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The Elasticity of Taxable Income in Slovakia

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Abstract

This paper uses administrative panel data on employment income from years 2004-2018 to investigate the elasticity of taxable income (ETI) in Slovakia. I also exploit Slovakia's heavy reliance on employer social security contributions and different reforms of the income tax and contributions rates to elaborate on the standard results. First, I find consistently inelastic responses of the gross taxable income with the central estimate of about 0.07. On the other hand, the aggregate employer labour costs have negative elasticity with respect to the net-of-tax rate in almost all models. This demonstrates that legal incidence largely determines economic incidence of payroll taxes at least in the short run. Second, I show that the size of the ETI is determined by the salience of the tax reforms. Namely hikes in the employer contributions are found to induce significantly weaker responses relative to the changes in the income tax rate. Finally, I investigate the degree of income shifting between employment and self-employment income using shorter time-series of tax returns data and conclude that the usual ETI methods cannot accurately capture complete shifting of income occurring in Slovakia in the observed period.

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Non-technical Summary

The paper analyses dynamic effects of changes in the tax burden on labour by estimating the elasticity of taxable income (ETI) for employees and the self-employed in Slovakia. The elasticity represents the percentage change in declared gross taxable income following a 1% increase in the net-of-tax-rate (i.e. 1 – the marginal effective tax rate). Given the standard disincentive effects of higher taxation, the ETI is therefore expected to be positive. This concept has become widely used in the literature on behavioural reactions to taxation as an extension of the traditional labour supply elasticity. It is able to capture different types of optimizing behaviour besides changes in the labour supply and can therefore give a more complex picture of the impact of tax changes.

Using individual-level data from employment records and tax returns, the paper finds several results. First, the average ETI for the whole population in Slovakia is relatively small but consistent with findings from abroad. This indicates that tax changes have small impact on the motivation of a majority of employees to work or report higher income. However, high-income workers, in particular the top 1%, are a lot more sensitive to tax changes, which can reflect not only labour supply changes but also more room for optimisation. The same holds for the self-employed who have a higher ETI than employees because of the ability to control how much income they report.

Second, statutory incidence of payroll taxes has real economic impact in the short run. This means that formally levying taxes on the employer produces different outcomes than if they are imposed only on the employee. In particular, firms are found to bear the cost of increased employer contributions. They are unable to fully pass them on to workers in the form of lower gross wages and therefore see an increase in their total labour costs. On the other hand, if the personal income tax (PIT) rate is increased, the gross income as well as labour costs decrease.

Finally, the behavioural reactions are stronger to taxes that are more "visible" to the workers. In particular, employees do not perceive employer contributions as much as the PIT. Therefore, gross income falls by relatively less following a hike in the employer contributions than after an increase in the PIT rate.

1 Introduction

Developed countries around the world have been experiencing growing income inequality since the 1980s, which has given rise to a new trend in personal income tax policy in the recent years. Even though the record is still mixed, the previous trend of falling top marginal tax rates and rising top income shares is slowly reversing and the public debate is increasingly tilting in favour of taxing the highest earners more again. For example, the US substantially increased its top tax rates again in 1993 after numerous tax cuts over the previous decade, partially to combat the growing income inequality. Other cases of top tax hikes include among others the UK in 2010, Portugal and Slovenia in 2013, the French experiment with the 75% tax in 2013-2014, or the introduction of an additional top tax bracket in Canada in 2016 accompanied by several increases in the provincial tax rates since the Great Recession. On top of that, according to a recent OECD survey, the majority in all 21 participating countries and almost 70% of respondents on average favour higher taxation of the rich in order to support the poor (OECD, 2019b).

Slovakia has not escaped this movement either despite being a country with one of the lowest income inequality in the world.[1] After a radical overhaul of the entire tax system in 2004, which introduced a single flat tax system, subsequent reforms mostly increased the overall tax burden at the higher ends of the income distribution. In 2013, a second higher tax rate was introduced again and the ceiling on social security payments was increased. Starting from 2017, the health insurance contributions (HIC) are no longer subject to a ceiling and the maximum assessment base for the social insurance payments was increased yet further. It is true that some measures were taken to reduce the tax burden at the bottom as well, most notably the introduction of the employee tax credit in 2009 and the HIC allowance in 2015. However, both measures were constructed in a way that the effect of the former became null in 2015 and the latter could no longer be claimed by full-time employees in 2020 only due to the effect of fiscal drag. Indeed, fiscal drag alone contributed to an increase in the tax wedge faced by the average individual by 1.8 percentage points between 2013 and 2020 (Mikloš, forthcoming). Contrary to the evolution abroad, the overall change occurring in the observed period was therefore one of heavier taxation everywhere.

However, such changes come at a cost and there are limits to continued increases in the tax burden. It goes without saying that heavier taxation discourages work and effort. However, tax systems also create other distortions of market incentives. Various tax deductions as well as loopholes can lead to misallocation of resources when certain inefficient activities receive favourable tax treatment. On top of that, higher taxes can motivate higher tax evasion or even complete reallocation of the source of income abroad. Following the recent reforms in Slovakia, the share of income of the top earners has been falling sharply. At the same time, economic convergence of Slovakia has slowed down in the recent years. It is worth investigating to what extent these developments have been caused by the tax changes themselves. Understanding the behavioural responses to taxation can shed some light on this issue and serve as key for the design of optimal tax policy in general.

Earlier research in this area focused solely on the labour supply responses, whether on the extensive (labour force participation) or intensive margin (hours worked). However, such an approach cannot give a full answer because it deals with only a single part of the behavioural response to taxation. Academic research has more recently started investigating the elasticity of taxable income (ETI) as a whole to get a more complex picture. The ETI represents by how much the overall taxable income changes in reaction to changes in the tax burden expressed by the net-of-tax rate. It allows us to capture all channels that determine the fiscal effects of tax reforms in a single measure. In addition to the effects on the real economy through the labour supply, these include different types of tax avoidance behaviour as well as zero-sum bargaining over compensation (Piketty et al., 2014). The ETI therefore serves as a more accurate measure of the deadweight loss of taxation and under certain conditions is a sufficient statistic for optimal tax analysis (Chetty, 2009; Feldstein, 1999; Saez et al., 2012b).

The existing ETI literature has found elasticities of much higher magnitude than those usually found in studies focusing only on the labour supply.[2] The initial estimates were mostly above 1, which could have served as a justification for further reductions of the tax burden on the top earners. However, more recent papers with a more rigorous methodology keep finding inelastic responses of the taxable income to tax changes. This suggests that countries are far from the prohibitive range of the Laffer curve, even

[1] Based on the Gini coefficient of equivalised disposable income by Eurostat or the World Bank Gini index.

[2] Compare for example a review of the labour supply literature in Pencavel (1986) with the most recent meta-analysis of the ETI literature by Neisser (2018).

though the relationship between the ETI and revenue maximization is not so straight-forward (Creedy & Gemmell, 2013). In fact, Neisser (2018) shows that the ETI estimates were systematically higher when published in the earlier decades. Nevertheless, there is still a large variability of the results to different specifications and contexts considered. Different results are found in different countries and even for different reform periods in those countries.

This paper is the first such estimate of the ETI for Slovakia. I utilize administrative panel data on employment income of the entire population covering the period 2004-2018 and exploit the variation created by two major reforms which took place in 2013 and 2017. The reforms increased the burden on the top earners either through an increase in the maximum social security payments or an increase of the top statutory personal income tax (PIT) rate. I use a standard difference-in-difference methodology as well as a more recent regression framework of Gruber and Saez (2002) to investigate how gross income as the tax base responds to changes in the marginal *effective* tax rate (METR) including social security contributions (SSCs). Such elasticity estimates should be most directly comparable to the results from the existing literature.

However, the Slovak tax system is characterized by a high share of employer SSCs, but it is not clear how most papers deal with them in their calculations. I use a definition of the METR inclusive of the employer contributions in the baseline because they form part of the implicit tax burden on labour.[3] I then expand on the existing approaches by working with different income and METR concepts. I therefore also look at how aggregate labour costs to the employer react to changes in the same tax burden. This is then compared to the responses of the gross wage to changes in the tax burden legally incident on the employee alone in order to better understand the economic incidence of different taxation changes and the role salience plays in its determination. In classical models, legal incidence of taxes does not matter and economic incidence is determined only by the relative responsiveness of labour demand and supply (Fullerton & Metcalf, 2002). In practice however, numerous studies have found that legal incidence can affect economic outcomes. One of the factors is the fact that the employer contributions are paid on top of the contractual wage. They are thus not directly visible to the workers, so it is questionable how much employees react to changes in that burden. But even if employees do not react at all, the employer payroll taxes represent additional costs to firms which are also likely to react in some ways. By exploiting the unique design of the Slovak tax system and its reforms, this paper attempts to investigate these different aspects of the behavioural responses. Finally, using a more detailed dataset of individual tax returns covering a shorter time period of 2014-2018, I also look at the elasticity of self-employment income and investigate the degree of income-shifting between employment and self-employment income.

The baseline results are quite in line with the findings elsewhere in the literature. I find inelastic responses of the gross income to changes in the marginal tax wedge across different specifications. The ETI estimates range from 0.02 to 0.11 in most models with the preferred central estimate of 0.07, but some specifications yield estimates as high as 0.8. These numbers also confirm the hypothesis that richer individuals tend to exhibit higher responsiveness relative to the rest of the income distribution. What is more, the substantially higher reaction which is found for the 2013 reform also sheds some light on the salience of more or less visible changes because the 2013 reform was the only one which included an explicit increase in the statutory PIT rate.

Breaking this down further into the burden on the employer and the employee, the results show a completely different picture. Almost all models yield negative elasticity estimates for the aggregate labour costs with some as low as -0.66. This means that despite some reduction in the gross income, total payments by the employers increased following the reforms nonetheless. This can be explained by the fact that most of the tax changes were driven by increases in (mostly employer) contributions. The 2013 reform proved again to be the only exception with the labour-cost elasticity around 0.3. On the other hand, employees show a much stronger reaction to more visible changes in the marginal tax rate faced by them alone and ignoring the employer contributions. The key elasticity results range from 0.25 to 0.35, but the response is even found to be elastic for the 2013 reform (elasticity of 1.02-1.04). Overall, these results support two key conclusions. First, salience of the tax reforms is another major factor explaining the variability of the size of the behavioural reactions. Second, legal incidence also matters for economic incidence of taxes, at least in the short run. Both of these findings have significant implications for the optimal design of the tax system.

[3] This is also called the marginal tax wedge in the OECD *Taxing Wages* methodology.

Finally, resorting to the tax-return data validates most of the previous results. The data also allow us to estimate the ETI for the self-employed, which I find to be slightly higher than for the employees, with the value in the range 0.12-0.19. This is consistent with the fact that the self-employed can claim substantially higher deductions than employees (see Kopczuk 2005 for a discussion of the role of deductions). On the other hand, the cross-tax elasticity which serves as a measure of income-shifting between the two types of income is estimated to be positive for employment income and negative for self-employment income. The former result is counter-intuitive because it suggests that employment income grows when the tax burden on the self-employed is reduced. This is refuted by other evidence from the data on compulsory health insurance contracts and thus suggests that the standard ETI methodology is not very reliable for estimating income-shifting in the context of Slovakia.

The rest of the paper comes in six sections. The next section reviews the main aspects of the existing empirical and theoretical literature on the elasticity of taxable income. Section 3 describes the key features of the existing Slovak tax system, which is followed by a section describing the data used in the analysis. The subsequent Section 5 deals with the methodology. It outlines the theoretical model and describes the empirical strategy including the specific tax reforms in Slovakia used for identification. The main results together with alternative specifications and several robustness tests are presented and discusses in Section 6. The last section then concludes.

