0.30	0.64
G5	[2300, ∞)	28	0.14	3078.40	6042.67	0.69	0.66
$\sum$		198	1				

Table 10: Sample statistics for childless singles, groups defined by net-of-taxes earnings thresholds (case beta)

Groups	Thresholds	#obs	h_n	c_n	z_n	EMTR	EPTR
G0	[0.00]	75	0.38	1025.24	0.00		
G1	(0,1200)	18	0.09	1016.00	325.57	1.03	1.03
G2	[1200,1600)	29	0.15	1449.69	1586.91	0.66	0.73
G3	[1600,2000)	28	0.14	1764.75	2730.33	0.72	0.73
G4	[2000,2500)	32	0.16	2319.13	3751.06	0.46	0.66
G5	[2500,$+\infty$)	16	0.08	3651.11	7463.06	0.64	0.65
$\sum$		198	1				

Table 11: Sample statistics for childless singles, groups defined by net-of-taxes earnings thresholds (case gamma)

Groups	Thresholds	#obs	h_n	c_n	z_n	EMTR	EPTR
G0	0.00	75	0.38	1025.24	0.00		
G1	864.70	15	0.08	944.29	180.69	1.45	1.45
G2	1300.00	11	0.06	1334.36	1228.67	0.63	0.75
G3	1700.00	28	0.14	1511.29	1944.01	0.75	0.75
G4	2100.00	27	0.14	1853.19	2937.14	0.66	0.72
G5	>=2100	42	0.21	2852.50	5232.81	0.56	0.65
$\sum$		198	1				

A.2.2 Marginal social welfare weights

Table 12: Marginal social welfare weight by group, as a function of elasticity scenarios for groups thresholds-defined (case alpha)

Scenario		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
n	h_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n
Group 0	0.38	2.89	2.60	2.86	2.20	2.00	1.71	1.96	1.49	2.40
Group 1	0.17	**-0.78**	**-0.35**	**-0.50**	**-0.14**	**-0.20**	0.24	0.08	0.31	**-0.09**
Group 2	0.10	**-1.05**	**-0.77**	**-1.07**	0.09	0.26	0.54	0.23	0.56	**-0.61**
Group 3	0.11	0.14	0.21	**-0.06**	0.34	0.54	0.60	0.33	0.80	0.34
Group 4	0.10	0.59	0.58	1.11	0.90	1.10	1.08	1.61	1.28	0.32
Group 5	0.14	0.49	0.49	0.05	0.39	0.59	0.59	0.15	0.78	0.71

Table 13: Marginal social welfare weight by group, as a function of elasticity scenarios for groups thresholds-defined (case beta)

Scenario		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
n	h_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n
Group 0	0.38	**-5.30**	**-3.13**	**-5.04**	**-2.90**	**-4.15**	**-1.98**	**-3.89**	**-2.74**	**-1.56**
Group 1	0.09	32.78	23.41	32.00	20.51	24.44	15.08	23.66	17.20	16.58
Group 2	0.15	**-0.50**	**-0.39**	**-0.26**	0.38	0.67	0.79	0.92	0.95	**-0.45**
Group 3	0.14	0.05	0.16	**-0.17**	0.29	0.46	0.56	0.23	0.73	0.33
Group 4	0.16	0.31	0.28	0.29	0.63	0.84	0.82	0.83	1.03	0.28
Group 5	0.08	0.54	0.54	0.19	0.45	0.64	0.64	0.28	0.82	0.72

Table 14: Marginal social welfare weight by group, as a function of elasticity scenarios for groups thresholds-defined (case gamma)

Scenario		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
n	h_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n	g_n
Group 0	0.38	1.46	1.62	1.48	1.38	0.94	1.11	0.96	0.72	1.74
Group 1	0.08	4.03	3.10	4.05	2.84	3.28	2.35	3.31	2.64	2.39
Group 2	0.06	0.09	0.03	1.24	0.86	1.37	1.31	2.52	1.67	**-0.58**
Group 3	0.14	**-0.02**	0.13	**-0.11**	0.28	0.43	0.58	0.34	0.73	0.25
Group 4	0.14	0.10	0.04	0.07	0.50	0.81	0.76	0.78	1.07	0.03
Group 5	0.21	0.59	0.59	0.33	0.50	0.68	0.68	0.42	0.87	0.72

B Stata do-file