Statutory, Effective and Optimal Net Tax Schedules in Lithuania

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1 Decleration

1.1 Availability of data and material

The results presented here are based on EUROMOD version I1.0+. EUROMOD is maintained, developed and managed by the Institute for Social and Economic Research (ISER) at the University of Essex, in collaboration with national teams from the EU member states. We are indebted to the many people who have contributed to the development of EUROMOD. The process of extending and updating EUROMOD is financially supported by the European Union Programme for Employment and Social Innovation "EaSI" (2014-2020). The results and their interpretation are the author's(') responsibility. This paper is based on data from Eurostat, EU Statistics on Income and Living Conditions [2015:2016], RPP 128/2019-EU-SILC. The responsibility for all conclusions drawn from the data lies entirely with the author(s). Data are available from the authors upon reasonable request and with permission of Eurostat and ISER only.

1.2 Competing interests

The authors declare that they have no competing interests.

1.3 Funding

Jousten acknowledges financial support from FNRS through grant J.0177.18. Work on this paper began when Alain Jousten was on sabbatical leave with ISM (Vilnius) and the IMF (Washington, DC) while Nerijus Černiauskas was working for the Bank of Lithuania and studying and working in Vilnius University.

1.4 Authors' contributions

Alain Jousten supervised the project, while Nerijus Černiauskas carried out the computations. Both authors analysed the data and have co-written the draft and the final version of the paper. Both authors agreed on the drafts and the final version of the paper.

1.5 Acknowledgements

We are grateful to Emmanuel Saez for sharing the optimal tax codes, for Benjamin Hemingway's help with the modelling, for the patience of the Bank of Lithuania's Economics Department and for comments provided by the anonymous referees, the participants at Bank of Lithuania's internal research seminar and Vilnius University's PhD seminar. The views expressed in this paper are those of the authors and do not necessarily represent those of the Bank of Lithuania or the Eurosystem.

Abstract

We estimate effective and optimal net income tax schedules and compare them to estimated statutory rates for the case of Lithuania in the period 2014-2015. Values of effective net tax rates are estimated from the survey of EU Statistics on Income and Living Conditions, the statutory net tax rates are estimated with the European tax-benefit simulator Euromod, while optimal net taxes are calculated via Saez (2002) methodology. We find that the three net tax schedules are similar for employees in the middle of the income distribution. At the bottom of the income distribution, optimal net tax schedules suggest higher in-work benefits. The net tax schedules diverge substantially for the self-employed. At the top of the income distribution, where the majority of self-employed are concentrated, the self-employed are required to pay 15 cents less net taxes per euro than employees - and they effectively pay 29 cents less.

Keywords: Optimal tax schedule, effective tax schedule, statutory tax schedule, taxes, transfers, employees, self-employed, Lithuania.

JEL code: H2, H21.

2 Introduction

Although it is widely accepted that taxes are necessary to finance government expenditures and social transfer programs, there is a great deal of disagreement concerning who should be paying these taxes. Regarding labor income taxation, the optimal tax literature considers three factors (income distribution, labour elasticities and society's preferences) when determining who should pay taxes and how much should they pay (see, e.g., Saez 2001). Oftentimes, however, statutory tax rates - the rates that are inscribed in the law - are smaller and less progressive than optimal ones (Saez 2002). Additionally, tax avoidance and fraud lead to further divergence between taxes that are actually paid (i.e. effective tax rates) and optimal ones. These three concepts (optimal, effective and statutory rates) are interrelated in a complex way: optimal taxes inform us about the desirable rate structure, whereas effective rates show how the tax system effectively taxes people based on rules set out by statutory rates, as prescribed by law. The interplay between these concepts is key to addressing urgent public policy questions: how do statutory rates effectively impact on individuals?; how does the tax system fare as compared to optimality principles?; etc.

We perform this analysis for the case of Lithuania. Our objective is twofold: first, we establish the extent to which the real world labour tax structure of the country is aligned with lessons from the optimal tax literature. Second, we compare the three schedules for employees and the self-employed. Governments utilise the tax system to encourage various types of behaviours - including the choice of self-employment. While this may have favourable effects on the labour supply or taxable income of those concerned, it may cause additional difficulties. For example, the self-employed usually face lower statutory income tax rates and are more likely to evade taxes as compared to employees, which leads to smaller government coffers and questions of social justice (Milanez and Bratta 2019). Lithuania is a particularly interesting case study in this regard. First, it applies rather distinct rules for employees and the self-employed. Second, it enjoys good survey and administrative data availability.

This paper relates to two bodies of tax literature. The first is the optimal tax literature, particularly the sub-branch which compares optimal tax schedules with statutory ones. The literature of optimal taxation started

with partial equilibrium models based on individuals, most notably Mirlees (1971). He demonstrated that higher marginal tax rates generate labour responses that cause employees to spend less time in employment. The Mirlees model was modified by Saez (2001) by replacing theoretical labour responses with observable income-dependent labour supply elasticities. This methodology was first used to argue that optimal gross income (which excludes social contributions) tax rates of top incomes in the USA could exceed 50%. More recent studies have replaced the labour elasticity with elasticities of taxable income. These are considered broader than labour elasticity, as they include other behaviour responses, such as tax evasion and avoidance, and not only labour supply. Klemm et al. (2018), also using Saez (2001) methodology and estimates of taxable elasticities, suggest that optimal income tax rates for top incomes exceed 60% for 27 global countries. A slightly modified version by Saez (2002) considers optimal tax rates at the bottom of the income distribution, by incorporating labour market responses at the intensive and extensive margin throughout the income distribution.

Subsequent authors have shown that optimal taxes rates differ, depending on the optimal tax schedule model. For example, Immervoll et al. (2011) extends Saez (2002) model (which includes only individuals) to couples, and suggests lower taxes on secondary earners versus primary earners for a sample of 15 EU countries. Additionally, the income tax schedule also depends on the existence of non-income tax schedules. For example, Huang and Rios (2016) shows that countries with a non-linear income tax and a linear non-income tax (such as the value-added tax in Russia) should have lower marginal income tax rates. However, if a country also exhibits high income under-reporting, then marginal income taxes should be lifted again. Using general equilibrium models, other authors such as Heathcote et al. (2017) find that incorporating skill investment and public good provision suggest lower progressivity (although high poverty rates that prevent skill investment undermine such claims). There are also models that look at employment and self-employment simultaneously, for example, Zawisza (2019). This model incorporates own-elasticities to declare employment or self-employment income and evaluates the cross-elasticities of switching between employment and self-employment. He found the elasticities of the self-employed to be three times higher than the elasticities of the employed in Poland. The lack of consensus leaves the researcher puzzled as to which model to use, but the lack of elasticity and other parameter estimates constrains the model choice to that of Saez (2002). This means that we work with the same elasticity for the self-employed and employed, which may lead to an over-estimation of the optimal tax schedule for the self-employed.

Furthermore, the optimal tax literature has attempted to analyse different tax and income concepts. Mir-

lees (1971), Saez (2001), and Immervoll et al. (2011) focused on income tax and employment income. Saez (2002) considered net taxes (income taxes minus public benefits), which means that individuals take into consideration their income taxes and (instantaneous) benefits when making employment decisions. This is useful when analysing optimal taxes at the bottom of the income distribution, since high public benefits (such as unemployment benefits) may discourage work as much as high taxes. However, for most OECD countries (OECD 2019), income tax constitutes a small part of the "tax" burden. For them, social contributions are both higher and not necessarily actuarially fair, meaning that this, too, can be seen as a tax.

We also relate to the tax literature which examines statutory and effective tax rate differences between employees and the self-employed. Studies focusing on labour taxation show that statutory tax schedules for employees (OECD 2019) and for the self-employed (Milanez and Bratta 2019) vary across OECD countries and across different households types within countries. Estimates of effective tax rates largely come from the tax evasion literature, which implicitly compares statutory and effective tax rates, although the focus is often on the individual. The closest work to our paper is by Matsaganis et al. (2013), who estimate income misreporting in Greece of wages and of self-employment income in the period 2005-2009. They find that about 43% of self-employment income was under-reported in 2009 and that the tails of income distribution under-reported income more often. They do this by comparing EU-SILC data on income coupled with administrative data on income, and use EUROMOD to streamline the definitions. They face the challenge of having different samples of people in the EU-SILC and the administrative records. In a different study, Johns and Slemrod (2010) finds that top income-earners tend to avoid taxes, leading to lower effective tax rates in the USA, and Alstadsæter et al. (2017) find that the most wealthy Scandinavians also exhibit a similar trend. Even though the evidence suggests that employees do evade income, up to 20% of the top incomes in Estonia do so (Paulus 2015), the self-employed tend to engage in tax evasion and avoidance substantially more (see, e.g. Baldini et al. 2009; Slemrod 2016) with some estimates showing that more than half of income may be concealed from the authorities (Artavanis et al. 2016).

We find that the three net tax schedules diverge much more for the self-employed than for employees. In fact, the optimal, statutory and effective tax rates for employees largely coincide for all but the tails of the income distribution. In contrast, for the self-employed, the effective tax rates are well below the statutory tax rates, while statutory rates are also below the optimal rates for most of the income distribution.

The paper is structured as follows. In section 3, we present the data sources and the definitions used throughout the paper. The following three sections cover the statutory, effective and optimal net tax schedules.

The results are presented and discussed in section 7, while the conclusions, recommendations and limitations are presented in section 8.

3 Data and definitions

We use the European Union Statistics on Income and Living Conditions (EU-SILC) dataset to estimate statutory, effective, and optimal net tax schedules for Lithuania. This is the only publicly available source of data with sufficient information for our analysis in one dataset for Lithuania, as it contains key information on employment income, taxes, benefits, household composition and information that can help to classify individuals as employees or self-employed. The yearly EU-SILC has been running since 2004 and is the reference for comparable data on personal income in Europe. Each year, around five thousand households encompassing around 10 thousand household members over 16 years of age who agree to share information on their incomes are included[1]. We pool data from surveys carried out in 2015-2016, which contain income data (reference years) of 2014-2015. While the data is well explained on the Eurostat website[2], some features are mentioned here.

Firstly, certain income components are only available for the household level in the survey. Notably, income tax and social contributions are calculated at the household level. This restricts the analysis to the concept of household (equivalised) income rather than individual income, which can be considered a blessing or a curse. On one hand, the literature suggests that individuals make economic decisions taking themselves as well as their household members into consideration (see, among others, Vogler and Pahl 1994). For example, the incomes of all household members comprise a common budget constraint (Chiappori and Meghir 2015), thereby influencing each household member's behaviour. Additionally, some benefits are only granted at the household level (e.g. social assistance benefit), making the allocation of this benefit to any specific household member artificial. Nevertheless, each household member has his/her own preferences and a typically unequal control of the household's budget, with evidence suggesting that decisions within households are rarely joint and more often taken by specific household members (Pahl 1995)[3]. To partly account for the limitations of working with household data we carry out an analysis of single's households as a robustness

1. For 2015 reference year, 5142 households out of 6161 households participated in the survey-interview. This means that at least one respondent was willing to fill in the survey on behalf of the household. For those 5142 households, information on all household members was collected.

2. https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions

3. Future studies should also compare them with net tax schedules for individual incomes or the interactions between individuals within a household.

check, but our results still hold.