2 Overview of the Previous Literature

Textbook analyses of the efficiency costs of taxation tend to focus solely on the labour supply responses. In a static model with leisure and consumption where individuals choose how much to work, income taxation reduces the net wage received. Given that the wage is the implicit relative price of leisure, increased income taxation increases demand for leisure and therefore reduces the labour supply in turn. This is then manifested in shorter hours worked when the solution is an interior one or a decision whether to work at all as the corner solution. As with all taxes, income taxation therefore discourages the very activity it taxes.

However, a relative consensus has emerged among economists over the years. Given the existence of certain hours constraints (see Altonji & Paxson, 1988), the labour supply elasticity of full-time working men is close to zero even though it can be substantially higher for women, especially those with children.[4] Yet this knowledge is not enough if people respond to taxation in other ways than varying their hours worked. Piketty et al. (2014) decompose these responses into three broad categories. In addition to the real labour supply elasticity, taxpayers can vary the amount and form of income that they formally declare to the tax authorities. These tax avoidance activities can include changing ways of compensation (non-monetary compensation, fringe benefits), intertemporal substitution (timing of bonuses, stock options, capital gains realizations), shifting of income between different tax bases, changing type of employment form or business organization, or even tax evasion and migration. The final channel is through zero-sum bargaining over how the aggregate income gets divided between different individuals. All of these optimizing reactions affect the composition and distribution of declared taxable income and can thus potentially lead to efficiency losses. Investigating the reactions of the broad tax base as a whole can therefore offer more insight into the efficiency costs of taxation.

Lindsey (1987) was the first to focus on all margins of behavioural responses to changing taxes in a single measure. He used repeated cross-sectional data to provide the first estimate of a comprehensive ETI for the US and found a value close to 2. However, it was Feldstein's (1995) seminal article which inspired widespread research in the area. Using a difference-in-difference approach with US panel data, he also found an elasticity above one but sometimes even as high as 3. These early results suggested that the income tax base is very elastic and responds sharply to any changes in the tax burden. Subsequent research focused predominantly on the United States and exploited the large tax reforms of the 1980s and 1990s which were targeted at the highest earners. However, as was already pointed out by Navratil (1995), a long-term trend of increasing income inequality in the US at that time can substantially bias the estimates upwards. Another problem is caused by the fact that individuals with high transitory income components in one year will tend to 'revert to the mean' in the following years.

[4] Overview of the empirical labour-supply literature is done for example by Blundell and MaCurdy (1999), Heckman (1993), Killingsworth and Heckman (1986), and Pencavel (1986) among others. Recent empirical evidence on the role of hours constraints can be found both in the US (Martinez-Granado, 2005) as well as European (Müller et al., 2018) context.

Numerous scholars had since then attempted to improve the methodology to provide more accurate estimates. Auten and Caroll (1999) propose to control for pre-reform income levels in a simple log-linear fashion and find substantially lower elasticity of about 0.6 in the main models. As an alternative, Gruber and Saez (2002) developed a model which became the workhorse method in the ETI literature. It allows for the use of a full time-series of evidence with potentially more reforms than the standard difference-in-difference methods. In addition, more sophisticated base-year income control can be used with more years of data and as a result they find their elasticity estimates for the US range between 0.1 and 0.6. On top of that, their method also allows the income effects of tax reforms to be estimated as well even though they find them to be small and insignificant.

However, a growing number of studies revealed large sensitivity of the results to different specifications used. Difference-in-difference estimates around a single reform vary strongly with the choice of comparison years or the definition of the treatment and control groups among others (Saez et al., 2012b). The results will also be different for different reform periods in the same country, which as Kopczuk (2005) suggests is due to the availability of deductions in the tax system at that time. As more data becomes available, results from many other counties emerge as well. For example, Kleven and Schultz (2014) find the ETI ranging between 0.04 and 0.1 in Denmark with negligible income effects. Paetzold (2019) calculates similar ETI of around 0.1 for Austria using bunching techniques. In the Netherlands, the elasticity of 0.1 is found only immediately after the reform but increases to 0.24 in the longer run (Jongen & Stoel, 2019). Blomquist and Selin (2010) estimate the elasticity in Sweden at around 0.2 for men but above 1 for women and also find substantial income effects. Similar results are found in Hungary where the ETI ranges between 0.2 and 0.3 for high-earners and also with substantial income effects (Bakos et al., 2008; Kiss & Mosberger, 2014). The estimates are also somewhat higher at about 0.14-0.3 in Canada (Sillamaa & Veall, 2001) or 0.6 in Germany (Gottfried & Schellhorn, 2004). Overall, Neisser (2018) quantifies the impact of different estimation techniques and contextual factors in a recent meta-analysis using more than 1400 ETI estimates from 51 studies. Other than that, a comprehensive overview of the methodology and the main empirical findings from the US as well as other countries is also done by Saez et al. (2009; 2012b).

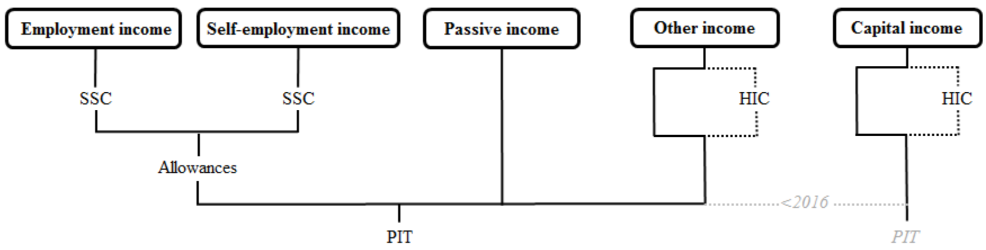
Nevertheless, several conclusions can be drawn from the existing ETI literature so far. The results are in stark contrast with the traditional labour-supply estimates. The elasticity of taxable income as a whole is usually quite substantial, but the most recent studies keep finding values below one, which suggests that it is still quite inelastic. However, the economists are far from arriving at a consensus value. Not only are the results different across countries and reforms, the values vary substantially with different estimation methods and control variables used (see Neisser, 2018). It is therefore important to continue with the research in this area. To the best of my knowledge, this paper provides the first such estimate of a comprehensive ETI for Slovakia and contributes to the literature by analysing how salience of the reforms affects the results. At the same time, due to a more rigorous treatment of the different definitions on income and marginal tax rate, the results contribute to the discussion on the incidence of taxation.

Estimating the economic incidence of different taxes represents a different strand of the literature. The classical proposition states that legal incidence of taxes does not matter and economic incidence is determined only by the relative elasticites of labour demand and supply (Fullerton & Metcalf, 2002). However, the empirical research provides evidence to the contrary. The central estimate from a meta-analysis by Melguizo and González-Páramo (2013) suggests that workers bear around two-thirds of the tax burden in the long run, but there there is large variability of the estimates as in the ETI literature (see also European Commission, 2015 for a detailed narrative review of the tax incidence literature). More importantly however, several studies show that statutory incidence plays a role in certain contexts. For example, Lehmann et al. (2013) find that increases in the employer contributions in France are fully reflected in the employer costs and have no impact on gross wages, at least in the short term, and Saez et al. (2012a) find the same for Greece even in the long run. This paper adds to the evidence using different tax reforms in Slovakia.

3 The Slovak Tax System

Despite some adjustments over time, personal income in Slovakia consists of five components which are treated differently at the intermediate steps but are eventually aggregated into a single PIT base. This is done only at the national level and for each individual taxpayer separately although there exist certain family-based benefits.[5] A simple graphical outline of the tax system is depicted in Figure 1. The first two main components are employment and active self-employment income. Both are first subject to social security contributions separately based on slightly different principles and are then considered jointly for several tax allowances where these social security payments are deductible. The next main component is capital income, which includes interest income, dividends, and realized capital gains among others, only some of which is liable for health insurance payments alone. It became a separate tax base in 2016. However even before, around 90% of all capital income was cleared separately through the withholding tax and thus never entered the PIT calculations. As a result, there is very little micro-data on capital income to work with and even those data have little variability. Therefore, the rest of the paper will not focus on capital income and will instead investigate only the elasticity of taxable *labour* income, i.e. the first two components only. The remaining components include passive income such as income from renting of property, and other income, with only some liability for health insurance contributions (HIC) again, but these are relatively marginal and will not be investigated in detail either.

Figure 1: Simple outline of the Slovak personal income tax system



Employment income is subject both to the employer and employee SSCs. The gross wage serves as the assessment base for the SSCs and employer contributions are paid on top of this wage which means that the actual costs to the employer are higher than the contractual gross wage itself. The amount paid for social security, whether by the employer or the employee, is then no longer subject to the PIT. Other than that, even though there exist numerous exceptions, allowances, or reduced rates for certain groups of workers (particularly more vulnerable groups such as students, pensioners, the long-term unemployed, or other short-term contracts) the Slovak tax system has essentially no deductions for employees. Therefore, unlike in many other countries, the concepts of broad and taxable income, which are so widely distinguished in the existing literature, are essentially the same in Slovakia.

On the other hand, the treatment of self-employment income is more complicated. First, unlike with employment income, SSCs are calculated based on the previous year's income, are subject to a minimum assessment base as well, and the rates are slightly different.[6] Second, even though self-employment income is part of the same personal income tax base as employment income, there are two different ways of claiming deductions and arriving at the taxable self-employment income. The first way resembles a normal corporation where the self-employed does standard accounting and their taxable income is equal to revenue minus allowable expenses.[7] However, there exists an alternative to simplify administration for small contractors; deductible expenses are calculated simply as a percentage of revenue up to a certain limit.[8] The latter option can significantly reduce the average tax burden on the self-employed, especially if they have no significant expenses, and can thus motivate income shifting for optimization purposes.

4 Data

I work with administrative panel data on gross income from employment for years 2004-2018, using individual-level monthly data from the Social Insurance Agency (SIA) which are then aggregated to yearly amounts. There are around 2.3 mil. individuals in the dataset each year, year-on-year changes can be tracked for around 2 mil. individuals a year, and around 860'000 individuals have an unbroken career record during the entire 15 years.

[5] For example the tax allowance for an unemployed/low-income spouse or the child tax credit.
[6] In particular, the self-employed do not pay work accidents insurance, employer insolvency insurance, and unemployment insurance, but pay higher sickness insurance.
[7] This in principle resembles using itemized deductions in the US.
[8] This is more akin to the non-itemizers' use of standard deductions in the US, but only for the self-employed.

The marginal tax rates and total tax liabilities are imputed using own tax calculator with several simplifications necessary due to the nature of the data. First, Social Insurance Contributions (SIC) in the Slovak system are calculated on a monthly basis, but since I am working with aggregated yearly amounts, the calculation of the SIC is also simplified to yearly amounts. This can slightly distort the picture for higher earners who optimize by paying large bonuses in a single month above the monthly maximum assessment base even though their total yearly income is below twelve times the monthly cap. Second, everyone is treated as an individual, so I abstract from the effect of the spouse tax allowance and children tax credits. Moreover, no distinction is made between different contractual forms behind the sources of income. As already mentioned above, there are numerous exceptions or reduced rates for different groups of employees, but these groups cannot be properly identified from the data and their income disentangled from other potential sources of income when working with total yearly amounts. Therefore, the tax simulation does not account for these differences and everyone is assumed to face the full SSC and PIT rates as a standard full-time employee over their entire income. This can introduce certain distortions at the bottom of the income distribution where such exceptions are most prevalent. However, most of the analysis in this paper focuses on individuals with at least average income, so the main results should not be affected. Finally, the simulation also does not consider the international aspect of taxation. The data contain information on all domestic labour income which is assumed to be fully tax liable at home, but at the same time it does not include income from abroad which might be subject to the domestic PIT, but these types of income are likely negligible.

In addition, using the data from the SIA might not be a perfectly accurate measure of the true labour income. Gross income is derived from the reported assessment base of the accidents insurance, which is a part of the compulsory SIC and is without an upper limit. However, certain groups of workers such as some corporations managers, judges, or prosecutors do not pay accidents insurance, so their income can only be derived from other assessment bases which are subject to a ceiling. Plotting the distribution of this derived gross income shows clear evidence of bunching at the maximum assessment base (see Figure A1 in the Appendix). This suggests that the top incomes for those who have the potential to earn the most can be underestimated in this dataset. However, the absolute number of observations affected this way is very small, so it should have negligible impact on the results.

Another disadvantage is that the social insurance database contains information only on employment income and not on any of the other types of income. This distorts the calculation of the marginal tax rate and the total tax liability for those who have income from several sources because the different types of income are parts of the same PIT base. This is most acute for those who also have self-employment income on top of the standard employment income. This group of people represented around 5% of all employees and around 26-27% of the self-employed in years 2014-2018. Second, using only employment income in the analysis distorts the picture of the overall elasticity of taxable income. The elasticity estimates will be biased upwards mainly due to the presence of potential income shifting between employment and self-employment. Hence, even though employment income might respond sharply to an increase in the METR, the overall labour income would respond by less if part of the employment income is shifted towards self-employment, which did not experience such a significant METR change.

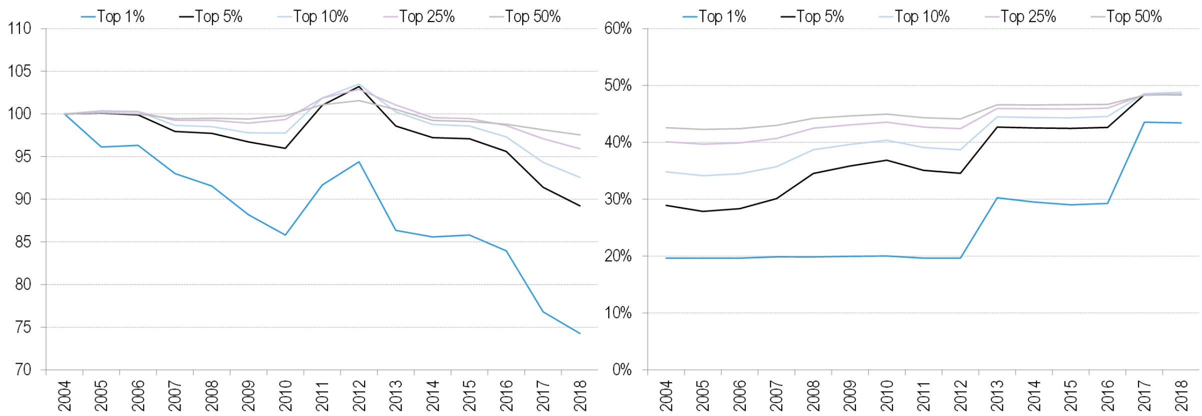
An alternative would be to work with individual tax returns which are the standard data source in this type of research abroad. Indeed, working with tax-return micro-data would substantially improve the picture because they contain a more detailed breakdown of the various sources of income. Tax returns include information on employment income, self-employment income and expenses, and whether they are calculated as allowable expenses or as a percentage of revenue, and also income from abroad. The problem is that such high-quality individual-level tax-return data is available only for years 2014-2018, which is not sufficiently long for the analysis conducted here. Therefore, I will rely primarily on the Social Insurance Agency data and use the tax returns only for certain robustness checks. The comparison of the summary statistics for the two data sources is presented in Table A1 in the Appendix.

Figure 2 plots the time-series of the aggregate data. Panel (a) shows the evolution of the income share of selected top-income groups indexed to 100 in 2004. What surprises at first sight is the falling inequality over time measured in this way. The top 1% income share has fallen from over 10.5% in 2004 to less than 8% in 2018. This fall has been continuous during the whole observed period except for a brief period in 2011-2012. Using the tax-return data (not shown here) confirms the same pattern, so it cannot be driven by the data shortcomings. Yet despite this atypical trend relative to the rest of the world, the income-weighted average marginal tax wedge for the same income groups have been steadily increasing

Figure 2: Evolution of top income shares and marginal tax rates in Slovakia over the last 15 years

(a) Income shares

(b) Average METR



as shown in panel (b). The biggest changes occurred in years 2013 and 2017 and this coincides with a strong fall of the top income shares in those years as well. This simple graphical evidence suggests that the expected ETI among the top earners is likely to be quite high.

5 Methodology

5.1 Micro-economic model

Estimation of the key elasticity parameters relies on the standard identification strategy in the ETI literature. It tries to explain changes in individuals' taxable income between years with changes in the marginal tax rates faced by the same individuals over the same period. The empirical framework is based on a traditional labour-supply model extended to cover the entire taxable income. Individuals choose consumption c and taxable income z to maximize a utility function $u(c, z)$ subject to a budget constraint $c = z - T(z)$ where $T(z)$ is the total tax liability as a (potentially) non-linear function of market income z. In this model, the taxable income z captures all possible margins along which taxpayers react to changes in the tax laws, including hours worked but also income shifting, tax evasion and others.

Using the virtual income specification of Kleven and Schultz (2014), the budget constraint can be rewritten as $c = (1 - \tau) \cdot z + y$ where τ is the marginal effective tax rate and $y = \tau \cdot z - T(z)$ is virtual income that would compensate the taxpayer if they faced the marginal rate τ over their entire income. The optimal choice of taxable income $z^* = z(1 - \tau, y)$ can then be written as a function of the marginal net-of-tax rate and the virtual income. A small change in the marginal rate τ changes the virtual income y as well, which together affect the taxable income supply as follows

$$dz = -\frac{\partial z}{\partial(1-\tau)} \cdot d\tau + \frac{\partial z}{\partial y} \cdot dy. \tag{1}$$

Defining the *uncompensated* elasticity of taxable income with respect to the marginal net-of-tax rate as

$$e = \frac{\partial z}{\partial(1-\tau)} \cdot \frac{1-\tau}{z} \tag{2}$$

and the income elasticity of taxable income as

$$\eta = \frac{\partial z}{\partial y} \cdot \frac{y}{z} \tag{3}$$

the percentage change in taxable income can be expressed as

$$\frac{dz}{z} = -e \cdot \frac{d\tau}{1-\tau} + \eta \cdot \frac{dy}{y}. \tag{4}$$

Using a log-log specification that is standard in the ETI literature, the baseline regression framework is

$$\Delta ln\, z = e \cdot \Delta ln(1-\tau) + \eta \cdot \Delta ln\, y \tag{5}$$

This model allows us to separately identify the income effect resulting from a change in the after-tax income, and using the Slutsky equation, also the substitution effect resulting from a change in the slope of the budget constraint.

5.2 Regression methods

Estimating equation (5) using a simple OLS regression would produce biased estimates of the elasticity parameters because of endogeneity of both the marginal tax rate and virtual income. Due to the progressivity of all standard tax systems, including that of the Slovak Republic, the marginal tax rate (and in turn the virtual income) is determined by the size of the taxable income. For example, any shock that would increase income could also lead to an increase in the METR if it forced the taxpayer into the next bracket. Therefore, this correlation of the regressors with the error term requires a different treatment.

The literature has developed several methods based only on legislated tax reforms. These serve as natural experiments allowing the use of such exogenous changes in the METR as instrumental variables for the endogenous regressors. The simplest method made famous by Feldstein's (1995) seminal paper implements a difference-in-difference principle by comparing the behaviour before and after a specific tax reform of sufficiently similar groups facing a different change in the marginal rate. The disadvantage of this approach is that it cannot control for the virtual income as specified in the micro-economic model and so implicitly assumes that income effects are zero. Equation (5) then takes the form

$$ln\, \frac{z_{i1}}{z_{i0}} = e \cdot ln \frac{(1-\tau_{i1})}{(1-\tau_{i0})} + \varepsilon_{it} \tag{6}$$

where the subscript $i0$ represents an observation of a given individual in the pre-reform period and $i1$ in the post-reform period. Because the change in the marginal rate $\Delta ln(1-\tau_i)$ is correlated with the error term ε_i, Equation (6) is estimated using two-stage least squares (2SLS) with the treatment group indicator $1(i \in T)$ used as the instrument, where individuals are assigned to the treatment and control groups based on their base-year income z_{i0}. Consequently, this method requires that only a specific part of the income distribution experiences a significant change in the marginal rate, for example the top 1% of earners (the treatment group), while the rest of the population remains relatively unaffected (the control group). As a result, it cannot handle well reforms whose effects are spread across the whole income distribution and by virtue of focusing only on a single reform period, it cannot fully utilize the entire time-series evidence if multiple reforms took place.

An alternative method developed by Gruber and Saez (2002) has become the workhorse model for estimation of the ETI in the most recent literature. Instead of using a simple difference-in-difference principle, instrumental variables for the endogenous regressors in Equation (5) are computed using predicted marginal rates and virtual income in the case of no behavioural response. The predicted METR $\widehat{\tau_1}(z_0)$ is the marginal rate that the individual would face in the post-reform period if their real income did not change from the pre-reform period. Using the predicted METR, we can derive the predicted marginal net-of-tax rate change $ln[(1-\widehat{\tau_{i1}}(z_{i0}))\,/\,(1-\tau_{i0})]$, which serves as an instrument for the actual change in the METR. Similarly, the predicted virtual income is defined as $\widehat{y_1}(z_0) = \widehat{\tau_1}(z_0) \cdot z_0 - T_1(z_0)$, which represents virtual income in the post-reform period if the individual had the same real income as in the base pre-reform year. The predicted change in virtual income $ln[\widehat{y_1}(z_0)/\widehat{y_0}(z_0)]$ is then used as an instrument for the actual change in virtual income. Constructing instruments in this way isolates only the mechanical changes in the tax parameters resulting directly from the reforms and allows a direct estimation of the income effect η as well. In addition, this model can fully exploit the tax changes across the entire income distribution as well as data from multiple years potentially covering several different reform periods. It is thus more flexible than a simple difference-in-difference specification.

Next, even though using valid instrumental variables to estimate Equation (5) cleans up the mechanical correlation of the marginal net-of-tax rate with the post-reform income z_1, the instruments remain dependent on the pre-reform income z_0. If any unexplained components of the overtime change in taxable income, which are captured by the error term, are correlated with z_0, the instruments will not be valid and even an IV regression of Equation (5) will yield biased estimates of the elasticity parameters.

There are two main mechanisms discussed in the ETI literature which make individuals with different initial income experience different overtime income changes that are unrelated to the tax reforms. The first is a natural trend in the income inequality in a given country. As already mentioned in the introduction, most developed countries have been experiencing increasing income inequality for numerous reasons not explored here. However, if individuals with higher incomes tend to experience higher income growth, there will be a positive correlation between the error term and the base-year income z_0. The second reason is mean reversion of transitory income shocks. If income is temporarily high in the pre-reform period due to a positive income shock, it will tend to be lower in the subsequent years, and this in turn creates a negative correlation between z_0 and ε. Even though these two channels usually act in the opposite direction, there is no *a priori* reason for them to cancel out. In fact, as Figure 2 (a) above shows, the income distribution in Slovakia has had a tendency to shrink over time even for non-tax reasons, which means that the two sources of instrument endogeneity reinforce each other in this case. It is therefore important to explicitly address this issue.