Second, EU-SILC has a large survey component, but, since 2012, Lithuania has made heavy use of register (administrative) data. The State Social Insurance Fund Board data and the State Tax Inspectorate under the Ministry of Finance of the Republic of Lithuania data have been linked to sample data and used for checking cash or near-cash employee income, social insurance contributions and taxes on income, as well as old age benefits. Maternity and maternity/paternity allowances, care allowance, social assistance, old-age, and survivor's pensions have been taken from the administrative data. See country report[4] for more information. Register data is directly imputed from the registers for households which agree to participate in the survey. If register data is not available, then survey data is used. In the case of income, particularly employment income and income from self-employment, data is taken from both administrative and survey sources, and the greater value of the two is used. This "true" income is later used to estimate statutory taxes. In this way, we can observe actual incomes and not just income that has been reported to the tax authorities. In the case of taxes and benefits, we mainly rely on administrative data.

Third, survey weights are used to partly adjust for probability of selection, non-response and, as appropriate, to adjust the sample to external data. Currently, the sample is adjusted for demographic and geographic external data only. The weights are further adjusted according to Eurostat 2018: weights of household members who are over age 16 are scaled up by distributing weights of those under age 16. For most of the calculations, we only considered households that had at least one non-student household member aged 18-62. This means we kept one observation per household whose weight was the sum of the individual weights in that household.

Fourth, there is evidence that income inequality is underestimated in EU-SILC (Hlasny and Verme 2018; Törmälehto 2017). Callan et al. (2020) find that in Ireland only the top 1% of income is missing from household surveys as compared to register data, after accounting for concept differences. In line with this, Navickė and Lazutka (2016) show that capital income is under-reported for Lithuania in EU-SILC, which is usually concentrated at the top of income distribution, while other income components are much less under-reported. A study of Estonian Household Finance and Consumption Survey by Meriküll and Room (2019) showed that the rich as well as the poor usually do respond to surveys and so unit non-response is a smaller problem, but income is under-reported due to item-non-response. That is, the richer individuals do participate in household questioners but tend to avoid questions related to specific income/wealth questions. Since employee income,

4. https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp

taxes and social contributions for those who agree to participate in the survey are taken from registers in Lithuania, item non-response should be a smaller problem here. One major exception is self-employment income, which is not imputed from registers and has been often found omitted in the mentioned study. Unfortunately, Meriküll and Room (2019) do not succeed in replicating register data with survey data using data imputation techniques, citing lack of common support as the key issue. Furthermore, as self-employment income is often under-reported to tax authorities, such imputation are unhelpful in the first place. As we focus on labour rather than capital income and we see self-employment income as problematic to weight, we refrain from reweighing our data.

Finally, EU-SILC is compatible with Euromod. Euromod is a European tax-benefit simulator which takes in EU-SILC data and calculates how much tax each individual should pay or how many benefits he should receive based on his market income and other characteristics (e.g. age, whether he has any dependants, employment status, etc.). This allows us to estimate statutory tax schedules. It should be noted that while EU-SILC is used for EUROMOD, there are adjustments made in the process[5].

This data and Euromod allows us to estimate the three net tax schedules. Specifically, we estimate household equivalised net taxes as a share of household equivalised gross employment income. Let us explain each term in more detail. *Gross employment income* is defined as yearly gross employee and self-employed income (including social contributions of the employee, the self-employed and the employer). *Net tax* is the difference between taxes paid and public transfers received. Gross employment income minus net taxes is net labour income. The unit of observation is a household to which we allocate an equivalised income[6]. To obtain equivalised income, we first sum the incomes of all household members for a given household. Then, we adjust the sum by an OECD-modified equivalence scale, where 1 is attributed to the first household member, 0.5 to the second and each subsequent person aged 14 and over and 0.3 to each child aged under age 14. Henceforth, any reference to income or taxes in this text relates to equivalised household income and taxes. Finally, we construct a working sample which includes only households with at least one member who is not a student and is between 18 and 62 years of age. This allows us to focus on the working-age population and excludes pensioners - implicitly also reducing the role of these benefits in household income. We do not re-

5. For example, 20 household members who were born after the income period were removed in the EUROMOD 2015 and 2016 input files. This meant that survey weights add up to different totals and equivalence scales also differ for those households. Unfortunately, the household id's differ in the two data sets and we were not able to identify which are the household members that should be removed from EU-SILC to generate the same weights.

6. The alternative would be to have different tax rates for different types of households (e.g. single, married, married with children) as done in Guner et al. (2014), but using equivalised income allows us to have a single summary statistic and worry less about sample size.

Table 1: Average yearly equivalised income and net taxes in Lithuania, euro

Variable	Full sample (population)	Working sample (18-62, non student)
gross employment income	7663	8952
net taxes (minus)	1045	1944
net labour income	6618	7008
number of households	9657	6459

Data for 2014-2015 income reference years comes from the EU-SILC dataset. Gross employment income and net taxes include employer's and employee's social contributions.

move them completely, because many households have at least one pensioner or student, and they contribute to the household income. Income and net tax statistics from EU-SILC for 2014 and 2015 reference years for the full sample, which represents Lithuania's population, and the working sample is summarised in Table 1.

We focus mainly on gross employment income and net labour income. These variables relate most closely with one's work incentives[7]. EU-SILC has more income variables that also relate to work incentives, but we refrain from discussing those[8] Gross employee income is defined as the total remuneration in cash payable by an employer to an employee in return for work done by the latter during the income reference period, plus the employer's social insurance contribution. Gross self-employment income is defined as the income received during the income reference period by individuals, for themselves or in respect of their family members, as a result of their current or former involvement in self-employed work. Self-employed work covers those jobs where the remuneration is directly dependent upon the profits (or the potential for profits) derived from the goods and services produced (where own consumption is considered to be part of profits).

We include social contributions and all benefits in our definition of net tax in order to better reflect the incentives Lithuania's households face when participating in the labour market. Social contributions constitute a relatively large share of labour costs as well as the biggest source of revenue for the government (11.9% of GDP in 2015 according to Eurostat, while income tax makes up only 5.4%, even lower than VAT - 7.7%). Although contributions are used to finance social benefits, and could be seen as tax-neutral, there are also reasons to think of them, at least in part, as a tax. In their book, Frölich et al. (2014) argue that

7. Other possible strategies could include looking at taxes only or net taxes, taking into account inter-temporal benefit accrual such as for pensions. We leave this aside for future research.

8. For example, disposable income includes all the variables that fall under net labour income as well as other incomes, such as private transfers, and other taxes, notably capital tax. These variables play a minor role in this survey and do not impact the results. EU-SILC also includes several non-cash items that may have a larger impact on income and decision-making, but it is not clear to what extent this can be taxed. For example, non-cash items, especially imputed rent, which is the approximate income one would receive if one was to rent his/her residence, constitutes about 18% percent of gross employment income of the working sample.

some people may either not want the benefits associated with social contributions or want less of them, in which case only the difference between the desired benefits and the paid contributions should be considered as tax. For example, using USA data Chetty et al. (2016) finds that poor people tend to live shorter lives, meaning they have less chance of getting any benefits despite their contributions. Knowing that the largest share of social contributions is to insure against old-age, not paying social insurance contributions may be a very rational response for these people. In such cases, people may either work less if the contributions are perceived as too high or turn to informal work to avoid paying them (Frölich et al. 2014). Since we cannot identify the part of social contributions that are paid willingly, or how much of other taxes people willingly pay in exchange for public goods and services, we include social contributions into our definition of tax. We include all benefits (old-age, sickness/health, disability, family, unemployment and other benefits) into the definition of equivalised income.

Detailed statistics of income and net taxes as a percent of gross employment income are shown in Table 2. 88% of gross employment income is derived from gross employee income, with the residual derived from self-employment income. Public transfers increase income, resulting in 21% higher gross labour income than gross employment income for the full sample, but only 13 % in the working sample. Public transfers increase income by less in the working sample because we exclude a large share of pensioners together with their old-age public transfers. Other public transfers[9] still constitute a sizable share of income in the working sample. Tax on income and social insurance contributions reduce gross employment income by just over a third. As a result, net labour income is 86% of gross employment income on average (resp. 78% of working sample). Therefore, the net taxes as a percent of income gross employment income is 34% in the working sample.

As Lithuania's tax system treats employees and the self-employed differently, we also examine different types of households. In total, there are three non-overlapping groups of households: employees, self-employed and other. We use two definitions to define a household. The preferred is the *Income* definition, where we sum household members' gross labour income components (employee, self-employed and public transfer income) in a household and see which of the three components is dominant. Additionally, employee/self-employed households must have received or made a loss of at least 10 euros of gross employee/self-employed income in the reference year; otherwise, they are classified as "other". The alter-

9. Disability benefits and family/children related allowances each constitute about a third of the other public transfers. While unemployment benefits only make up 10% of other public transfers.

Table 2: Detailed equivalized income and net tax in Lithuania, % of gross employment income

Variable	Full sample (population)	Working sample (18-62, non student)
gross employee income	88	88
gross self-employed income	12	12
gross employment income	100	100
old-age public transfer	12	4
other public transfers	9	8
gross labour income	121	113
tax on income and social insurance contributions	-34	-34
net labour income	86	78
number of households	9657	6459

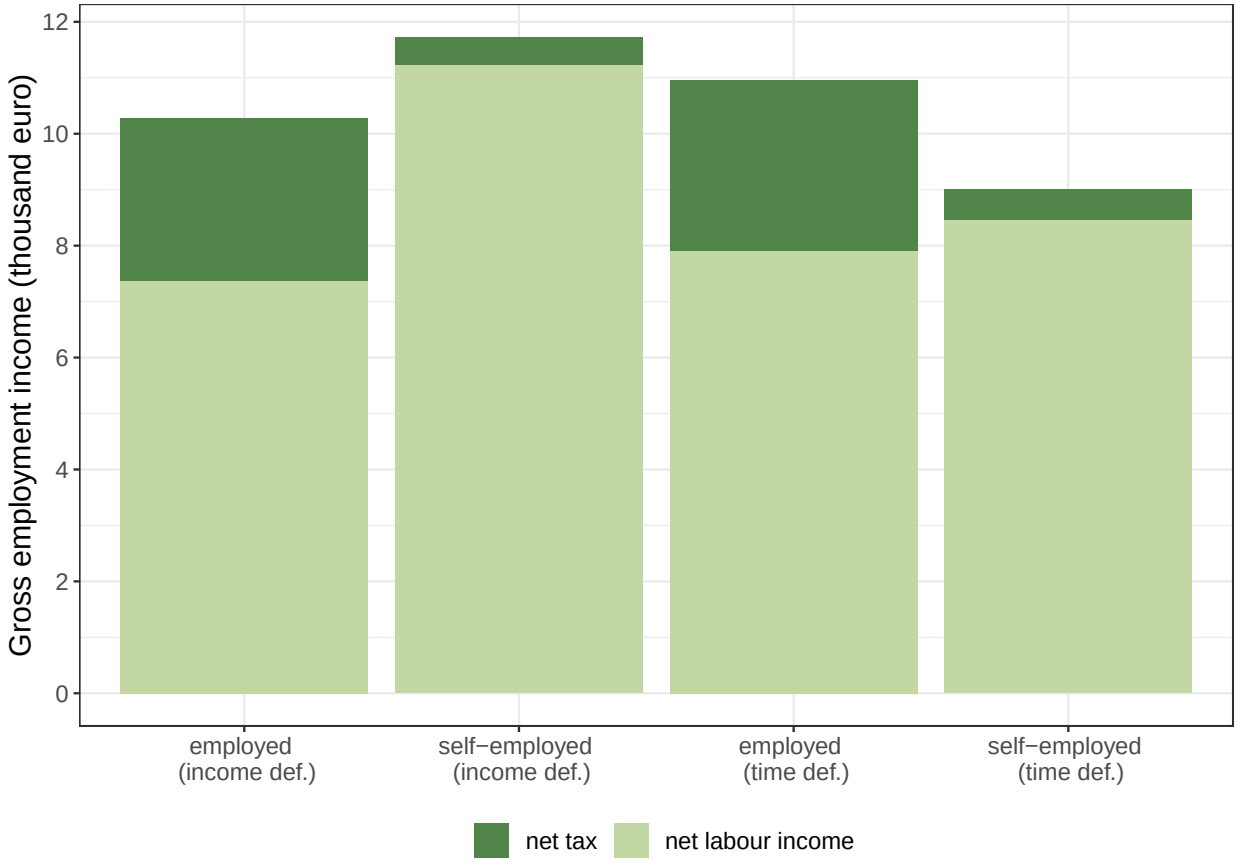
All variables are in percent of gross employment income. Data for the income reference years of 2014-2015 comes from EU-SILC. Gross employment income and it's components include employer's and employee's social contributions.

native is the *Time* definition, where the total household member's months spent in an activity is considered. Specifically, each household member had to identify his/her main activity in each month of the income reference year, be it an employee, self-employed or other. We then sum all the months of all household members, note which is the largest, and label that household accordingly.