One solution advocated by Saez et al. (2012b) in the case when only two years of data are available and the tax changes are targeted at a specific part of the income distribution is to use the original approach by Lindsey (1987). One can ignore the panel structure of the data altogether and instead conduct a repeated cross-sectional analysis. It is also the method employed by Kleven and Schultz (2014) in their analysis of the graphical evidence on taxable income changes in Denmark. The regression specification is

$$ln\, z_{it} = e \cdot ln(1 - \tau_{it}) + \beta_1 \cdot 1(t = 1) + \beta_2 \cdot 1(i \in T) + \varepsilon_{it} \qquad (7)$$

where $1(t = 1)$ is the post-reform year dummy and $1(i \in T)$ is the treatment group indicator, and the treatment and control groups are identified separately for both time periods based on the corresponding income. Estimating Equation (7) using 2SLS with the post-reform $\times$ treatment-group indicator $1(t = 1) \cdot 1(i \in T)$ as the instrument for the marginal net-of-tax-rate will yield an unbiased difference-in-difference estimate of the ETI as long as the income distribution is stable between the years in the absence of tax changes. Furthermore, this model is not vulnerable to mean reversion because individuals are not tracked over time as in the panel analysis. However, the results will still be biased if the income distribution is changing as is the case of Slovakia. On top of that, as Saez et al. (2009; 2012b) showed, the results are extremely sensitive to the reform episode considered, the choice of years compared, and the definition of treatment and control groups among others.

Instead, the standard method for dealing with the correlation between ε and z_0 which became established in the ETI literature is to control for flexible specifications of past income in the baseline regression (5). Auten and Carroll (1999) were the first to address this problem by including the log of base-year income $ln\, z_0$ in the regression. However Gruber and Saez (2002) point out that simple $ln\, z_0$ would not be enough if the correlation was non-linear, and richer controls would be needed. They therefore include ten decile-based splines in the log base-year income instead, which is sufficient for unbiased estimates as long as the correlation between ε and z_0 does not change over time. Kopczuk (2005) brings this even further by experimenting with the log of income from the year preceding the base year, growth in the base-year income relative to the previous one, 10-piece splines of those variables, and their various combinations in order to control separately for income inequality trends and the mean-reversion problem. However, Weber (2014) argues that regardless of the income controls, the predicted mechanical changes in the

METR will not be exogenous and suggests that lagged mechanical changes should be used instead to ensure validity of the instrument. Nevertheless, this was not possible in some of the earlier studies. Using such sophisticated controls for past income requires multiple years of data, potentially with multiple reform periods at different points in the income distribution. Otherwise, the control variables would soak up too much of the independent variation and destroy identification of the effect of the tax reform itself.

Stacking multiple years of data together therefore allows us to estimate the elasticity parameters using the final regression framework

$$ln\,\frac{z_{i1}}{z_{i0}} = e \cdot ln\frac{(1-\tau_{i1})}{(1-\tau_{i0})} + \eta \cdot ln\frac{(y_{i1})}{(y_{i0})} + f(z_{i0}) + \theta_0 + \varepsilon_{it} \tag{8}$$

where θ_0 represents base-year dummies and $f(z_{i0})$ captures the different possible controls for the pre-reform income. Based on the discussion in this section, Equation (8) can be estimated by 2SLS using two different methods. The first method assumes that $\eta = 0$ and implements a simple difference-in-difference principle by using the base-year treatment group × reform year interaction $1(i \in T_0) \cdot 1(t = t_{reform})$ as the instrument for the log change in the net-of-tax rate. The second uses predicted change in the METR $ln[(1-\widehat{\tau_{i1}}(z_{i0}))\,/\,(1-\tau_{i0})]$ as an instrument instead and also instruments the actual change in virtual income using the predicted change $ln[\widehat{y_1}(z_0)/\widehat{y_0}(z_0)]$ in order to estimate the income effect η. To compute these synthetic variables, base year income is first inflated using the growth of the average income from the dataset and then plugged into the tax calculator using all the tax system parameters (including nominal rate thresholds) from period 1.

In addition, the aggregate elasticity e is estimated by weighting (8) by individuals' income in both cases because high-income individuals contribute proportionally more to the total response of the population (Gruber & Saez, 2002; Saez et al., 2012b). However, Weber (2014) cautions that such an approach can also bias the results. Neisser (2018) shows that unweighted elasticity estimates are systematically lower and preliminary tests (not presented) uncover the same pattern here as well. Finally to account for potential correlation of a given taxpayer's unexplained income changes over time, standard errors are clustered at the individual level.

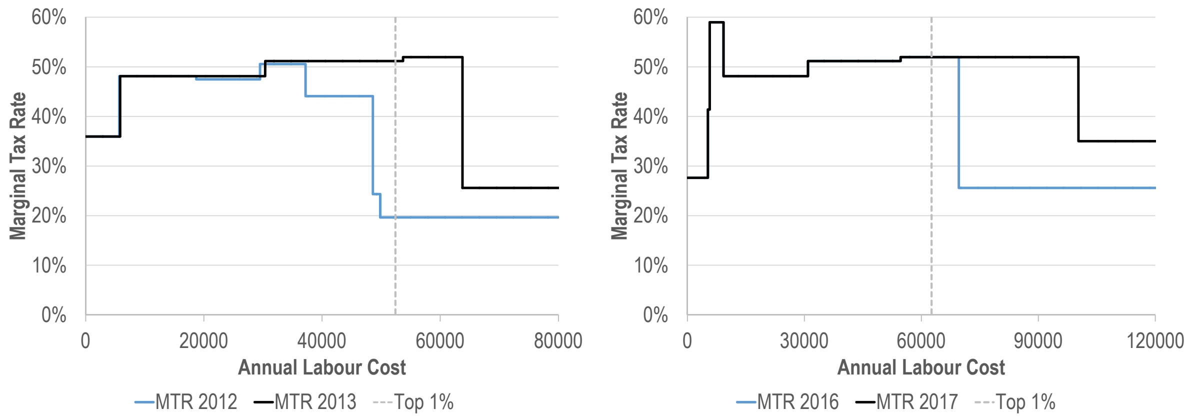
5.3 Identification in the Slovak context

As already mentioned in the previous section, Slovakia experienced two major tax reforms during the observed 15 years. In 2013, the maximum assessment bases for different social insurance and health insurance contributions were unified and increased. In addition, a 2nd income tax bracket with the statutory rate of 25% was introduced to a previously flat personal income tax system of 19%. In 2017, the maximum assessment base for the SIC was increased yet further and the ceiling on HIC payments was abolished altogether. However, this reform was probably more concerned with raising revenue rather than addressing any income inequalities. As a result, the reform was not communicated to the public sufficiently, which is supported by the fact that both measures were introduced only as legislative amendments by parliamentary committees rather than by the government itself. This could have created certain information asymmetry with implications for the salience of the reform further investigated below.

The effects of these two reforms were concentrated mostly among the top 1% of earners as shown in Figure 3, so they offer ideal variation for the difference-in-difference estimation strategy with the top 1% as a natural treatment group. Nevertheless, besides the two main reforms targeting the highest earners, the rest of the income distribution experienced significant changes in the tax burden throughout the observed period as well. For example in 2007, a phase-out was introduced to the PIT allowance, which essentially served as a separate tax bracket with 0% marginal rate until then. The PIT allowance was then temporarily increased for low-income individuals and reduced for the better-off as an anti-recession measure in 2009 and 2010. Finally in 2015, a HIC allowance was introduced as well for workers with income around the minimum wage. All of these create additional variation which the method of Gruber and Saez (2002) can fully exploit.

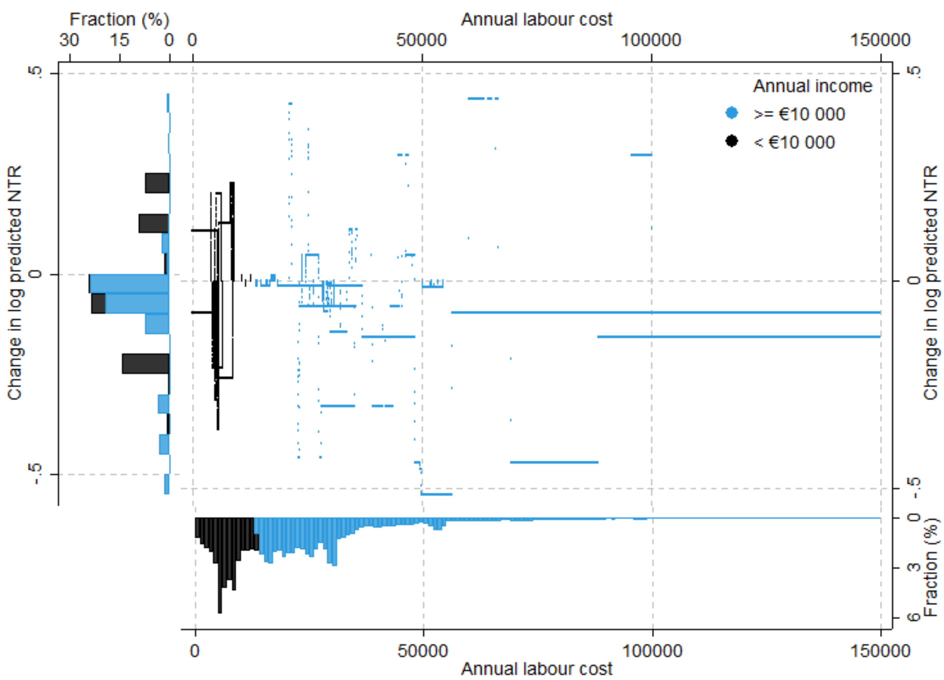
Figure 3: Change in the effective MTR for the selected reforms

(a) 2013 reform (b) 2017 reform



The income-weighted distributions of these changes in the predicted net-of-tax rate that serve as instruments in the final regression (8) are plotted against income in Figure 4. Based on the income distribution on the x-axis, it is clear that most of this variation from which the ETI is estimated comes from low and middle-income individuals. Looking at the second dimension on the y-axis, there is large variability in the size of the changes themselves, but increases in the tax burden clearly dominate. Only individuals with income below €10’000 experienced reductions in taxes over the observed period.

Figure 4: Distribution of changes in the predicted net-of-tax rate over the period 2004-2018



Note: Probability density in histograms calculated by weighting observations by their annual income. Only non-zero changes are depicted.

In addition, there was a parallel increase in the allowed deductible flat-rate expenses for the self-employed without accounting from 40% of revenue and a maximum of €5’040 to 60% and €20’000 in 2017. This significantly reduced the tax burden on the self-employed and made it a more attractive form of earning income. As a result, not only should have the existing self-employees be motivated to earn more, we would also expect an increased incentive for employees to shift income to self-employment for optimization purposes. This behaviour would bias the estimated elasticity using only employment income, so resorting to the tax-return data will be necessary to validate the results.

Since Feldstein's (1995) paper, the standard in the literature has been to use three-year growth rates to analyse the effect of tax changes on taxable income. That is, observations in the post-reform period 1 represent data three years after the base year 0. The prevailing opinion is that using longer intervals helps to better capture the longer-term effects while still not losing identification power. Kleven and Schultz (2014) also provide graphical evidence showing that the behavioural responses to tax changes take some time to fully materialize, but the majority occurs after approximately the first three years. Jongen and Stoel (2019) also show that the estimated ETI increases with the length of the lag as taxpayers gradually adjust their behaviour over time.

On the other hand, Gruber and Saez (2002) consider different lengths of the lag between period 0 and period 1. They test one, two as well as three-year growth rates but their results are not very sensitive to the different variations. Only when one-year lag is used, they find slightly higher elasticity. This is consistent with taxpayers re-timing part of their income in a preemptive reaction to an announced but not yet implemented reform. For example, Goolsbee (2000) shows in a similar fashion how executives in the US realized their stock options in 1992 just before the top tax rate hike of 1993.

In this paper, I will also use only one year changes because the time series of available data is relatively short. What is more, the two main reforms which serve as the source of independent variation occurred quite close to each other. Using longer time differences could therefore confound the results because the earlier reform would still have an effect on the base year of the more recent reform, and it would thus be hard to disentangle the two. On top of that, the data primarily used in the analysis here have certain weaknesses as outlined in Section 4. In order to be able to validate the main results using more detailed tax-return data, one-year differences are necessary with only five years of those data available. It is true that such approach will reveal only the short-term responses to taxation, but these can be indicative not only of economic costs but also of the immediate political costs of continued tax hikes. In fact, using only 1-year changes is as frequent in the literature as using 3-year changes and tends to yield slightly higher estimates on average even though the difference is not always statistically significant (Neisser, 2018).

Next, even though the concepts of broad and taxable income are very similar for employees, there is a different important distinction to be made in the Slovak case. The labour tax mix in Slovakia is heavily skewed towards the SSCs, and the employer contributions most of all. In fact, Slovakia continues to have the highest share of compulsory social contributions on total taxation in the whole EU as well as OECD (European Commission, 2020; OECD, 2019a).[9] What is more, the share of the employer SSCs on the total tax wedge was the fifth highest in the OECD in 2018 at above 56% of the overall burden for a single earner with average income (OECD, 2019c). This creates a large gap between gross income which serves as the underlying tax base and the total labour costs to the employer as a more accurate measure of the true economic activity behind these earnings. In addition, even the main reforms analysed here were mostly aimed at social security payments rather than the PIT system itself. Because these changes impacted the employer payroll taxes disproportionately more, this creates an interesting variation relative to other countries worth investigating.

The existing taxable income literature is not clear about the treatment of the SSCs in general and the employer contributions in particular. It is therefore difficult to evaluate what marginal tax rate concepts are used in the calculations. Most studies seem to work only with the statutory PIT schedule applicable to the final taxable income. This is an implicit result of working with individual-level tax returns where sources of income other than labour income, such as capital income, rental income, or sometimes even social benefits are aggregated into a single tax base. Even though a lot of attention is paid to deductible expenses, researchers seem to overlook other payroll taxes levied at the earlier stages. Kiss and Mosberger (2014) are an exception when they include at least the employee contribution in their measure of the METR. However, it seems natural to include employer contributions in the measure of the total tax burden as well. Such practice at least yields an internationally comparable measure across countries with different reliance on the SSCs. Furthermore, the employer contributions also create a wedge between the marginal product of labour and the worker's take-home pay and thus play a role in the optimizing decisions.

Brewer et al. (2010) are one of the few who chose this approach. They explicitly include employer National Insurance payments in their calculations of the marginal rates and simple estimation of the ETI for the

[9] See also older versions of the reports.

UK (see also their online appendix).[10] But ignoring employer contributions might not necessarily pose a major problem for other studies either. The reforms they analyse affected primarily the personal income tax system. Moreover, the share of employer SSCs is much smaller in these countries (none in the case of Denmark analysed by Kleven & Schultz, 2014) and is especially negligible for the highest earners affected by these reforms, given that the SSCs are usually subject to a ceiling. However, it matters for the case of Slovakia with its high share of employer SSCs and reforms that significantly and asymmetrically increased them for some groups. I therefore define the baseline marginal effective tax rate τ inclusive of the employer SSCs following an increase in the gross income z by €1 as

$$\tau = \frac{T(z+1) - T(z)}{LC(z+1) - LC(z)} \tag{9}$$

where $T(z) = SSC_{er}(z) + SSC_{ee}(z) + PIT(z)$ is the total tax liability including employer and employee contributions and $LC(z) = SSC_{er}(z) + z$ represents the employer labour cost of the contractual gross wage z.

Subsequently, the role of the SSCs can be addressed empirically. It is worth investigating how the economic incidence of employer contributions is shared, how well workers perceive this additional burden, and how much they react to the changes in that burden. Employees are likely to be more sensitive to visible changes in their gross and net income differences. Nevertheless, employers themselves can also react to a tax reform if they are disproportionately more affected by it, for example by workforce reduction, reduced hiring, or reduced wage growth in the future. I will therefore try to explicitly address these differences by repeating the analysis separately for different measures of the tax burden and taxable income here. I will first estimate how gross labour income responds to changes in the marginal tax wedge including the employer contributions, which should be most closely comparable to the estimates from other countries. I will then expand on this by looking at the behaviour of the aggregate labour compensation paid by the employers and compare these to the reactions to the more visible taxation legally faced only by the employee. This can help us better understand the different behavioural responses and the salience effects of different tax reforms.

6 Results

6.1 Basic results

The first part of this section looks at the reaction of gross income to changes in the marginal net-of-tax rate including the employer SSCs using the baseline definition in Equation (9). With such a large share of employer contributions, this variable is the closest measure of the total tax burden in the context of Slovakia. At the same time, the focus of the existing literature was to estimate responsiveness of gross or taxable income which serves as the assessment base for all tax payments. This approach should therefore yield standard estimates of the ETI for Slovakia and allow their comparison to the results from other studies.

The set of results in Table 1 are estimated using a simple difference-in-difference principle applied to Equation (8) which imposes the restriction of no income effects. The top 1% of earners serve as the treatment group and the remaining top 10% (i.e. those not already in the treatment group) are used as the control group in the baseline results. The estimation is done separately for the 2013 reform using data from years 2010-2016 and for the 2017 reform using data from 2014-2018, where 1-year differences are used in both cases as explained before. In place of the pre-reform income controls $f(z_{i0})$, I consider several alternative specifications often used in the previous research. On top of that, since the regression (8) is weighted by income, I drop observations with income above €1.5 mil., which represents only 97 observations, in order to avoid seriously biasing the results by a few outliers. Censoring of top income is often an issue in other studies. For example Giertz (2007) shows that dropping only the 100 most influential observations reduces his elasticity estimates to about a quarter. While the results are still

[10] They also go one step further and include uniform consumption taxes (VAT and excise) in an alternative measure of the METR, although this might be a large simplification given the existence of broad reduced rates in the UK.

sensitive to such censoring even in this paper, the estimated elasticities are in fact slightly lower when the highest incomes are included.

Table 1: Elasticity of gross income w.r.t. the net-of-tax rate (difference-in-difference)

z_0 controls	2013 reform (1)	2017 reform (2)	Placebo reform (3)
No controls	1.530***	0.799***	10.708***
	(0.067)	(0.046)	(0.659)
$ln\, z_0$	0.757***	0.141***	2.707***
	(0.076)	(0.043)	(0.828)
10 splines of $ln\, z_0$	0.766***	0.109**	0.246
	(0.076)	(0.044)	(0.398)
10 splines of $ln\, z_0$ + $\Delta ln\, z_0$	0.780***	0.112***	0.339
	(0.073)	(0.043)	(0.377)
Observations	1 085 154	655 596	894 227

Notes: Top 1% as the treatment group and remaining top 10% as the control group. 2SLS regressions weighted by income. Individuals with income above €1.5 mil. excluded. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

The results confirm the importance of controlling for pre-reform income in panel regressions. As shows in the first row of estimates without any income controls, the estimated elasticity is hugely inflated relative to the rest of the table. This is the result of the specific case of Slovakia where a long-term trend of narrowing income distribution and mean reversion of transitory shocks reinforce each other and bias the elasticity upwards in the case of a tax increase. When the pre-reform income is controlled for in any way, the estimates are significantly lower and relatively stable across the different specifications used. The results are thus more robust than similar findings from the United States despite the reforms being concentrated at the very top as well. Using only a simple linear control for log-income $ln\, z_0$ might not be enough, but once a non-linear specification in the form of a 10-piece spline is included, the results are almost identical whether a further lagged income change as in Kopczuk (2005) is included or not.

However, the results in Table 1 also show significant differences between the 2013 and 2017 reform periods. The estimates are less sensitive to the specification of income controls for the 2013 reform compared to 2017. The estimates with only log-income are also very similar to those with non-linear controls in the former case. Moreover, the overall estimates are much higher for the 2013 reform in all cases. This provides the first evidence for the salience effects of the different reforms considered here. The 2013 reform was probably perceived by the employees more strongly because it also entailed an explicit increase in the statutory tax rate, as compared to only an increase in the SSC ceilings in 2017, which affected the employer contributions more and was also not clearly communicated to the public.

Nevertheless, the validity of the results in the diff-in-diff specification depends on the common trends assumption. This means that without any tax changes, income changes experienced in the treatment and control groups would have been identical on average. Column (3) of Table 1 attempts to shed more light on this assumption. It contains the taxable income elasticity estimated using a placebo test of a diff-in-diff regression between the top 1% as the treatment and the top 10% as the control group using years 2004-2009 when no major reform occurred, especially none affecting the top earners. The reform year is assumed to be 2007 and all remaining specifications are the same as those for the first two columns of Table 1.

The placebo elasticity in column (3) seems to validate the findings from the rest of Table 1. Without income controls as well as with only a simple log-income control, the estimates are substantially biased upwards. This means that falling income inequality and mean reversion significantly affect the results even in the absence of real tax changes. However, when non-linear income controls are included in the bottom two rows, the coefficients are not statistically different from zero. This means that the treatment and control group do not experience different income changes outside of those caused by inequality trends and transitory income shocks.

To further test the robustness of these results, Table 2 evaluates the sensitivity of the estimated elasticity to varying definitions of the treatment and control groups. I try different combinations of the top 1, 5, and 10% of earners as the treatment group and the remaining top 5, 10, 25, and 50% as the control group. Even though some variability is present, all of the general patterns are confirmed. The estimates using the 2013 reform are substantially higher than the estimates based on the 2017 reform. The former results are also much more consistent across the different columns. This is probably caused by the fact that the 2017 reform did not create sufficient variation across a bigger portion of the income distribution. Finally, richer specifications of the base-year income controls proved to be necessary again in all cases. Overall, using the baseline definitions of treatment (top 1%) and control (remaining top 10%) groups yield quite robust results and will therefore be used throughout the rest of the paper.

Table 2: Diff-in-diff elasticity of gross income using different treatment/control groups

z_0 controls	Top 1/5% (1)	Top 1/25% (2)	Top 1/50% (3)	Top 5/10% (4)	Top 5/25% (5)	Top 5/50% (6)	Top 10/75% (7)	Top 10/50% (8)
	2013 reform							
No controls	1.824***	1.351***	1.207***	1.012***	0.933***	0.777***	0.854***	0.624***
	(0.087)	(0.056)	(0.052)	(0.038)	(0.033)	(0.031)	(0.032)	(0.029)
$ln\, z_0$	0.784***	0.861***	1.018***	0.260***	0.344***	0.440***	0.120***	0.148***
	(0.106)	(0.063)	(0.059)	(0.047)	(0.039)	(0.036)	(0.044)	(0.038)
10 splines of $ln\, z_0$	0.928***	0.746***	0.718***	0.672***	0.539***	0.533***	0.705***	0.637***
	(0.112)	(0.063)	(0.059)	(0.041)	(0.036)	(0.034)	(0.036)	(0.033)
10 splines of $ln\, z_0$	0.974***	0.749***	0.717***	0.649***	0.541***	0.529***	0.699***	0.627***
+ $\Delta ln\, z_0$	(0.106)	(0.061)	(0.058)	(0.040)	(0.035)	(0.034)	(0.035)	(0.033)
N	540 433	2 716 022	5 378 290	1 085 154	2 716 022	5 378 290	2 716 022	5 378 290
	2017 reform							
No controls	0.746***	0.819***	0.804***	1.105***	1.028***	0.940***	0.952***	0.827***
	(0.045)	(0.045)	(0.045)	(0.057)	(0.050)	(0.049)	(0.047)	(0.046)
$ln\, z_0$	0.055	0.295***	0.463***	-0.597***	-0.238***	0.103	-0.774***	-0.469***
	(0.046)	(0.042)	(0.043)	(0.122)	(0.087)	(0.072)	(0.115)	(0.096)
10 splines of $ln\, z_0$	0.060	0.198***	0.214***	0.522***	-0.047	0.069	0.318***	0.393***
	(0.045)	(0.043)	(0.043)	(0.061)	(0.076)	(0.069)	(0.060)	(0.057)
10 splines of $ln\, z_0$	0.070	0.196***	0.213***	0.493***	-0.025	0.078	0.325***	0.397***
+ $\Delta ln\, z_0$	(0.043)	(0.042)	(0.043)	(0.060)	(0.074)	(0.068)	(0.059)	(0.057)
Observations	326 766	1 639 164	3 245 296	655 596	1 639 164	3 245 296	1 639 164	3 245 296

Notes: 2SLS regressions weighted by income. Individuals with income above €1.5 mil. excluded. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

The next table presents estimates of the ETI using the regression approach of Gruber and Saez (2002) to Equation (8) which utilizes the full time-series evidence. Results are shown for the full population of individuals with positive income (0+) as well as for a sub-group of above-average earners with annual income above €10'000 (10K+). The former group includes also those with various part-time contracts and irregular income, so it is more prone to inaccuracies in the estimation. On the other hand, using the latter group helps us avoid large noise at the very bottom of the income distribution and the results should also be more comparable to the diff-in-diff estimates which looked primarily at the top 1%. The same set of income controls as in the previous specifications is used throughout and the top incomes are equally censored at €1.5 mil.