Using the income definition results in a higher net labour income of the self-employed households, as summarised in Figure 1. Under the income definition, self-employed households receive around 14% more gross employment income than employee households, but pay only 17% of the net taxes that employee households pay. This results in 52% higher net labour income of the self-employed as compared to employees. Under the time definition, the self-employed pay less net taxes than employees, but they also earn much less gross employment income. More generally, while self-employment is not the activity that households report spending most of their time on collectively, it is the one that generates the largest net labour income. Indeed, only 3.3% of households report spending most of their time in self-employment, while 7.4% report gaining most of their gross labour income from self-employment. This is largely because over half of household members who earn their own self-employment income also earn employee income, and 60% cohabit with someone who earns employee income. Those who earn their own employee income are much less likely to earn self-employment income (10%) or cohabit with someone who does (14%).

Finally, we compute average and marginal tax rates throughout the paper. The formula for the average tax rate for the gross employment income decile $i = 1, 2, ..., 10$ is

Figure 1: Average equivalised yearly income in Lithuania for 2014-2015 reference years



Bars represent average equivalised income for employee and self-employed households under two grouping definitions: income definition and time definitions. The sum of equivalised net labour income and equivalised net tax is equivalised gross employment income. Calculations are based on the working sample. There are 264 households that fall under the time definition for the self-employed and 545 under the income definition (4566 and 4889 for the employees respectively).

$$atr_i = \frac{\sum_{k=1_i}^{n_i} taxes_k * w_k}{\sum_{k=1_i}^{n_i} income_k * w_k}$$

defined by the sum of taxes paid by households $k = 1_i, 2_i, ..., n_i$ and n_i would mean the n^{th} household member of decile i. We adjust the distribution of taxes using survey weights w_k. Then, we divide the weighted taxes paid by the income of all households multiplied by their weights in decile i.

Similarly, marginal taxes for gross employment income decile $i = 2, 3, ..., 10$

$$mtr_i = \frac{\sum_{k=1_i}^{n_i} taxes_k * w_k - \sum_{k=1_{i-1}}^{n_{i-1}} taxes_k * w_k}{\sum_{k=1_i}^{n_i} income_k * w_k - \sum_{k=1_{i-1}}^{n_{i-1}} income_k * w_k}$$

4 Statutory net tax schedule

We proxy the characteristics of the statutory net tax schedule in Lithuania by applying the tax and benefit rules applicable in the country to the observations from EU-SILC. Specifically, we utilise Euromod - a tax and benefit simulator - to estimate the amounts of taxes and benefits that would be due if we simply apply the statutory rules to the data at hand for all households, and for the separate groups of employees and self-employed. We use the income definition to allocate households into employee and self-employed throughout this section. Finally, we present statutory average tax schedules for Lithuania for the two groups.

Lithuania's tax and benefit system is complex. First, it incorporates various taxes, social contributions and benefits. We consider income tax, all social contributions, and a wide range of benefits. Most benefits, including pensions, are related to household members' previous income, although various coefficients, ceilings and floors ensure some income redistribution in the system. Second, there are various household-member and household-level characteristics that determine how much net taxes a household member should pay. This results in a wide range of net taxes to consider.

Figure 2 presents the statutory social contribution rates and bases that we derive for the household member in our sample[10]. Different contribution rates and bases are applied to employees and the self-employed; gross employee taxable income is subject to a monthly minimum wage (MMW) floor, while most forms of self-employed income benefit from a 50 percent tax base reduction. Therefore, the effective taxes paid by the self-employed can be much smaller than those paid by employees. A likely possible weakness of our data is that some tax-relevant information for properly applying the statutory rules may not be factored in, hence inducing a potential bias of an a priori unknown sign. For example, the self-employed may benefit from carried-forward losses, a factor that would effectively further widen the difference in statutory rates between employees and the self-employed[11].

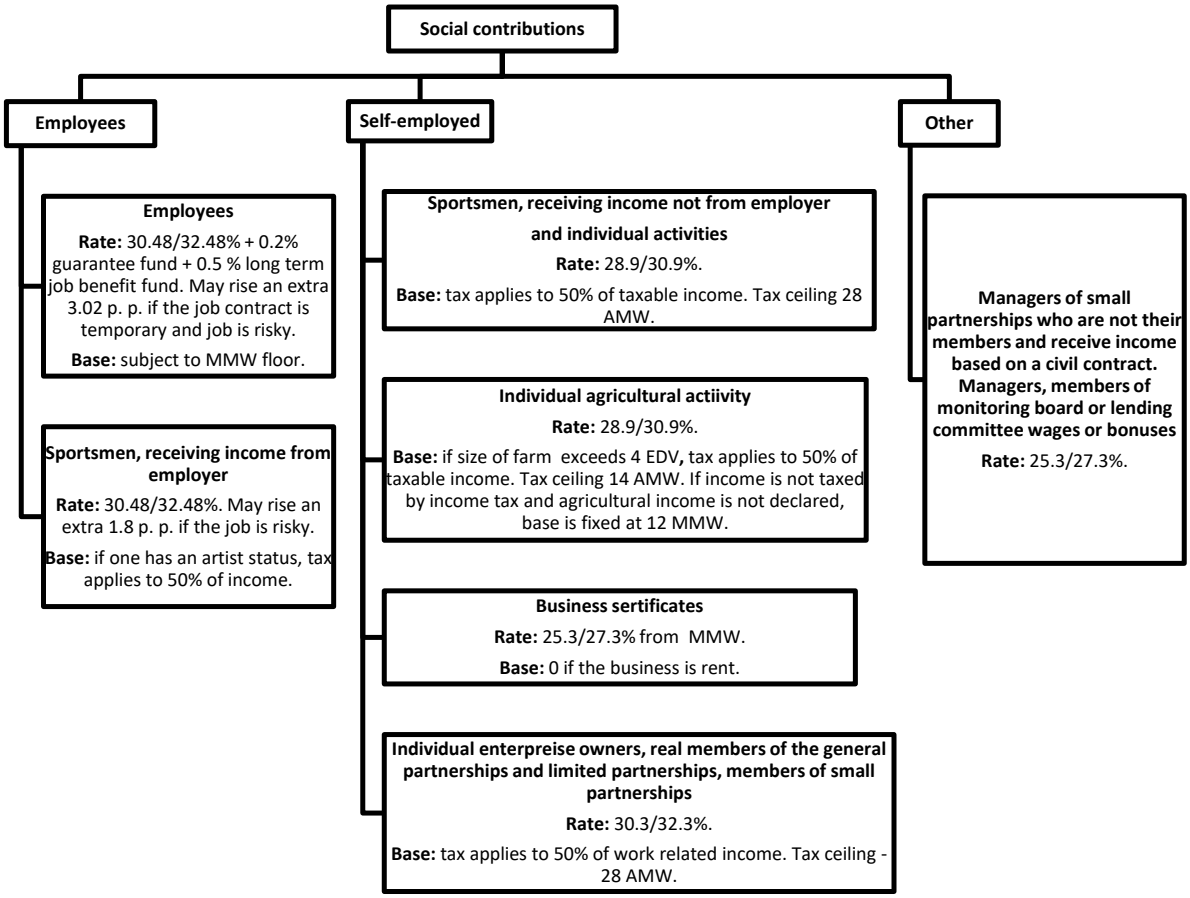
Euromod and EU-SILC dataset for Lithuania is able to estimate the majority of taxes and a portion of benefits[12]. For example, family benefits that depend on the number of children and their ages are simulated. Furthermore, simulations are made for a number of contributory (social insurance-based) benefits, such as

10. These social contributions were effective before a large tax reform that took place in 2019.

11. Other examples are tax exemptions for specific disabilities, economic activity or information that is not collected in EU-SILC survey. If these were fully accounted for, the statutory rates would be lower and closer to the effective tax rates. It is also likely that these specificities will be more important for the self-employed.

12. Euromod input files are slightly modified versions of EU-SILC data. In the case of Lithuania, 10 household members that were not yet born in the reference period were dropped in the 2016 and 2015 survey. Euromod also reads country-specific files which describe the statutory taxes and benefits of those countries that are then applied on the input files. More information on Euromod can be found at http://www.euromod.ac.uk and in Navickė and Čižauskaitė (2018) in particular.

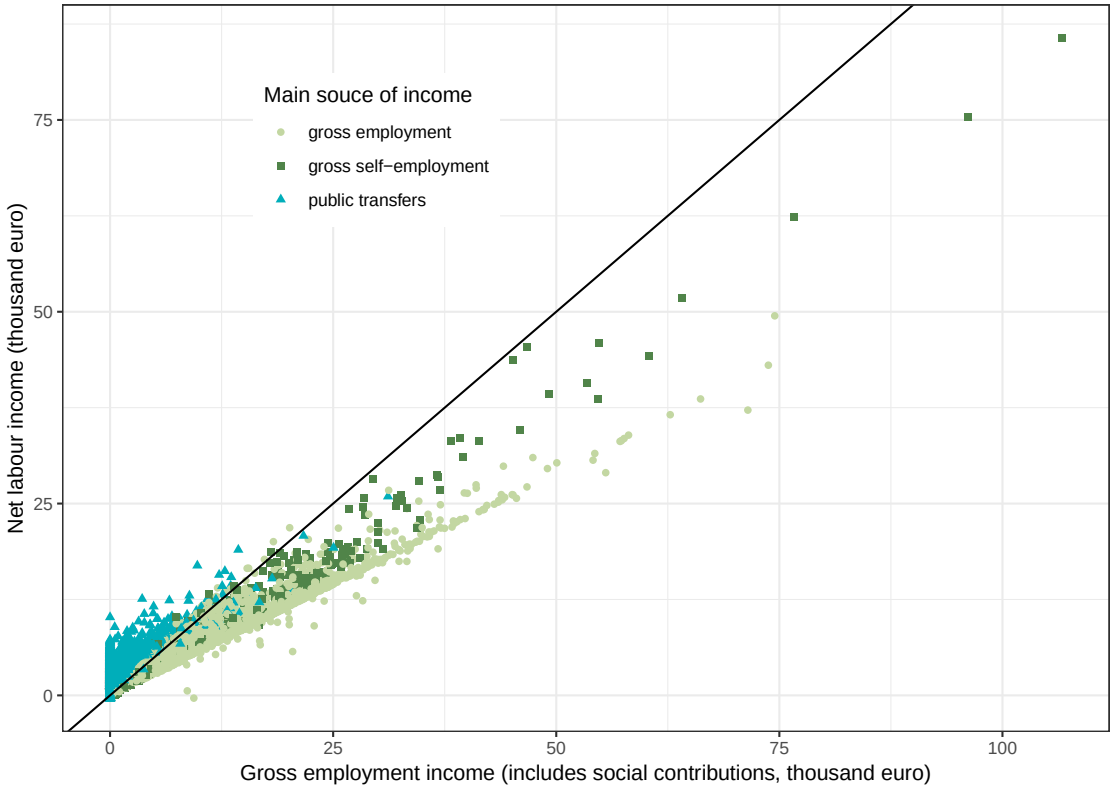
Figure 2: Statutory social insurance contributions excluding the statutory health insurance contributions prior to 2019 reform