The first part of Table 3 includes estimates without the income effects. The results shows similar patterns as seen in the case of the difference-in-difference specification above. The 10K+ group exhibits slightly lower elasticity than the estimates using the 2017 reform but much lower compared to the 2013 reform. This seems natural because the top 1% treatment group only includes individuals with income above around €45'000. Individuals with lower income tend to exhibit lower elasticity, so these results are also consistent with findings elsewhere in the literature (see Neisser, 2018). It is equally important to control for the base-year income as shown by the estimates in the different rows. In the absence of income controls, the elasticity is strongly biased upwards and using only a simple log-income control surprisingly yields a negative estimate. However, once richer controls are included, the results are no longer sensitive and remain of modest size.

Table 3: The elasticity of gross income estimated using the full time-series evidence

	Without income effects		With income effects			
	0+	10K+	0+		10K+	
	e	e	e	η	e	η
z_0 controls	(1)	(2)	(3)	(4)	(5)	(6)
No controls	0.149***	0.184***	0.250***	-0.044***	1.754***	-0.733***
	(0.006)	(0.010)	(0.012)	(0.002)	(0.125)	(0.055)
$ln\, z_0$	0.065***	-0.029***	0.081***	-0.025***	1.00***	-0.469***
	(0.006)	(0.011)	(0.011)	(0.002)	(0.112)	(0.048)
10 splines of $ln\, z_0$	0.018***	0.066***	0.057***	-0.028***	0.802***	-0.340***
	(0.006)	(0.010)	(0.011)	(0.002)	(0.103)	(0.044)
10 splines of $ln\, z_0$	0.018***	0.068***	0.058***	-0.027***	0.798***	-0.337***
+ $\Delta ln\, z_0$	(0.006)	(0.010)	(0.011)	(0.002)	(0.102)	(0.044)
Observations	23 624 817	6 441 084	22 246 988		6 390 954	

Notes: 2SLS regressions weighted by income. Individuals with income above €1.5 mil. excluded. Base-year fixed effects included. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

In a similar fashion, the estimated elasticity for the full population is even smaller but remains statistically significant. This can have several explanations. Obviously, the fact that the elasticity is expected to be lower among individuals with lower income plays a role here. In addition, the measures adopted at the bottom of the distribution were probably not strong enough to induce any tangible behavioural reaction. Chetty (2012) argues that big reforms with sufficiently large identifying variation are necessary to overcome optimization frictions such as attention or adjustment costs. This is also consistent with findings in Kleven and Schultz (2014) who compare reform episodes of different sizes and find that elasticities estimated using only the biggest reform is around 2 times larger than when estimated using the full sample and even 3 to 5 times larger compared to the estimates using only small reforms. Even though Figure (4) shows that individuals with the lowest income experienced relatively large percentage changes in the net-of-tax-rate, the changes themselves were not particularly salient. First, the increase in the PIT allowance following the Great Recession was only temporary, so employees probably did not significantly adjust their behaviour. Other changes such as the HIC allowance affected only the social security contributions which fall predominantly on the employer and are thus again less visible for the workers. This adds further evidence to the role of salience in the size of the behavioural reactions.

Columns (3) to (6) of Table 3 show results including income effects. The estimated *uncompensated* elasticity of taxable income e using the restricted sample (10K+) is much higher than when no income effects are included and is higher than even the difference-in-difference estimates from Table 1. The income elasticity estimates η are negative which is consistent with the expectation that leisure is a normal good. However, the values are quite substantial in magnitude and strongly statistically significant. This departs from the values found in other papers. For example Gruber and Saez (2002) or Kleven and Schultz (2014) also find negative income effects but they are usually insignificant or essentially negligible in size. Blomqvist and Selin (2010) found significant income effects of bigger magnitude in Sweden, but even those are nowhere near the estimates found here. The only comparable result is found by Bakos et al. (2008) in Hungary. It is not clear what could explain such large income effects, especially in the presence of already high ETI estimates, so this topic will require further investigation in the future. Similar patterns are found for the full population (0+), but both the net-of-tax as well as the virtual income elasticity estimates are much smaller in magnitude. Sensitivity to the inclusion of income controls persists throughout, with the non-linear specifications proving to be the most robust.

Overall, the estimates of the gross income elasticity presented in this subsection seem to be in line with the findings in the most recent studies from other countries. Using the METR measure including the employer contributions from (9) revealed significant yet inelastic behavioural responses in Slovakia overall. More importantly however, the results offered the first tentative support of different behavioural reactions to reforms with different degrees of salience. The responses were found to be much stronger in the case of the 2013 reform which included an explicit increase in the PIT rate. The next subsection investigates these salience effects in greater depth.

6.2 Labour costs, salience, and incidence of the tax reforms

This subsection follows the same methods as the previous one but looks at the reactions of aggregate labour costs faced by the employer as the variable z in Equation (8). This does not serve as the tax base but more accurately reflects the real economic activity on which this taxation is imposed and at the same time, it allows us to gain a better understanding of the optimizing behaviour of employers. The next part then attempts to distinguish these reactions from the behavioural responses of employees themselves to the most salient changes in the tax burden legally incident on the alone. In this case, the elasticity of gross income z is estimated with respect to a redefined METR $\tau = T(z+1) - T(z)$ where the tax liability $T(z) = SSC_{ee}(z) + PIT(z)$ includes only only the employee contributions and the PIT.

Table 4 shows the elasticity of the labour costs with respect to the net-of-tax rate including the employer contributions and using the simple difference-in-difference method for the 2013 and 2017 reforms. The specifications are the same as those used for the results presented in Table 1 above. After controlling for the pre-reform income, the estimates are much smaller than the elasticity of gross income alone in both cases. Part of the reason is that the elasticity is calculated with respect to a larger base, but it also likely reflects the reduced willingness or ability of employers to react. In fact in the case of the 2017 reform, the results are even significantly negative, albeit close to zero. This seems like a counter-intuitive result which suggests that the aggregate labour payments will indeed increase if the marginal tax burden increases.

Table 4: The difference-in-difference elasticity of total labour costs

z_0 controls	2013 reform (1)	2017 reform (2)
No controls	0.977***	0.446***
	(0.056)	(0.038)
$ln\, z_0$	0.344***	-0.061*
	(0.063)	(0.036)
10 splines of $ln\, z_0$	0.335***	-0.099***
	(0.063)	(0.038)
10 splines of $ln\, z_0 + \Delta ln\, z_0$	0.354***	-0.086**
	(0.060)	(0.036)
Observations	1 085 154	655 596

Notes: Top 1% as the treatment group and remaining top 10% as the control group. 2SLS regressions weighted by income. Individuals with income above €1.5 mil. excluded. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

The results in the next table try to validate these findings using the method of Gruber and Saez (2002) both with and without income effects. Even though they are very close to zero, the estimates without income effects in the first two columns confirm the statistically significant negative elasticity. This holds true for the full population as well as for the restricted sample of above-average earners (10K+). Sensitivity of the results to the specification of income controls is small and in line with the rest of the findings in this paper. Similar results are found in the specification with income effects. The labour cost elasticity remains negative, but the magnitude is somewhat higher. In contrast to the results from Table 3 above, the income effect η remains negative and significant but is also very close to zero, which more closely corresponds to the findings elsewhere in the literature. The magnitude of the income effects therefore cannot explain the negativity of the uncompensated ETI because the *compensated* ETI calculated using the Slutsky equation remains negative as well.

Table 5: The elasticity of labour costs estimated using the full time-series evidence

	Without income effects		With income effects			
	0+	10K+	0+		10K+	
	e	e	e	η	e	η
z_0 controls	(1)	(2)	(3)	(4)	(5)	(6)
No controls	0.078***	0.073***	-0.045***	-0.001***	-0.554***	-0.069***
	(0.006)	(0.009)	(0.007)	(0.000)	(0.034)	(0.011)
$ln\, z_0$	0.021***	-0.097***	-0.027***	0.001	-0.742***	-0.021
	(0.005)	(0.009)	(0.007)	(0.000)	(0.081)	(0.022)
10 splines of $ln\, z_0$	-0.023***	-0.028***	-0.192***	-0.009***	-0.642***	-0.039**
	(0.006)	(0.009)	(0.007)	(0.000)	(0.066)	(0.017)
10 splines of $ln\, z_0$	-0.022***	-0.024***	-0.158***	-0.007***	-0.663***	-0.033**
+ $\Delta ln\, z_0$	(0.006)	(0.009)	(0.008)	(0.000)	(0.055)	(0.014)
Observations	23 624 817	6 441 084	18 628 570		5 537 216	

Notes: 2SLS regressions weighted by income. Individuals with income above €1.5 mil. excluded. Base-year fixed effects included. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

The estimated elasticity of the total labour costs faced by the employer violates the traditional expectations about the direction of the behavioural reactions. Even though the previous subsection showed that the gross income behaves in the usual way by falling in response to an increase in the tax burden, the labour costs seem to increase nevertheless. However, there are several factors simultaneously at play here that explain this behaviour. Part of the effect is simply mechanical; labour costs are a function of the employer contributions, so increasing the employer SSC burden increases the labour costs *ceteris paribus*. This effect strongly biases the estimated elasticity downwards. In principle, the employers should be able to respond to such a change by reducing the labour costs (through a reduction of the gross income) back to the new profit-maximizing level. However, there are several reasons why this might not be fully possible in the specific context of the tax reforms in Slovakia analysed here. First, using only 1-year growth rates between period 0 and period 1 might not be enough to reveal the long-term structural behaviour of firms. With relative rigidity of the labour market, full reaction by employers is probably possible only after a longer period of time. What is more, the well-known downward rigidity of wages leaves very little room for reduction in the case of a tax increase. Gross income cuts would be possible at most with variable components of remuneration, where they exist. Of course, this problem occurs only if the specific reform is driven mostly by an increase in the SSC rates, which impacts the employer disproportionately more, and not an increase in the PIT rate faced by the employee alone.

The results presented here offer some support for these views. The difference-in-difference estimation for the top 1% yields either standard positive elasticity or negative but very close to zero. This shows that employers have more flexibility with cutting gross income of the highest earners because a tangible portion consists of bonuses or other variable payments. At the same time, the better-off probably also have more opportunities to optimize their income in other ways, for example by paying a portion of their income in the form of dividends or changing the contractual form of their work. On the other hand, negative elasticity is consistently found in the full time-series regression with the entire population as well as with only small trimming at the bottom of the income distribution. Here, variable components of remuneration probably form only a small part of the income, so they cannot be cut sufficiently to offset the increase in the labour costs. Moreover, the fact that a positive elasticity was found in the case of the 2013 reform alone and negative in the case of the 2017 reform seems to confirm the hypothesis that it is the increase in the employer contributions, which was more predominant in the latter reform, that drives the increase in the labour costs. In fact, repeating the full time-series regression on a shorter period of time not covering the 2017 reform yields a positive elasticity at least for the group with income above €10'000 as shown in Table 6.