MMW - monthly minimum wage, AMW - average monthly wage. Sources: based on state tax inspectorate of Lithuania.

maternity leave or benefits assigned to low-income household members. A number of benefits with entitlement rights dependent on contribution history (i.e. pensions, sickness benefit, disability benefits, etc.) are not simulated due to the lack of data on previous employment history and salaries received, some event occurrence (i.e. disability or accident at work), or lack of information on previous partner entitlements (i.e. survival pensions). In those cases where potential benefits are not simulated, they are replaced with effective benefits from the input file. We run the simulations at a household-member level, after which we aggregate to household-level and adjust incomes by an equivalence scale. Finally, we construct a working sample by keeping households with at least one household member who is 18-62 years of age and is not a student. We use EUROMOD version's H1.0+ 2014 and 2015 Lithuania's system files on LT_2015_a1 and LT_2016_a2

Figure 3: Statutory equivalised incomes of households grouped using the income definition in Lithuania



Equivalised gross employment income and net labour income is in thousands of euro per year. Households are allocated to groups according to the income definition for 2014-2015 income reference years and are represented by dots in the graph (see Section 3). The diagonal line illustrates that household employment income is equal to net labour income. Any dot above the diagonal line illustrates that the household receives additional benefits, while dots under the horizontal line means that the household pays additional taxes or social contributions.

input data respectively.

The relation between two simulated variables is plotted in Figure 3. On the x-axis is the gross employment income, and on the y-axis is net labour income (gross employment income minus net taxes). The figure thus links the mechanisms which transform gross employment income into net labour income. The diagonal line represents no transformation: what a household earns from employment income becomes its net labour income. Anything below the diagonal line refers to income that is taxed away. Anything above the diagonal line means that the household received public transfers that exceed paid taxes. The colours and shapes of the points represent the groups according to their main source of income: gross employee income, gross self-employment income, and public transfer income.

Many households that receive hardly any gross employment income are legally entitled to substantial public transfers which raise their net labour income above the diagonal line. This is largely because some or

all households are able to apply for old-age benefits or disability benefits. Once households start earning some gross employment income, their net labour income becomes dispersed and their main source of income is increasingly likely to be employment income. As gross employment income rises, the majority of households tend to be below the diagonal line, as they have to pay taxes and receive fewer benefits.

The self-employed households receive higher net labour income as compared to the employee households, especially at higher gross employment income levels. This is because employees are legally subject to higher statutory average tax rates than the self-employed for the same level of gross employment income. In part, this is due to the lower taxable base of the self-employed. Furthermore, the self-employed have access to more types of tax treatment. For example, the self-employed may purchase business certificates. This requires their holders to pay a one-off fee determined by the municipality if they receive under 4500 euro from the activity. For a couple with two business certificates, this could lead to $9000/1.5 = 6000$ euro equivalised income that is barely taxed, while other types of incomes could be declared under different activity forms or taxed at a different rate thereafter.

Not only do the self-employed earn more net labour income on average due to lower taxes, but self-employed households are concentrated at the top of the income distribution. For example, in the bottom 20% of the net labour income distribution, only 5% of households can be considered self-employed under the income definition. The share of households that are self-employed almost triples in the top 20% of the income distribution, and reaches 30% for the top 5% in Lithuania. Such a distribution of self-employed households also encourages us to make stronger claims on the richer self-employed rather than the poorer ones. Nevertheless, the data suggests that the self-employed are faring worse at the bottom of the income distribution. As seen in Table 3, employee households grouped using the income definition in the second (pseudo) decile receive 1.77 thousand euro net labour income, and do not pay any net taxes. The self-employed receive less net labour income (0.83 thousand euro) and pay more net taxes. This is because the self-employed receive fewer benefits as compared to employees at the bottom of the income distribution, but they pay similar taxes.

Table 4 contains data on the composition of average statutory net tax rates. As gross employment income rises, average net tax rates rise as well. In particular, average net taxes are negative for the bottom percentiles (as people receive more benefits than they pay in taxes), and they rise to 36.7% of gross employment income.

At the bottom of the income distribution, both groups pay similar taxes as a share of gross employment

Table 3: Statutory equivalised gross employment income, net taxes and net labour income in thousand euro per year.

percentile	gross employment income	net taxes			net labour income		
		all	employees	self-employed	all	employees	self-employed
0-7	0.00	-2.25			2.25		
7-20	1.41	-1.12	0.25	0.42	2.53	1.72	1.19
20-30	3.59	0.07	0.76	0.70	3.52	2.86	2.95
30-40	5.10	0.78	1.29	1.01	4.32	3.81	4.14
40-50	6.61	1.54	1.80	1.32	5.07	4.79	5.27
50-60	8.22	2.29	2.48	1.86	5.93	5.73	6.34
60-70	10.08	3.03	3.16	2.83	7.05	6.96	7.03
70-80	12.36	4.08	4.28	2.91	8.28	8.08	9.39
80-90	15.69	5.67	5.86	4.09	10.02	9.84	11.50
90-100	27.65	10.29	10.91	7.02	17.36	16.65	21.21

Data is sorted according to equivalised gross employment income (includes social contributions). Net taxes include tax minus public benefits (public transfers). Net labour income is gross employment income plus benefits minus taxes. We report averages of percentile ranges. Gross employment income is taken from EU-SILC, while net taxes are estimated by Euromod, which takes into account various individual and household characteristics (e.g. age, health status). All figures are taken from Euromod and are weighted to include only those households with at least one member who is aged 18-62 and is not a student. The number of observations per decile is available in Table 10 in the Appendix.

Table 4: Household statutory average net tax rates in Lithuania, net taxes as a share of gross employment income

percentile	net taxes			taxes		public transfers	
	all	employees	self-employed	employees	self-employed	employees	self-employed
0-7							
7-20	-1.121	-0.106	0.171	0.336	0.340	0.442	0.169
20-30	-0.018	0.076	0.104	0.369	0.303	0.293	0.199
30-40	0.130	0.168	0.104	0.379	0.314	0.211	0.210
40-50	0.222	0.237	0.138	0.395	0.287	0.158	0.149
50-60	0.270	0.281	0.200	0.400	0.286	0.119	0.086
60-70	0.293	0.301	0.277	0.400	0.318	0.099	0.041
70-80	0.326	0.335	0.226	0.411	0.293	0.076	0.068
80-90	0.355	0.366	0.257	0.412	0.300	0.046	0.043
90-100	0.367	0.393	0.238	0.419	0.276	0.026	0.037

Percentiles are sorted by gross employment income (includes social contributions). Taxes include income tax and social contributions. public transfers include old-age, disability, unemployment and other benefits. Net taxes are taxes minus public benefits. Gross employment income is taken from EU-SILC, while all other figures are estimated by Euromod, which takes into account various individual and household characteristics (e.g. age, health status). Number of observations per decile is available in Table 10 in the Appendix.

income, even though reasons differ[13]. As gross employment income rises, employees receive less benefits and start paying more taxes as a share of gross employment income (due to the diminishing effect of non-taxable minimum for employees). The self-employed also receive less benefits but are not required to pay higher taxes. As a result, the richest employee households pay 39.3% for the their income in tax, while the

13. The employees pay less tax because of a non-taxable minimum, which gradually diminishes as income rises. The self-employed tend to pay less social contributions because of a lower tax base and exemptions.

self-employed households pay 23.8%.

Similar observations can be made when considering marginal net tax rates. Statutory marginal net tax rates increase from 39% to 43% for employee households, while they fluctuate around 25% for most self-employed households. Two observations, in particular, are worth mentioning. The first is that the self-employed in the sixth decile face marginal taxes as high as 46%. This is partly related to public transfers which are capped at these levels. The second observation is that business certificates are no longer allowed at such high levels, and income composition changes. If we remove all households which have both self-employed and employee incomes and remove households with business certificates, the marginal statutory tax rates fluctuate between 24 and 36% for the self-employed.

Our results may be influenced by income concepts and definitions used. In particular, taxes are applied to individuals and not to households in Lithuania, so it is important to consider individuals in the analysis instead of equivalized households. As mentioned, EU-SILC data bundles several income components at the household level, most notability income taxes and social contributions, which are difficult to disentangle. Thus, while EUROMOD can model individual level taxes, the same does not apply to effective taxes[14].

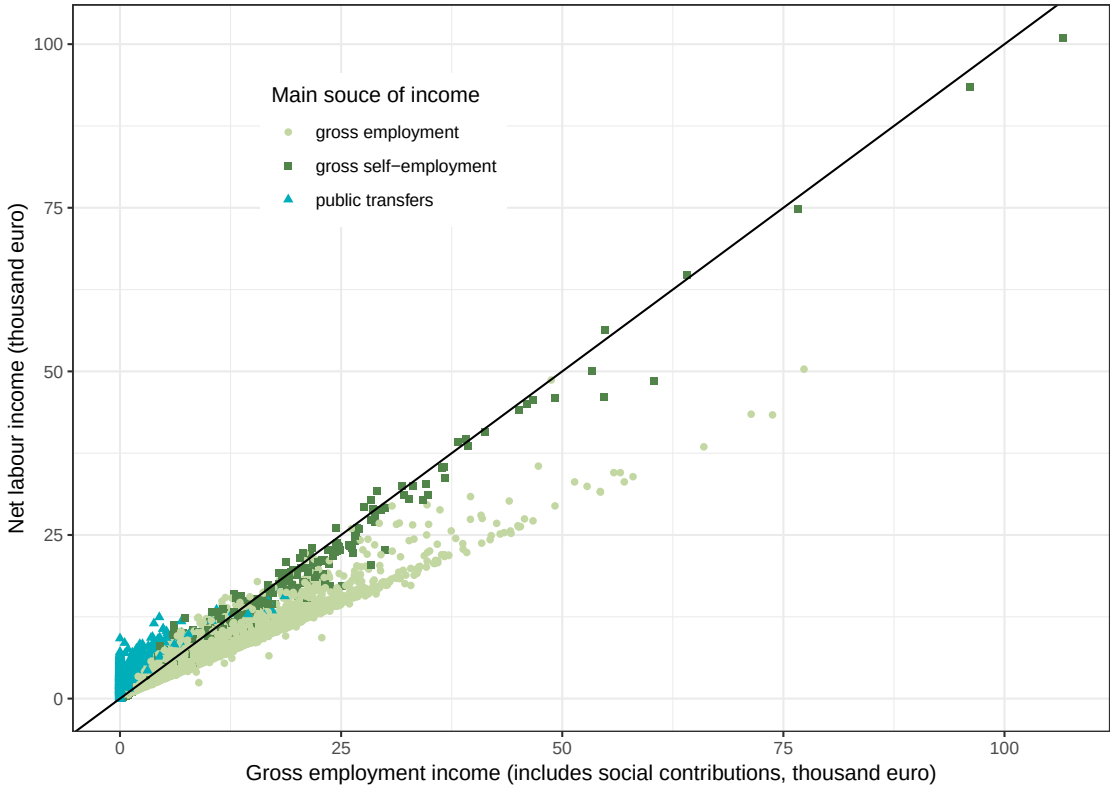
5 Effective net tax schedule

We estimate effective equivalised net tax schedule for Lithuania in a similar fashion as was done for statutory tax section. We use EU-SILC data for the period 2014-2015 and simply compare the net taxes that each household paid with the gross employment income that each household received. The vast majority of net taxes paid by households in EU-SILC come from administrative sources and therefore represent effective taxes paid. Gross employment income in the EU-SILC represents actual income, rather than the income that the tax authorities observe[15]. We find that there is little difference between the statutory and effective net tax

14. As a validity check, we restrict the sample of households to those where there is only one person aged 18-62, although other individuals can also live there. We label this as single households as this removes the issue of married households. The results presented in Table 12 in the appendix are similar to our previous analysis even though the small sample size requires smaller bins. In particular tax rates are very similar in magnitude. Public transfer rates, however, became larger when considering single households as these households tend to contain pensioners or dependants. If we further restrict households to pure one person households, where the one person must be aged 18-62, tax rates remain similar but public transfer rates become closer to those observed in Table 4. Moving to single households removes both the issue of focusing on households instead of individuals and remove equivalization effects. Unfortunately, there would be too few observations to allow reporting. Nevertheless, it seems that the results are not significantly affected by the choice of the concepts and we proceed further with our initial ones.

15. This is because in producing the EU-SILC data for Lithuania, households are asked to report their gross employment income in the questionnaire. Gross employment income is also taken from administrative records for the same household. The two sources (administrative and survey) are compared for each household by the EU-SILC team, and only the larger value of gross employment income is kept in the EU-SILC data that is available to us. Therefore, if respondents revealed more gross employment income in the questionnaire than to authorities, a gap arises between the effective and statutory net tax schedules.

Figure 4: Effective equivalised incomes of households grouped using the income definition in Lithuania



Equivalised gross employment income and net labour income is in thousands of euro per year. Households are allocated to employment groups according to the income definition for the 2014-2015 income reference years and are represented by dots in the graph (see Section 3). The diagonal line illustrates that what a household earns from employment is what it receives as its net labour income. Any dot above the diagonal line illustrates that the household receives additional benefits, while dots under the horizontal line means that the households pay additional taxes or social contributions.

schedules for employee households, but the self-employed households pay even less net tax than statutory rates predict. For example, self-employed households effectively pay 29 percent points less net tax on average than employee households at the top of the income distribution.

As in Section 4, we plot gross employment income against net labour income for different employment groups in Figure 4. In many respects, the effective graph depicting effective tax schedule is similar to Figure 3 depicting the statutory tax schedule. The main difference is that self-employed households receive even greater net labour income than employee households. Furthermore, in Figure 4, for a large number of households, gross employment income is equal to or even above the diagonal line, irrespective of the amount of gross employment income they earn.

The effective average net tax rates for the self-employed are much below the statutory rates. The top decile of the self-employed pay 7% of their gross employment income as net taxes, as shown in Table 5, even

Table 5: Household average effective net tax rates in Lithuania, net taxes as a share of gross employment income

percentile	net taxes			taxes		public transfers	
	all	employees	self-employed	employees	self-employed	employees	self-employed
0-7							
7-20	-0.812	-0.095	-0.113	0.320	0.122	0.416	0.235
20-30	-0.041	0.041	-0.101	0.331	0.130	0.290	0.231
30-40	0.074	0.119	-0.144	0.327	0.167	0.207	0.310
40-50	0.191	0.205	0.006	0.352	0.141	0.147	0.135
50-60	0.219	0.241	-0.005	0.365	0.103	0.123	0.108
60-70	0.242	0.267	0.083	0.364	0.124	0.097	0.041
70-80	0.278	0.297	0.048	0.373	0.106	0.076	0.058
80-90	0.313	0.336	0.057	0.387	0.098	0.050	0.041
90-100	0.313	0.359	0.070	0.385	0.101	0.026	0.032

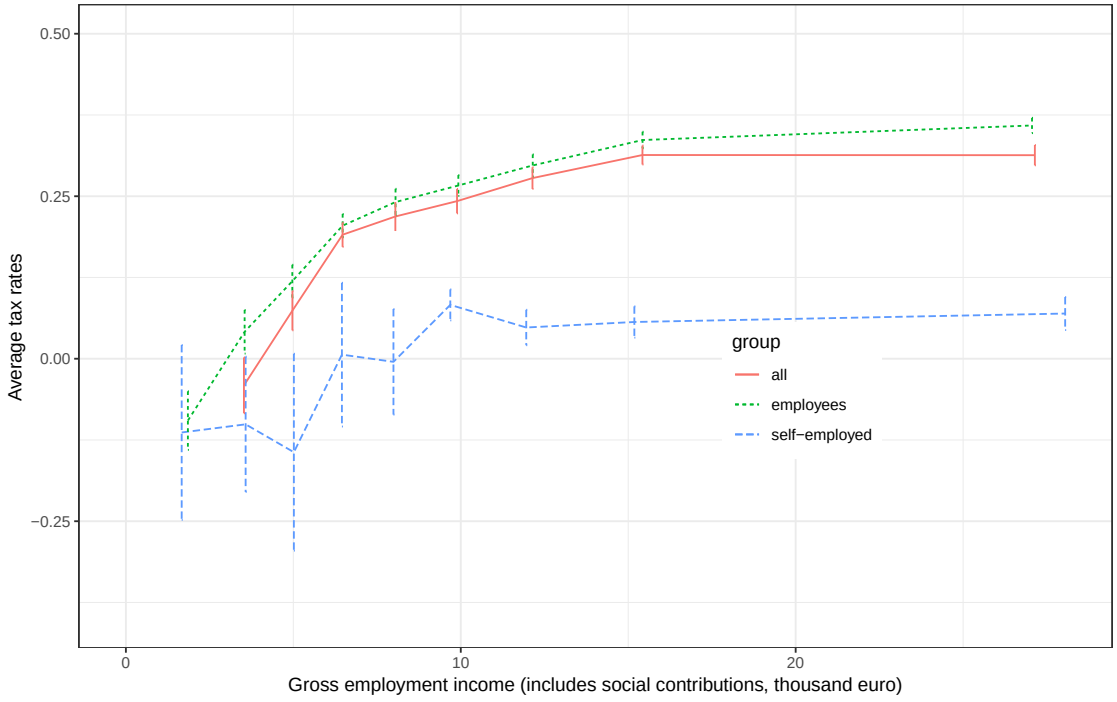
Percentiles are sorted by gross employment income (which includes social contributions). Taxes include income tax and social contributions. Public transfers include old-age, disability, unemployment and other public benefits. Net taxes are taxes minus public benefits. All figures are taken from EU-SILC and are weighted to include only those households with at least one member aged 18-62 and is not a student. The number of observations per decile is available in Table 11 in the Appendix.

though statutory rates suggest that they should be paying 24% (see Table 4). While statutory rates might be somewhat overstating taxes because of carried-forward losses, or other tax-relevant features imperfectly captured by the EU-SILC data, the difference is sufficiently large to be noteworthy. In fact, the main drivers are lower effective taxes and social contributions paid by the self-employed (whereas effective and statutory benefits received by the self-employed are similar). In contrast, the statutory and effective net tax rates for employees are similar. This results in a large effective net tax rate difference between the two groups: effective average net tax rates are up to five times lower for the self-employed as compared to employees. Additionally, self-employed average net tax rates are less progressive: effective average tax rates are flat, with some progressivity coming from public transfers. The lack of progresivity of effective tax rates for the self-employed can be seen in Figure 5.

As in the section of statutory net taxes, our concepts and definitions may influence the results, but moving to an individual analysis is problematic given our EU-SILC data. Nevertheless, the results for this restricted subsample of "single" households as in section 4 are in line with the fuller sample - if anything the difference in net tax rates between employees and self-employed is larger meaning that our results can be seen as conservative[16].

16. We test a subsample of households with one household member aged 18-62, but allow older and younger members to coexist in Table 13 in the appendix. We label this as single's households. Again, tax rates are similar as to the previous analysis, although the difference in tax rates between the employed and the self-employed becomes even more apparent. Public transfer rates (and subsequently net tax rates) become higher in the single's households because of many co-inhabiting pensioners or dependants. Removing them and keeping only households with a single household member aged 18-62 brings public transfers closer to initial estimates found in Table 5, while tax rates are closer to those found in Table 13 in the appendix. These results are not presented due

Figure 5: Net taxes are higher and more progressive for employees than for the self-employed



Standard errors were compiled taking into account survey design with the help of codes from Goedemé 2013; Zardo Trindade and Goedemé 2016 and computed using Lumley 2018 R package as described in Lumley 2004. We use 95% confidence intervals.

6 Optimal net tax schedule

In this section, we estimate an optimal net tax schedule for Lithuania. This allows us to evaluate whether the statutory net tax schedule described in Section 4 is in line with the economic fundamentals of the country. Additionally, it could shed light on whether the difference between the effective and statutory rates is likely due to overly high (economically unsustainable) statutory rates, or to low tax compliance. We use a model developed by Saez (2002): it provides the whole optimal net tax schedule given a number of elasticities, government preferences for redistribution and its budget, and a pre-existing income distribution.

6.1 The model

The model is taken from Saez (2002), with the exception that individuals are replaced with households (see Section 3). The model starts by indexing households by $m \in M$. The measure of households on M is denoted by $dv(m)$. The household's utility depends positively on net labour income c, and the chosen occupation

to too few observations.

$i \in 0, 1, .., 10$, thus $u(c, i)$. $i = 0$ denotes unemployed or inactive households. The higher the i, the higher the gross employment income w associated with that occupation and the higher the net labour income. In our study, the i represents the same (pseudo) deciles used in Sections 4 and 5.

The fraction of households choosing i is denoted by $h(c_0, c_1, ..., c_I)$, meaning that households weight the net disposable income associated with each job before choosing the best one for them.

The government chooses the net taxes, T_i, that each household should pay or the benefits it should receive and maximises welfare:

$$W = \int_M \mu^m u_m(w_i - T_i, i) dv(m)$$

where μ^m are positive weights and subject to a budget constraint (1) described below.

The rest of the derivations are found in Saez (2002), but they eventually lead to a system of three equations

$$\sum_{i=0}^{I} h_i T_i = H \tag{1}$$

$$\sum_{i=0}^{I} h_i g_i = 1 \tag{2}$$

$$\frac{T_i - T_{i-1}}{c_i - c_{i-1}} = \frac{1}{\zeta_i h_i} \sum_{j=i}^{10} h_j [1 - g_j - \eta_j \frac{T_j - T_0}{c_j - c_0}] \tag{3}$$

that show how the government chooses T to maximise W. Let us go through each equation separately.