Table 6: The elasticity of labour costs over a shorter time period 2004-2015

z_0 controls	0+ (1)	10K+ (2)
No controls	0.083***	0.011
	(0.006)	(0.009)
$ln\, z_0$	0.055***	-0.108***
	(0.006)	(0.010)
10 splines of $ln\, z_0$	-0.015**	0.026***
	(0.006)	(0.010)
10 splines of $ln\, z_0 + \Delta ln\, z_0$	-0.015**	0.025**
	(0.006)	(0.010)
Observations	19 925 523	4 881 660

Notes: 2SLS regressions weighted by income. Individuals with income above €1.5 mil. excluded. Base-year fixed effects included. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

Finally, the willingness to bear the cost of an increase in the employer contributions could be a signal of the ability of the firms to absorb this additional burden in other ways. If firms evade taxes by under-reporting their revenue, the increase in the labour costs could also help reduce the shadow economy in the short run. Firms could use previously undeclared income to cover the cost of the higher taxation. There is already a well-documented case of a similar suspected behaviour of firms in Slovakia after the introduction of the so-called tax licence (see for example Porubský & Šaling, 2016 or Bukovina & Remeta, 2018). The tax licence served in years 2014-2017 as a minimum tax on corporate income regardless of the actual tax liability. Its introduction lead to a significant increase in the declared tax liability of a large number of firms that previously kept declaring zero or even negative profits, and there was strong bunching at the values of the licence payments.[11] The main reason is that firms would have had to pay the tax licence anyway, but it is costly for them to optimize profits to zero. A more detailed investigation showed that the increase was driven almost exclusively by declaring much higher revenue rather than a cut in expenditure (Šaling, forthcoming). This shows that many firms might have had additional (undeclared) cash available that could in a similar manner be used to temporarily cover the higher obligatory SSC payments analysed here. Of course, higher labour costs still affect the firms' overall profitability and this is likely to have some macroeconomic implications in the long run.

An alternative reaction if firms pay a portion of the wages cash-in-hand and do not declare it to the tax authorities is to cut such payments in place of a reduction of the declared gross income. Since such illicit payments probably do not face the same downward rigidity, the employers could again offset the increase in official labour costs at the expense of the shadow economy. However, unreported work is most likely to occur at the very bottom of the income distribution, so it probably does not play such a role in the reforms analysed here which affected mostly the top earners. Overall, these results all together suggest that despite some reduction of the gross income, employers nevertheless bear a significant portion of the costs of higher employer contributions.

To put this into contrast, I finally look at how gross earnings alone respond to changes in the effective marginal rate faced by the employee alone. This approach ignores the changes in the employer contributions in order to isolate the behavioural reaction of the employees and better understand the salience of the different components of the tax burden. As shown in Table 7, the results for the difference-in-difference (DID) method are significantly higher than when the tax wedge including the employer contributions is used in Table 1 above. The same is true for the full time-series regression without income effects, but the evidence including income effects is somewhat mixed and not statistically significant. All of these results provide further evidence in favour of the expectation that changes to the explicit taxes faced by the employee are more salient and induce a stronger reaction than those implicit in the employer SSCs.

[11] There were several thresholds defined based on the firm's revenue and whether it is a registered VAT payer.

This has important implications for the setup of taxation because less salient taxes cause lower economic distortions.

Finally, the combined evidence presented here has implications for incidence of different taxes as well. We see that statutory incidence largely determines the economic incidence of different taxes, at least in the short run. When the PIT rate is increased, both the gross wage and the aggregate labour costs fall as workers are discouraged from earning more. On the other hand, when the reforms are driven mostly by increases in the employer contributions, the discouraging effect on workers is relatively small because of their lower salience. However, employer costs increase because they bear most of the burden of the higher contributions due to factors such as downward rigidity of gross wages.

Table 7: The elasticity of gross income w.r.t. to the employee marginal net-of-tax rate

	(A) DID method		*(B) Full time-series*					
			Without income effects		With income effects			
	2013 reform	2017 reform	0+	10K+	0+		10K+	
			e	e	e	η	e	η
z_0 controls	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No controls	2.262***	2.618***	0.341***	0.615***	0.229***	0.003***	0.327***	-0.019***
	(0.103)	(0.155)	(0.012)	(0.028)	(0.027)	(0.000)	(0.067)	(0.003)
$ln\, z_0$	1.018***	0.434***	0.242***	0.002	-0.013	0.000***	-0.148**	-0.010***
	(0.105)	(0.134)	(0.011)	(0.028)	(0.025)	(0.000)	(0.058)	(0.003)
10 splines of $ln\, z_0$	1.024***	0.337**	0.041***	0.250***	-0.005	0.001***	-0.099*	-0.029***
	(0.105)	(0.138)	(0.011)	(0.027)	(0.025)	(0.000)	(0.058)	(0.004)
10 splines of $ln\, z_0$	1.043***	0.347***	0.041***	0.254***	-0.005	0.001***	-0.087	-0.028***
+ $\Delta ln\, z_0$	(0.100)	(0.133)	(0.011)	(0.026)	(0.025)	(0.000)	(0.057)	(0.003)
Observations	1 085 154	655 596	23 624 817	6 441 084	17 515 845		6 194 477	

Notes: 2SLS regressions weighted by income. Individuals with income above €1.5 mil. excluded. Top 1% as the treatment group and remaining top 10% as the control group in the DID method (A). Base-year fixed effects included in the full time-series method (B). Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

6.3 Evidence from individual tax returns

In this subsection, I will compare the key elasticity estimates with those estimated using individual tax returns available for the period 2014-2018. As already mentioned in Section 4, the tax returns contain more detailed information on all income components outlined in Figure 1 and thus require fewer simplifications and omissions than using the data from the Social Insurance Agency. Following Kleven and Schultz (2014), the marginal tax rate on one income component, which is a function of all five income components in Slovakia can then be calculated more accurately as $\tau^i = T\left(z^1, ..., z^i + 1, ..., z^5\right) - T\left(z^1, ..., z^i, ..., z^5\right)$ where $T(\cdot)$ includes all the SSCs as well.[12] Utilizing their method further, this also allows us to estimate the cross-tax effect between employment and self-employment income in order to understand the degree of income shifting between these two employment forms.

First, Table 8 shows the difference-in-difference elasticity estimates for the 2017 reform. The available data cover the same period as the period used in the previous sub-sections. For both the employment income and self-employment income, I try different sample restrictions to check the sensitivity of the results to variation induced by factors other than the change in the marginal tax rate. Besides no sample restrictions, I drop observations which reported income from abroad as well as those that report income from any of the other 4 sources. In addition, the only difference for the self-employed is that the treatment group is defined as individuals with annual income below €33'333.33, which is the group that benefited the most from the increase of the flat-rate deductible expenses. Consequently, the control group represents those with income above that but below €75'000. Those earning even more were also affected by the

[12] In the employee case, the change is further divided by the change in the labour costs $LC(z) = SSC_{er}(z) + z$, while in the self-employed case z already represents broad income before expense deductions.

changes in the SSC ceilings, so their potential behavioural reactions could confound the results. Finally, the usual base-year income controls are used throughout.

Table 8: Difference-in-difference elasticity using the tax returns

	Employment income			Self-employment income		
z_0 controls	No restrictions (1)	No foreign income (2)	No other income (3)	No restrictions (4)	No foreign income (5)	No other income (6)
No controls	0.767***	0.885***	0.814***	1.026***	1.101***	1.025***
	(0.044)	(0.052)	(0.055)	(0.056)	(0.060)	(0.060)
$ln\, z_0$	0.175***	0.217***	0.164***	0.040	0.060	-0.012
	(0.041)	(0.047)	(0.051)	(0.036)	(0.038)	(0.039)
10 splines of $ln\, z_0$	0.149***	0.180***	0.111**	0.158***	0.163***	0.124***
	(0.042)	(0.048)	(0.053)	(0.044)	(0.046)	(0.047)
10 splines of $ln\, z_0$	0.143***	0.171***	0.108**	0.153***	0.154***	0.120**
+ $\Delta ln\, z_0$	(0.040)	(0.045)	(0.049)	(0.044)	(0.046)	(0.047)
Observations	528 117	448 403	411 067	758 105	718 798	568 838

Notes: Top 1% as the treatment group and remaining top 10% as the control group in the case of the employment income. Individuals earning <= €33'333.33 as the treatment group and those with income between €33'333.33 and €75'000 as the control group in the case of the self-employed. 2SLS regressions weighted by income. Individuals with income above €1.5 mil. excluded. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

The results for the employees are very similar to those obtained from the Social Insurance Agency data in column (2) of Table 1. The estimates from the two datasets are not statistically different from each other regardless of the income controls used. Similarly, columns (4) to (6) show elasticity estimates for self-employment income. After using non-linear base-year income controls, these are also statistically indistinguishable from the elasticity of employment income. This seems a bit surprising because the self-employed usually exhibit a larger degree of flexibility in how much they choose to work and earn. In addition, Kopczuk (2005) argues that the responsiveness to tax changes depends on the availability of deductions as well. The self-employed in Slovakia, unlike employees, can deduct any business-related expenses or simply write off a large percentage of their income. However, the estimates for the two groups might not be perfectly comparable under the difference-in-difference specification. While the treatment group among the employees is defined at the very top of the income distribution, the opposite is true for the self-employed. Nevertheless, all the results are quite robust to different sample restrictions. Therefore, the rest of the estimates will rely only on the sample without individuals who report income from abroad because the different methods of the avoidance of double taxation could not be accounted for in the calculations.

Next, the results obtained with the method of Gruber and Saez (2002) are presented in Table 9. The full population of individuals with positive income was used in order to make the results comparable across employment and self-employment income this time. Despite using the data only from the last 5 out of the 15 years available from the Social Insurance Agency, the estimates for employment income are again relatively similar to those in Table 3. The taxable income elasticity ranges from about 0.02 to 0.05 in both cases. The only differences are that the tax-return ETI is instead smaller in the model with income effects and it is insignificant as well. On top of that, the virtual income elasticity η remains almost identical and significant at the value around -0.03. On the other hand, the elasticity of self-employment income in this specification is substantially higher than for the wage earners and is more in line with the difference-in-difference results. This finding corresponds more closely to the estimates from elsewhere in the literature. Higher elasticity for the self-employed are found for example by Auten and Carroll (1999), Sillamaa and Veall (2001), and Kleven and Schultz (2014) among others. Using this method is therefore likely more reliable than a simple difference-in-difference estimation.

Table 9: Gruber-Saez elasticity using the tax returns

	Employment income			Self-employment income		
	Without income effects	With income effects		Without income effects	With income effects	
	e	e	η	e	e	η
z_0 controls	(1)	(2)	(3)	(4)	(5)	(6)
No controls	0.210***	0.332***	-0.036***	0.227***	0.196***	0.054***
	(0.012)	(0.020)	(0.005)	(0.033)	(0.045)	(0.007)
$ln\, z_0$	-0.049***	0.041***	-0.022***	0.162***	0.160***	0.057***
	(0.010)	(0.016)	(0.005)	(0.032)	(0.045)	(0.007)
10 splines of $ln\, z_0$	0.047***	0.018	-0.028***	0.155***	0.187***	0.061***
	(0.014)	(0.019)	(0.007)	(0.034)	(0.046)	(0.007)
10 splines of $ln\, z_0$	0.046***	0.016	-0.026***	0.157***	0.190***	0.064***
+ $\Delta ln\, z_0$	(0.014)	(0.019)	(0.007)	(0.034)	(0.045)	(0.007)
Observations	4 357 167	3 720 374		776 845	631 605	

Notes: 2SLS regressions weighted by income. Individuals with income above €1.5 mil. and with any income from abroad excluded. Base-year fixed effects included. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

Finally, Table 10 presents the estimates of the own-tax elasticity e^{jj} and the cross-tax elasticity e^{jk} from the regression

$$ln\, \frac{z^j_{i1}}{z^j_{i0}} = e^{jj} \cdot ln \frac{(1-\tau^j_{i1})}{(1-\tau^j_{i0})} + e^{jk} \cdot ln \frac{(1-\tau^k_{i1})}{(1-\tau^k_{i0})} + f(z^j_{i0}) + \theta_0 + \varepsilon_{it} \quad (10)$$

which is an extended version of Equation (8) where the superscript j represents employment income and k self-employment income in column (1) and (2) and vice versa for the last two columns. The equation is estimated using the Gruber-Saez method where predicted changes in the respective marginal rates are used as instruments for the observed changes.