Equation (1) is the government's budget constraint mentioned previously. H is the per capital government's budget net of redistribution. In the simulation, $h_i(c_i - c_0)$, meaning that each household considers the relative gain in net labour income of becoming employed $c_i - c_0$.

Equation (2) is a normalisation of the welfare function expressed in terms of social welfare weights. Specifically, g_i denotes the value (in terms of public funds) of giving an additional dollar to a household in occupation i. That is, the government is indifferent regarding giving one more dollar to a household in occupation i and getting g_i of public funds. The higher the g_i, the happier the government is to give money to this occupation and, assuming the government values redistribution, g_i decreases as i increases. Additionally, g depends on net labour income c, the marginal value of public funds p and the distributional

tastes of the government v as shown in (4). If c is already equally distributed, then there is less reason to further redistribute and so g should be equal across i's. The higher the p, the more the government values its public funds and the less keen it is to redistribute income. The higher the v, the keener the government is to give money to the poorest members of society instead of to the wealthiest.

$$g_i = \frac{1}{pc_i^v} \tag{4}$$

Equation (3) defines the optimal net tax schedule of a change in net tax rate for occupation i by a small amount dT. Three effects are at work here, which have to be balanced to reach optimal net tax rates. First, there is the mechanical effect of a change in net tax rate. The rise in T_i causes the government to collect more revenue from all those in occupation i and all richer occupations $i+1, i+2, ..., 10$. This is represented by $\sum_{j=i}^{10} h_j$. Second, we include the effect of social weights, g_i attached to each occupation. This is done by stating that the government values each dollar collected by occupation i at $1 - g_i$, since the government may prefer not taking money from some groups in the first place (e.g. the very poor). Third, it includes two behavioural responses: the extensive response and the intensive response.

The extensive response is captured by the extensive labour supply elasticity (technically, the extensive mobility elasticity),

$$\eta_i = \frac{c_i - c_0}{h_i} \frac{\partial h_i}{\partial (c_i - c_0)} \tag{5}$$

which refers to T_i becoming so large that some people working in i may choose to become unemployed or inactive (i_0). It measures the percentage change in number of employed in occupation i when the difference between net labour incomes of employed in occupation i and unemployed/inactive changes by 1%. For example $\eta_i = 0.5$ means that if $c_i - c_0$ increases by 1%, employment in i will rise by 0.5%.

The intensive response is captured by the intensive mobility elasticity (akin to the intensive labour supply elasticity)

$$\zeta_i = \frac{c_i - c_{i-i}}{h_i} \frac{\partial h_i}{\partial (c_i - c_{i-i})} \tag{6}$$

which refers to people moving from one occupation to another in search of lower net taxes. It measures the percentage increase in supply of job i when $c_i - c_{i-1}$ is increased by 1%. This specification ignores income effects, or the effect of rising incomes for all occupations simultaneously. In the literature, however, income effects are in any case found to have a small impact (Saez 2002).

Finally, h_i represents the optimal i distribution given the empirically observed h_i^0 distribution

$$h_i = h_i^0 (\frac{c_i - c_0}{c_i^0 - c_0^0})^{\eta_i} \tag{7}$$

where the h_i^0 are reconfigured to account for the extensive response to change in net taxes. Here, c^0, represent the actual net income and c_i represent the optimal net income which is estimated simultaneously with (1, 2, 3). Whenever net taxes are lowered for households of occupation i, so that $c_i - c_0$ becomes bigger, more households should be working in i, given extensive elasticity η_i and actual net incomes $c_i^0 - c_0^0$.

6.2 The parameters

There are several parameters that need to be chosen for Lithuania: the labour supply elasticities (or, actually, long-run taxable income elasticities), societies' preferences and other. We use taxable income elasticities, e_z, defined as

$$e_z = \frac{1-\tau}{z} \frac{\delta z}{\delta(1-\tau)}$$

the percent in reported income when the net-of-tax rate increases by 1 percent. The benefit of this "sufficient" elasticity is to capture directly all behavioural effects or raising taxes, including real responses (e.g. labour supply adjustments), tax avoidance (e.g. claiming deductions or (legal) income shifting between tax bases) and illegal tax evasion behaviour (see Saez et al. 2012, for example). Nevertheless, we also rely on the available labour supply elasticity estimates for Lithuania.

Elasticities

We start with choosing (uncompensated) intensive and extensive labour mobility elasticities for (5) and (6) respectively. Income effects are usually found to be small on aggregate (Saez 2002; Bargain et

al. 2014), which justifies considering uncompensated labour supply elasticity instead of compensated labour supply elasticity. Additionally, we require different extensive and intensive mobility elasticities for high and low income households. If these differ, this should produce a kink in the optimal tax schedule: higher extensive elasticities for low incomes calls for subsidies to the poor.

First, it should be noted that ζ is not observed empirically, but can be calculated

$$\zeta_i = \frac{\epsilon_i w_i}{w_i - w_{i-1}}$$

by first estimating

$$\epsilon_i = \frac{1-\tau}{w} \frac{\delta w}{\delta(1-\tau)}$$

where ϵ show how much wage responds to the net-of-tax rate change.

Second, as the magnitude of elasticities is uncertain, Saez (2002) proposed a wider range of ϵ's and η's for the upper and lower tail of distribution based on the summary of literature (see Table 6). Unfortunately, the ranges are large, are based mainly on US data, are ambiguous about being short- or long-run elasticities and refer to labour supply responses only (i.e. are not elasticities of taxable income). This has been partly remedied by newer studies.

Table 6: intensive and extensive elasticities as proposed by Saez (2002)

	High income ($w \geq 20,000$\$)	Low income ($w < 20,000$\$)
η	0	[0 - 1]
ϵ	[0.25 - 0.5]	[0.25 - 0.5]

The table indicates a range of possible elasticities for the United States.

Barrios et al. (2019) estimated Lithuania's short-run labour supply elasticity,

$$e_h = \frac{w}{h} \frac{\delta h}{\delta w} \tag{8}$$

denoting a percent change in net-wage on the number of hours worked, to be between 0.15 for high-skill individuals and 0.3 for low-skill individuals. This elasticity captures the main behaviour effect: the real response of labour employment and work duration (the sum of ϵ and η). While there are no estimates for Lithuania's intensive, e_{hi}, and extensive, e_{he}, margin, Bargain et al. (2014) study these distributions across income quantiles countries largely comparable to Lithuania, such as Estonia, Hungary, Finland and Poland. For the four countries, the extensive labour elasticities for the lower quantiles, e_{hel} range between 0.08 to 0.26 (an exception is Finland, with 0.8). For the higher end, e_{heh} range between 0.05 to 0.23. For the same four countries, intensive labour elasticities range between 0 to 0.03 for the lower, e_{hil}, and -0.04 to 0.03 for the higher e_{hih} deciles. The extensive elasticity was found to vary between 0.3 to 0.65 in Staehr (2008) for Estonia, while intensive elasticity was negligible. This suggests that for Lithuania, also, most of the labour supply would come from the extensive margin for both the lower and higher income households, even though there may not be large differences between the upper and bottom income distributions.[17]

Lithuania's long-run labour supply elasticity could be much higher, and long-run taxable income elasticities are larger still. We opt for long-run elasticities to capture long-run effects on the economy. Jäntti et al. (2015), who has access to long-term data for largely Scandinavian countries, finds e_{he} to range between 0 and 0.4, while e_{hi} ranges between 0 and 0.28. This suggests that a fair long-run range for Lithuania's e_h is 0.1 to 0.7. It is expected that $e_z >= e_h$. Empirical studies such as Jongen and Stoel (2019) for the Netherlands show that e_h is only 0.05, while e_z is 0.21 in the long run. Lithuania's long-run elasticity of taxable income should also have a similar range, but is more likely to be from 0.2 to 0.8, with the most likely elasticities at 0.5 at the top and the bottom of the income distribution (the intensive margin more relevant for the top and the extensive margin for the bottom). This falls within the range of e_z estimates, although it exceeds the average of 0.3 (Neisser 2017).

One reason for the larger e_z in Lithuania could be the tax system. The narrower the tax base, hence many tax avoidance possibilities, the higher is the elasticity (Saez et al. 2012). The statutory net tax of Lithuania shows that avoidance possibilities exist, especially for the self-employed. Another reason could be the low level of law enforcement (Saez et al. 2012). The large shadow economy in Lithuania suggests that tax rules there are not enforced sufficiently. The final list of e_z is presented in Table 7. We assumed that the high

17. The unresponsiveness of elasticities to income deciles was explained in a more recent study for Slovakia by Senaj et al. (2015). There, e_{heh} falls to 0.06 from 0.16 e_{hel} when only prime age workers are considered, but not when a larger share of older workers are included. For Lithuania, then, where pensions are relatively low compared to the average wage, potential pensioners are also more likely to respond strongly to wages.

income corresponds to 12000.

While elasticities in Table 7 apply to the general population, which is dominated by employed households, it does not necessarily apply to average self-employed households. For instance, tax evasion can be higher amongst the self-employed, since they are not subject to third-party reporting. Indeed, the elasticities for the self-employed are found to be up to three times larger in Spain by Almunia and Lopez-Rodriguez (2019) and in Poland by Zawisza (2019). Other studies also show that elasticities of self-employed income are roughly two times higher than for other types of income (Neisser 2017). However, since we have no available elasticities for Lithuania, we leave this for future work.

Table 7: Ranges of elasticities of taxable income for Lithuania

	High income ($w \geq 12000 euro$)	Low income ($w < 12000 euro$)
η	[0.2, **0.3**, 0.5]	[0.2, **0.4**, 0.6]
ϵ	[0.1, **0.2**, 0.3]	[0.02, **0.1**, 0.2]

The preferred taxable income elasticities for Lithuania are **bolded** while the range of possible elasticities are in brackets. w is equivalised employment income, which includes employer's and employee's social contributions.

Society's preferences and other parameters

Another parameter is the society's preference parameter v. Saez (2002) in most cases used $v = 1$, which already has a high preference for redistribution, while $v = 0.25$ would be a lower point estimate. According to surveys, 92% of Lithuanians believe income inequality is too high, one of the leading countries in the EU. Additionally, Lithuania's government explicitly tries to reduce poverty and income inequality (LR Vyriausybė 2017). Therefore, v should be clearly positive and relatively high. We set $v = 1$ in the baseline and $v = 0.7$ as an alternative scenario.

The other parameters are derived from EU-SILC data itself. $H = 2199$ as this was the sum of net transfers from the EU-SILC survey, c_i^0 and h_i^0 was taken from the EU-SILC survey as well. $i = 1, 2, ..., 10$ so that each occupation constitutes about 10% of population, although the first bin is smaller, so that $w_0 = 0$.

6.3 The simulations

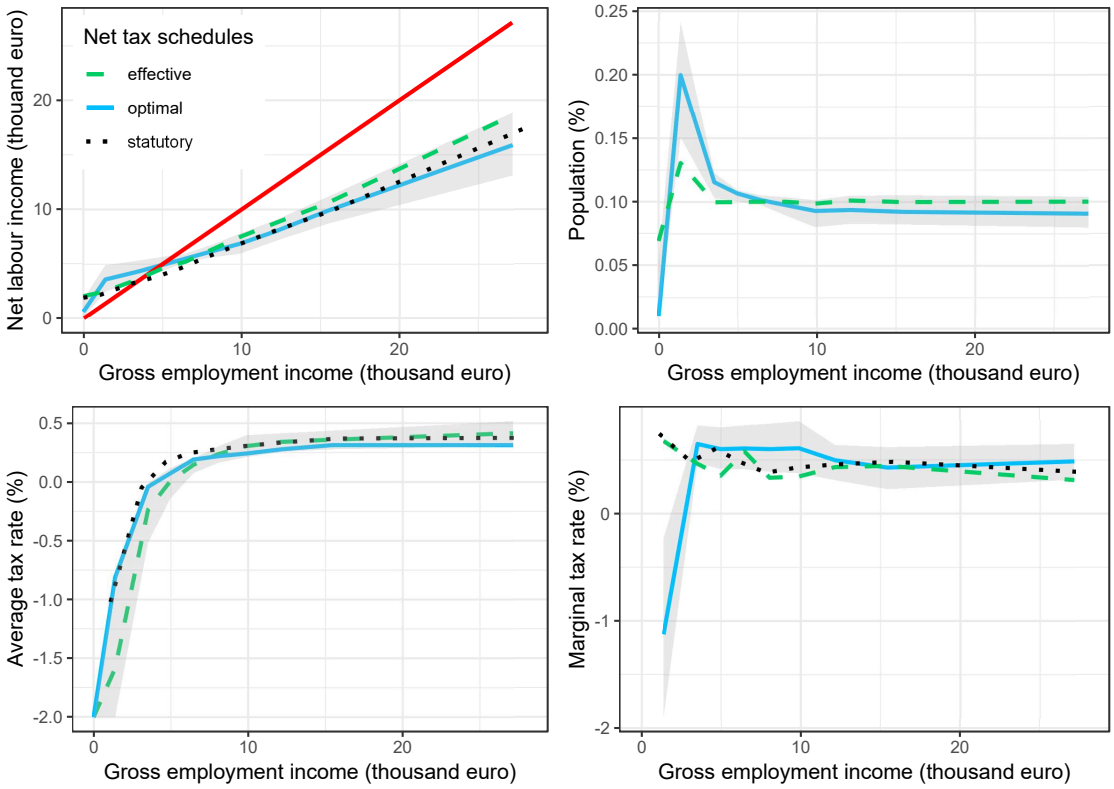
Given the model and the parameters, we utilise an R-package by Hasselman (2018) to run the simulations for Lithuania. We obtain four key variables: net labour income, population distribution by income, and average and marginal net tax rates. Information about each variable is presented in four graphs in Figure 6 and in Table 8. In each graph, the preferred parameter specification is depicted by a blue line, and alternative

parameter choices are presented as a shaded area around the blue line. The green dashed line represents the effective net tax schedule, and the black dotted line is the statutory tax schedule. Let us go through what messages each graphs suggest in turn.

The effective and statutory net tax schedule coincides with the optimal net schedule for the middle of the income distribution, but less for the tails. The figure on the top- left holds the transformation from gross employment income to net labour income. Effective net labour income and statutory schedule coincides with the optimal net labour income for middle (gross employment) incomes, and, in most cases, falls within the range of optimal schedules. At higher incomes, the optimal net labour income is slightly below the net labour income of the statutory and well below the effective net tax schedules. For those earning little gross employment income, the optimal tax rates suggest that more can be done to increase labour market participation and reduce unemployment: less income should be directed to the very poorest, and in-work credits should be provided. Unemployment and non-participation would then drop (from 6.9% to close to 0.9%) while the share of households employed at lower income levels rises (from 13.0% to 20.0%) because of more in-work credit, as illustrated by the top-right figure. The unemployment and non-participation drop should be taken with caution. The optimal net tax model does not distinguish between work capacity and household preferences. For example, some households may suffer from severe disability or wish to attend to their own children. In these cases, it may not make sense to fully remove benefits or expect that in-work incentives would encourage these people to work.

Effective/statutory average and marginal tax rates are close to their optimal levels in the middle of the income distribution, but not the tails. Optimal marginal tax rates for the bottom deciles are strongly negative: 112.4% of their gross employment income. This contrasts markedly with the effective positive 67.7% marginal tax rate for the bottom deciles. Additionally, the optimal marginal tax rate for the top of the gross employment income distribution is 48.7% while the effective marginal tax rate is 31.3% or about 11% below statutory. Empirical studies suggest that optimal tax rates tend to be much higher than statutory rates at top incomes. Saez (2002) shows that the majority of estimates of optimal tax rates for top incomes for the USA lie above 50%. Klemm et al. (2018) also find that the top optimal marginal tax rates exceed 50% and tend to be 10 - but sometimes even 30 - percent points above the statutory marginal tax rates in 27 countries. Therefore, the 11% difference is on the lower side of the estimates. Part of the reason for the gap is the large extensive labour elasticity in Lithuania for top incomes, which prevents taxing high incomes too high. Another reason is a large presence of self-employed.

Figure 6: Optimal, effective and statutory net tax schedules



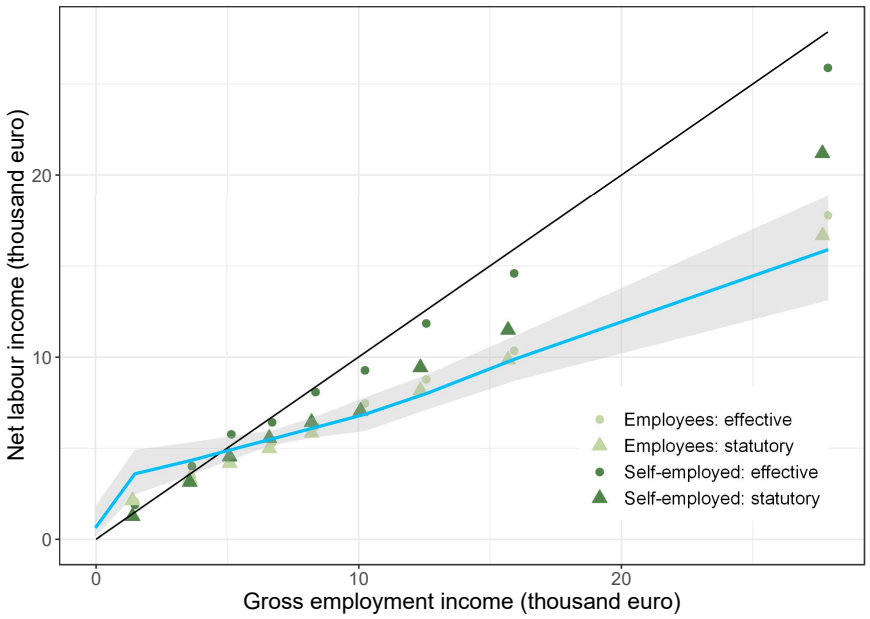
In each graph, the optimal net tax schedule with the preferred parameter specification (see Table 7) is depicted by a blue line while alternative parameter choices are presented as a shaded area around the blue line. The green dashed line and the black dotted line represents the variables distributions in line with the effective and statutory tax schedules respectively. The diagonal red line on the top-left figure is a 45 degree line depicting zero net taxes.

Table 8: Effective and optimal variables for Lithuania

percentile	gross employment income	net labour income[a]	net labour income[b]	percent of households[a]	percent of households[b]	average tax rate[a]	average tax rate[b]	marginal tax rate[a]	marginal tax rate[b]
0-7	0.0	2.1	0.6	6.9	0.9				
7-20	1.4	2.5	3.6	13.0	20.0	-81.2	-158.5	67.7	-112.4
20-30	3.5	3.7	4.4	10.0	11.5	-4.1	-23.5	46.4	64.8
30-40	5.0	4.6	4.9	10.0	10.7	7.4	0.8	35.4	60.1
40-50	6.5	5.2	5.5	10.0	10.1	19.1	14.7	57.9	60.7
50-60	8.0	6.3	6.2	10.0	9.8	21.9	23.6	33.4	60.1
60-70	9.9	7.5	6.9	9.9	9.3	24.2	30.5	34.6	60.9
70-80	12.1	8.8	8.0	10.1	9.4	27.8	34.1	43.3	49.7
80-90	15.4	10.6	9.9	10.0	9.2	31.3	36.0	44.5	42.9
90-100	27.1	18.6	15.9	10.0	9.1	31.3	41.4	31.3	48.7

[a] Effective variable. [b] Optimal variable. Gross employment income and net labour income are in thousand euro per equivalized household in Lithuania in the period 2014-2015. Share of households, average tax rates and marginal tax rates are in percentages. Number of observations per decile is available in Table 11 in the Appendix.

Figure 7: Statutory, effective and optimal equivalised tax schedules for households grouped according to income



The graph illustrates how household's equivalised gross employment income translates into equivalised net labour income for three tax schedules: effective, statutory and optimal. The effective and statutory tax schedules are presented as points (for each decile) for employees and the self-employed. The optimal tax schedule is calculated for the the total population aged 18-62, and excludes students. The shaded area around the dashed blue line illustrates a range of optimal tax schedules using a range of parameters as shown in Table 7. The data comes from EU-SILC, the simulation was carried out with the help of Euromod and the optimal tax schedule was computed along the lines of Saez (2002).

7 Statutory, effective and optimal net tax schedules for employees and the self-employed

Here, we compare statutory, effective and optimal (equivalised) net tax schedules for employee and self-employed households. The three net tax schedules coincide more for employees than the self-employed. This can be seen in Figure 7 where the two groups are distinguished. The effective and statutory net tax schedules for employees lie close to the optimal tax schedule, while the self-employed are further away - in most cases, outside of the optimal net tax schedules range. The self-employed are subject to lower statutory net tax rates which exceed the range of optimal net tax schedules for higher gross employment income deciles. Additionally, the self-employed effectively pay even lower effective tax rates than they are required. This holds true for the whole gross employment income distribution. There is also a smaller difference between the two groups at the bottom. The self-employed face relatively higher net tax rates than employees due to lower public transfers (compare Tables 4 and 5).

There are several possible ways to explain the large gap between the effective and statutory net tax schedules for the self-employed. The most likely explanation is tax evasion. In Lithuania, there is a tendency to under-report self-employment income or to not declare being self-employed at all, as previously noted by Navickė and Čižauskaitė (2018). Assuming that survey respondents are more willing to reveal their true self-employed incomes in questionnaires, we can compare the effective and statutory tax rates to obtain an estimate for evaded taxes in Lithuania, as done in Table 9. Employee households may not pay up to about 5.6% to 14.4% of their taxes, while the self-employed may evade as much as 69.9%, depending on the gross employment income distribution. Assuming that missing taxes arise from under-reported income, we see that these numbers are high, but plausible, given the empirical literature. An estimate for Lithuania is found in Kukk et al. (2019), who estimated income under-reporting of the self-employed in surveys to be around 25% to 30%, depending on the definition of "self-employed". The study, however, uses the consumption approach to estimate tax evasion, which should give a lower bound of under-reporting estimates. Also, income under-reporting in surveys does not necessarily mean that people equally under-report income to authorities. For example, the same study estimated that, in Estonia, the self-employed under-report 22% of their income, while Paulus (2015) estimated that as much as 71% of self-employment income is unreported to authorities, which is what matters for tax collection. Estimates from other countries are generally in line with what we expect given our results. Paulus (2015) finds that, in Estonia, up to 20% of employees under-report income. Paulus (2015) also finds that under-reporting is greatest at the tails of the income distribution, something also found by Johns and Slemrod (2010) for the USA. While there is greater under-reporting at the lower percentiles for Lithuania, the message is less clear for the top. However, this may be due to failure to capture top incomes in the survey for Lithuania. Many more studies find that the self-employed evade much more taxes than employees by under-reporting income. Baldini et al. (2009) finds that, in Italy, the self-employed tend to evade more income tax than employees. Pissarides and Weber (1989) find that the self-employed in UK actually have 1.55 times the reported income, meaning that they under-report income by 35% in the UK, while Slemrod (2016) cites IRS studies in the USA, where 56% of income may be unreported for the self-employed. A study by Artavanis et al. (2016) in Greece shows that the self-employed in certain professions, such as doctors, lawyers, engineers and scientists, as well as accountants and financial service agents, under-report more than half of their income.