Table 10: Own-tax and cross-tax elasticities

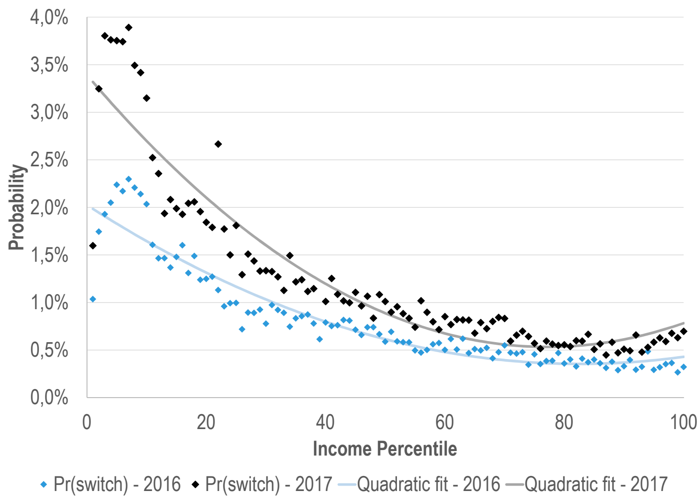
	Employment income		Self-employment income	
	Own-tax effect	Cross-tax effect	Own-tax effect	Cross-tax effect
z_0 controls	(1)	(2)	(3)	(4)
No controls	0.217***	0.699***	0.259***	-0.225***
	(0.012)	(0.100)	(0.038)	(0.069)
$ln\, z_0$	-0.048***	0.711***	0.188***	-0.178***
	(0.010)	(0.097)	(0.038)	(0.069)
10 splines of $ln\, z_0$	0.048***	0.782***	0.192***	-0.244***
	(0.014)	(0.096)	(0.040)	(0.072)
10 splines of $ln\, z_0$	0.046***	0.779***	0.192***	-0.233***
+ $\Delta ln\, z_0$	(0.014)	(0.093)	(0.040)	(0.071)
Observations	4 271 551		776 845	

Notes: 2SLS regressions weighted by income. Individuals with income above €1.5 mil. and with any income from abroad excluded. Base-year fixed effects included. Standard errors (in parentheses) clustered by individual. Different controls for the log of base-year income z_0 included.
*p<0.1,**p<0.05,***p<0.01

The own-tax elasticity for both types of income remains robust and very similar to the previous estimates from Table 9. In contrast, surprising results are found for the cross-tax effects. On the one hand, the estimated cross-tax elasticity for the self-employment income is substantially negative which suggests the two types of income are viewed as substitutes in line with the expectations. On the other hand, the estimated effect of changes in the self-employment METR on employment income in column (2) is substantially positive. Not only is there inconsistency between these two results, it also suggests that the two types of income are complements. This would violate the hypothesis of income-shifting for optimization purposes.

Nevertheless, other evidence suggests that most people usually completely switch their employment form and do not shift only a portion of their income. For instance, looking at the changes in the types of compulsory health insurance contracts at the individual level, we can see a significant increase in the probability of switching from employment to self-employment between 2017 and 2016 (Figure 5). This is especially pronounced at the bottom end of the income distribution where the increase in the allowable flat-rate expenses brought the largest benefits. However, by virtue of using differences in log-income in the standard methodology of Kleven and Schultz (2014), observations where the type of income is completely switched are dropped from the estimation. Therefore, the method cannot capture this sort of binary behaviour occurring in Slovakia in the observed period and thus cannot be used for estimating the degree of income shifting here.

Figure 5: Probability of switching from employment to self-employment in each income percentile



Note: A "switch" is identified when a person registered in their Health Insurance Company as an employee in one month registers as self-employed in the next month. Probability calculated as the share of employees switching in the given year on the total number of employees. Percentiles derived from the average income from employment before the switch.

7 Conclusion

Investigating the elasticity of taxable income as a much broader concept has gained significant interest in the recent years because it can provide more insight into the optimal design of the tax systems than a simple labour-supply elasticity. This paper used administrative labour income data on the entire population to provide the first estimates of the elasticity of taxable employment and self-employment income for Slovakia. Utilizing further the specific characteristics of the Slovak tax system and its reforms focusing mostly around the social security contributions rather than the personal income tax, I expand on the standard estimates in the existing literature by looking at the changes in the aggregate labour costs to the employer as well as the salience of different reforms. Since employer contributions are not directly visible to the workers, their changes induce very different behavioural responses than those usually found in other countries. This then has implications for the incidence of different taxes, which very much falls on the side legally responsible for paying them.

Overall, the baseline estimates showed a quite modest inelastic response of the gross income to changes in the marginal tax burden. While there is some variation across different specifications, these results only confirm the general patterns described by the empirical research so far. Stronger responses are found at the higher end of the income distribution and they are especially pronounced around big reforms. In addition, the size of the elasticity is much lower than the numbers found for the United States and is in the lower part of the distribution for European countries as well. This reflects the fact that the Slovak tax system has a comparatively quite broad tax base with very few deductions, which limits the ability to optimize one's taxes. Similarly, the labour market is dominated mostly by fixed-hours contracts, which limits the ability to significantly adjust one's labour supply. On the other hand, the elasticity for the self-employed who have more opportunities for adjustment on both margins is considerably higher.

In addition, I found that in the context of Slovakia, the reductions in the gross taxable income are driven primarily by employee reactions rather than adjustments on the side of the employer. In fact, despite some reduction in the gross taxable income, the total labour costs seem to have increased in most cases where employer contributions increased sharply following a tax reform. This shows that due to the high downward rigidity of wages, the employers do not have much room to reduce wages further in order to offset their growing costs. Even though the analysis here focused only on the short-run impact, some adjustments are likely possible over time. What is more, additional macroeconomic consequences such as workforce reduction or reduced hiring, product price increases, or reduced investment could not be captured by the methodology of this paper which only tracks given individuals over time. In contrast, employees displayed a much larger responsiveness to the tax changes that are directly incident on them alone.

Expanding on this further, explaining the effect of salience on the size of the behavioural responses was also one of the main contributions of this paper. Much like in the previous research, high variability of the estimated elasticities persisted throughout the different models here. Indeed, the sensitivity of the results to different specifications is one of the weaknesses of the ETI literature which prevents us from drawing general conclusions. The evidence presented here provides additional explanation for this variability. More salient reforms tend to induce much higher responses, so the specific reform setup can never be ignored. In the context of Slovakia, much stronger reactions are found around the 2013 reform, which involved an explicit increase in the statutory PIT rate directly visible to the employees. The reduction in taxable income in this case was even sufficient to prevent the aggregate labour costs from increasing due to an increase in the employer contributions, which was also a part of the reform.

Finally, investigating the degree of income shifting using the methodology here did not prove fruitful. Employment income is found to be a complement to the self-employment income which defies other evidence of strong income shifting between the two types of income. Following the sharp reduction in the tax burden on the self-employed in 2017, many employees completely switched their form of earning income to self-employment. The simple measure of cross-tax elasticity cannot accurately capture such binary behaviour. On the other hand, this also means that the baseline estimates of the employment ETI are not significantly biased by income-shifting either.

Altogether, the findings in this paper can provide important lessons for the direction of tax reforms in Slovakia as well as other countries with similar tax systems. Broadening the tax base and thus limiting the room for tax optimization can play a key role in the reduction of the responsiveness to changes in the tax burden. In a similar fashion, reliance on less salient taxes, namely employer social security contributions, which are not directly observed by the workers, can also help reduce the inefficiency costs of higher labour taxation. On the other hand, richer individuals are increasingly more responsive nevertheless, so increasing their tax burden has limited revenue potential and incurs substantial dead-weight loss. On top of that, providing an attractive alternative in the form of highly advantaged self-employment can erode the tax collection even further over time. Finally, it is important to also consider the long-term structural implications of such a setup of the tax system. Further research in the area can help provide even better informed policy decisions in the future.

Appendix

Figure A1: Distribution of derived income around the SIC ceilings

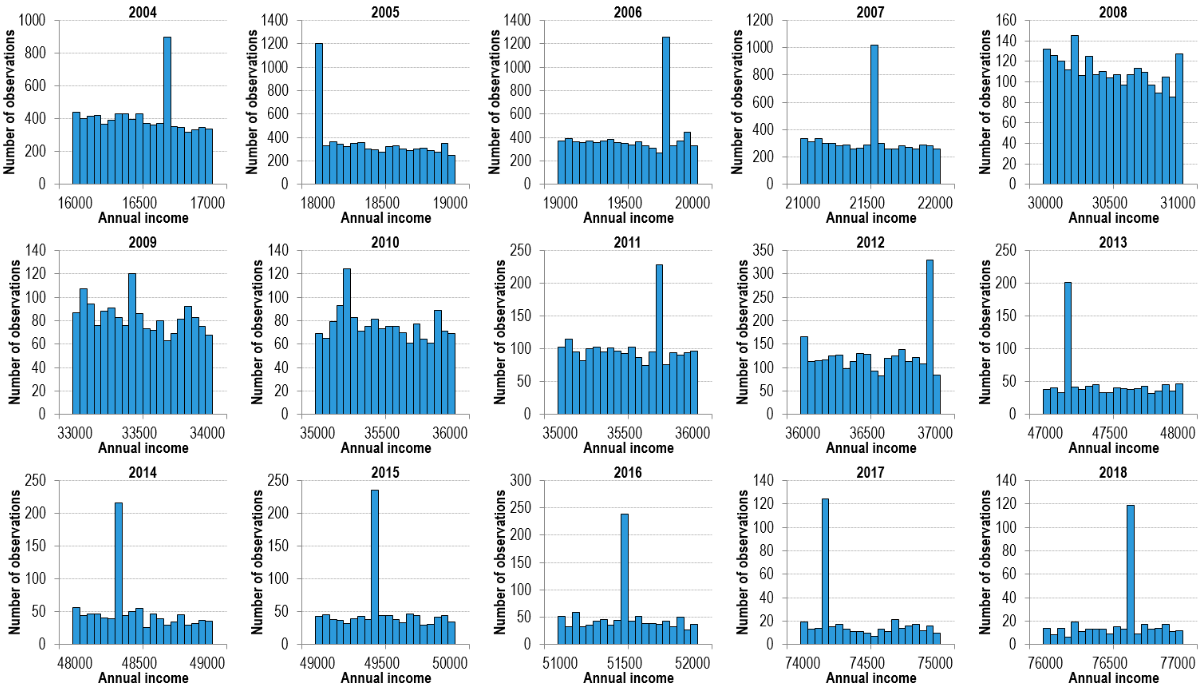


Table A1: Summary statistics

	SIA		Tax returns
	2004-18	2014-18	2014-18
Employment income	7290	9254	10839
	(16338)	(12716)	(15941)
Self-employment income			29896
			(260491)
Total tax liability	4072	5305	6038
	(5664)	(6605)	(7527)
Employee tax liability	1642	2179	
	(3661)	(3622)	
Individuals (i)	4 136 597	2 938 213	2 938 543
Time periods (t)	15	5	5
Observations (N)	34 056 216	11 139 482	11 204 964

Notes: Yearly amounts in EUR, mean (standard deviation)

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