Even though tax evasion is a likely explanation for the difference between effective and statutory tax rates for the self-employed, it is also reasonable to assume that some of this difference is due to measurement error.

Table 9: Estimated difference between statutory and effective tax schedules per equivalised household per year

percentile	% of statutory tax		th. euro	
	employees	self-employed	employees	self-employed
0-7				
7-20	4.76	64.12	0.02	0.28
20-30	10.30	57.10	0.14	0.62
30-40	13.72	46.82	0.27	0.75
40-50	10.89	50.87	0.28	0.96
50-60	8.75	63.99	0.29	1.50
60-70	9.00	61.01	0.36	1.96
70-80	9.25	63.95	0.47	2.33
80-90	6.07	67.33	0.39	3.17
90-100	8.11	63.41	0.94	4.83

The figures are derived from the difference between statutory and effective average tax rates from Tables 4 and 5 respectively. Percentiles are sorted according to the equivalised household gross employment income of all non-students aged 16-62.

However, it is not clear if in aggregate the error under- or overestimates the difference. First, Euromod does not model all taxes and contributions, which would result in lower tax evasion. Second, there might still be some income, particularly self-employment income, that is not reported to the authorities and not revealed in the questionnaire, which would mean greater tax evasion.

The difference in statutory rates between employees and the self-employed could be accounted for in several ways. For example, the government may perceive the self-employed more favourably than employees. There could be at least two reasons for this. One is that the self-employed would not be able to become employees, and this scenario is better than being unemployed. A second reason is that the government believes that the self-employed tend to contribute more to society, either by themselves producing significantly more earnings due to lower taxes, by supporting the rest of the economy by being entrepreneurs and eventually hiring more labour, or by producing other positive externalities (see Scheuer and Slemrod (2019)). However, the first theory does not stand up to the data and the literature, while the second lacks credible evidence. Regarding the first reason, the self-employed are bunched at the top of the income distribution. If these households tend to earn high incomes, it is not clear why they could not become employees or pay higher taxes as self-employed. Regarding the second reason, a minority of the self-employed, according to EU-SILC, could be considered entrepreneurs and less than 10% of self-employed at the top of income distribution have employees of their own.

This leaves the possibility that the self-employed are especially responsive to tax rate changes or bring

about large positive externalities - something that has not yet been tested for Lithuania. At the same time, a review of the literature suggests that a major reason for becoming self-employed is not entrepreneurship, but greater tax evasion/avoidance opportunities (Baliamoune-Lutz and Garello 2014). Additionally, the empirical literature is mixed concerning whether the self-employed respond to tax changes, thereby placing lower statutory rates into question (Baliamoune-Lutz and Garello 2014). For example, Bruce (2002) show that higher statutory tax rates on self-employed income in the USA did not lead to the closing of small businesses. On the contrary: higher proportional taxes on the self-employed, together with the possibility of offsetting losses, actually encourage entrepreneurship via a risk-sharing channel, as first explained by Domar and Musgrave (1944) and later found in empirical work (e.g. Baliamoune-Lutz and Garello 2014). What seems to deter self-employment is progressive self-employment taxes, as shown by Gentry and Hubbard (2000) for the USA and by Baliamoune-Lutz and Garello (2014) in Europe.

8 Conclusions, limitations and recommendations

We compared the statutory, effective and optimal net tax schedules for Lithuania for the period 2014-2015. We did this for all Lithuanian households and then looked at employee and self-employed households separately to investigate different forms of employment.

We found that the three schedules largely coincide for the middle of the income distribution for all households. The three diverge, however, at the tails of the income distribution. At the bottom of the income distribution, the optimal net tax schedule suggests that more in-work benefits should be provided for the least paid, to encourage employment. At the top of the income distribution, more effort could be made to extract tax revenue in order to improve tax compliance. The results for employee households were similar to that of all households.

We found that the three net tax schedules coincide more for employee households than for self-employed households. Except for those at the very bottom of the income distribution, the self-employed are subject to lower statutory net tax rates and very low progressivity, as compared to employees. Unfortunately, using the same elasticities for the employed and the self-employed does not allow us to draw strong conclusions about optimal taxes for the self-employed. Nevertheless, the self-employed do effectively pay much lower taxes than the statutory tax schedule would suggest. This holds throughout the income distribution and could mean that as much as 70% of self-employed taxes are not paid.

Our conclusion can be viewed as a conservative one. If we were to exclude pension contributions or consider all social contributions as generating actuarially fair benefits, the inadequacy in taxation levels would likely be even larger. The divergence would be greater still if we were to consider income taxes only, and not social contributions or benefits. Additionally, we considered a budget-neutral tax schedule. Finally, the fact that statutory rates differ substantially can explain why optimal taxes are also relatively low. Were there fewer opportunities to avoid taxes by having a broader tax base, measured elasticities would be smaller and optimal taxes would be higher.

As this is an initial step in comparing the three schedules, there are ways to improve the estimates. First, the EU-SILC is known to poorly capture top incomes; greater access to administrative data could help solve this problem. Second, the fact that the statutory tax schedule differs from the effective tax schedule for the self-employed means that the household misreport their employment status and incomes to the authorities, to EU-SILC or both. Third, we were not able to find Lithuania-specific long-run estimated elasticities, meaning that the current ones had to be taken from other studies. Nonetheless, such elasticities can be eventually estimated, particularly as a large income tax reform took effect in 2019. Obtaining taxable income elasticities for the self-employed and the employed separately would be especially beneficial. Fourth, one may consider a different set of elasticities or/and preferences for the optimal net tax schedules of employees and the self-employed. For example, society could value the self-employed more, or they themselves could be more responsive to wages.

The findings presented in this paper point to several recommendations.

First, the effective net tax schedule indicates that less taxes and social contributions are collected than households are statutorily required provide. Therefore, more effort can be placed on the auditing of households, especially at the upper tail of the income distribution, to extract more government revenue. Before doing so, the marginal cost of the audit and the marginal value of public funds should be estimated.

Second, the optimal net tax schedule recommends providing tax credits to those who receive low wages. Upon obtaining better estimates of the bottom of the distribution, this policy could be considered further. This is especially relevant with the resurgence of discussions on universal incomes, which counters in-work credit suggestions.

Third, the optimal tax schedule recommends less benefits to unemployed and non-active households. With the combination of lower out of work benefits and higher tax credits, households would be more inclined to seek employment. However, one would first have to consider at least the health and preferences of

households, as many benefits relate to health, disability and children.

Fourth, the benefits of the current lower statutory taxes for the self-employed should be closely weighted alongside the associated costs of lower tax revenue. As the majority of the self-employed are found at the upper tail of the income distribution, a great deal of tax revenue is not collected. Furthermore, international evidence shows that some companies start hiring and individuals start choosing self-employment purely for the purpose of paying less taxes. In such cases, it may be in the general interest to raise statutory tax rates for the self-employed closer to, or even above, the tax rates of employees.

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A Appendix

Table 10: Number of observations per decile from EUROMOD output

percentile	gross employment income	total observations	employed	self-employed
0-7	0	690	0	0
7-20	1,413	784	174	20-49
20-30	3,588	649	385	59
30-40	5,102	649	462	20-49
40-50	6,609	641	543	20-49
50-60	8,219	635	559	20-49
60-70	10,080	626	557	20-49
70-80	12,357	615	545	52
80-90	15,690	635	578	20-49
90-100	27,651	572	461	107

Data is sorted according to equivalised gross employment income (includes social contributions which are evaluated by Euromod). All figures are taken from Euromod and are weighted to include only those households with atleast 1 member who is 18-62 year old and is not a student. Deciles are based on weighted observations, which results in different number of observations per quantile. 20-49 indicates that there are between 20 and 49 (inclusive) number of observations, although the number is not publishable due to confidentially reasons. The first 7 percentiles do not have any gross employment income.

Table 11: Number of observations per decile from EU-SILC

percentile	gross employment income	total observations	employed	self-employed
0-7	0	680	0	0
7-20	1,395	787	300	20-49
20-30	3,525	629	501	60
30-40	4,972	636	557	20-49
40-50	6,470	653	602	20-49
50-60	8,047	631	576	20-49
60-70	9,888	623	569	20-49
70-80	12,141	619	557	55
80-90	15,425	625	569	20-49
90-100	27,143	576	467	107

Data is sorted according to equivalised gross employment income (includes social contributions). All figures are taken from Euromod and are weighted to include only those households with atleast 1 member who is 18-62 year old and is not a student. Deciles are based on weighted observations, which results in different number of observations per quantile. 20-49 indicates that there are between 20 and 49 (inclusive) number of observations, although the number is not publishable due to confidentially reasons. The first 7 percentiles do not have any gross employment income.

Table 12: Household statutory average net tax rates in Lithuania, net taxes as a share of gross employment income. Sample restricted to households with 1 household member aged 18-62, but can include older and younger household members as well.

percentile	net taxes			taxes		public transfers	
	all	employees	self-employed	employees	self-employed	employees	self-employed
0-24							
24-50	-0.946 [996]	-0.006 [281]	-0.012 [60]	0.354 [281]	0.327 [60]	0.361 [281]	0.339 [60]
50-75	0.116 [720]	0.170 [599]	0.003 [53]	0.398 [599]	0.303 [53]	0.229 [599]	0.300 [53]
75-100	0.293 [653]	0.312 [577]	0.207 [68]	0.419 [577]	0.295 [68]	0.106 [577]	0.088 [68]

Percentiles are sorted by gross employment income (includes social contributions). Taxes include income tax and social contributions. public transfers include old-age, disability, unemployment and other benefits. Net taxes are taxes minus public benefits. Gross employment income is taken from EU-SILC, while all other figures are estimated by Euromod, which takes into account various individual and household characteristics (e.g. age, health status). All figures are taken from EU-SILC and are weighted to include only those households with one member aged 18-62 and is not a student, but older and younger household members may be present. The number of observations per quantile is in [].

Table 13: Household average effective net tax rates in Lithuania, net taxes as a share of gross employment income. Sample restricted to households with 1 household member aged 18-62, but can include older and younger household members as well.

percentile	net taxes			taxes		public transfers	
	all	employees	self-employed	employees	self-employed	employees	self-employed
0-24							
24-50	-0.522 [996]	-0.064 [287]	-0.190 [55]	0.316 [287]	0.117 [55]	0.380 [287]	0.307 [55]
50-75	0.142 [721]	0.173 [605]	-0.115 [51]	0.362 [605]	0.105 [51]	0.188 [605]	0.221 [51]
75-100	0.285 [653]	0.323 [576]	0.018 [68]	0.399 [576]	0.082 [68]	0.076 [576]	0.064 [68]

Percentiles are sorted by gross employment income (which includes social contributions). Taxes include income tax and social contributions. Public transfers include old-age, disability, unemployment and other public benefits. Net taxes are taxes minus public benefits. All figures are taken from EU-SILC and are weighted to include only those households with one member aged 18-62 and is not a student. The number of observations per quantile is in [].