Behavioural Responses to Taxes and Optimal Taxation of Top Labour Incomes in Croatia

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Abstract: We use a model of optimal labour income taxation and tax records data to determine the optimal marginal tax rate for top labour income earners in Croatia in the period 2014–2021. Behavioural responses to taxation through labour supply and tax evasion, captured by the elasticity of taxable income, are estimated based on several tax reforms. Responses through international migration are also considered. In 2021, for most combinations of the relevant parameters, the optimal top marginal rate of personal income tax is higher than the actual rate. Also, for most parameter combinations, the reductions in the top marginal rate over 2014–2021 cannot be justified from the optimal taxation perspective. Further reductions in the top rate can be justified for only a few parameter combinations. While the literature on the elasticity of taxable income and the optimal taxation of top earners was focused on Western Europe and the US, this paper contributes by considering a Southeast European country.

Keywords: optimal taxation, personal income tax, top earners, elasticity of taxable income

JEL: H21, H31

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Over the last decade, Croatia's personal income tax system has been reformed several times. Changes took place across the income distribution, and top income earners faced substantial cuts to the marginal tax rate. The marginal tax rate in the top tax bracket was reduced in 2017 from 40 to 36 per cent, and in 2021 from 36 to 30 per cent. In this context, we analyse the optimal taxation of Croatia's top one per cent labour income earners over 2014–2021. We pose the following questions: (1) Are top earners optimally taxed? (2) Can the top rate reductions over 2014–2021 be justified from the optimal taxation perspective?

We use administrative tax records data and a simple model of optimal taxation of top incomes to answer the questions. The model yields a top rate formula which depends on the following factors: the government's preference for redistribution from the top earners to the overall population, the shape of income distribution, and taxpayers' responses to taxation through labour supply, tax evasion/avoidance, and international migration. We estimate or assume the relevant parameters capturing these factors to implement the optimal tax formula.

We make three contributions. There are studies of the optimal top tax rate for only eight countries, focused on Western Europe and the US (with one exception), and only one of them considered international migration as taxpayers' response. Our first contribution is providing a study of a Southeast European country that allows for taxation-driven migration. Moreover, estimates of the elasticity of taxable income (ETI), capturing labour supply and evasion/avoidance responses, are lacking for Southeast Europe. Our second contribution is providing ETI estimates for a Southeast European country. Finally, past research on the Croatian tax system was focused on the tax wedge, progressivity, and redistributive effects.[1] Our third contribution is offering an optimal taxation analysis of the Croatian tax system.

The paper is structured as follows: Section 1 reviews related literature. Section 2 derives the optimal tax rate. Section 3 describes the data, analysed population, income concept, and top earners. Section 4 describes how we obtain the parameters of the optimal tax formula. Section 5 presents the results. Section 6 concludes.

1. Brief overview of related literature

In this section, we briefly overview the literature most related to the present paper, stressing the differences and similarities between our work and other authors' work. Our work is most closely related to about a dozen studies that used a model of optimal

[1] On the tax wedge, see: Suzana Petrović (2007), Anamarija Šeparović (2009), Ana Grdović Gnip and Iva Tomić (2010), Primož Dolenc, Suzana Laporšek and Šeparović (2011), Predrag Bejaković, Ivica Urban and Slavko Bezeredi (2013), Mitja Čok et al. (2013); Urban (2016), Milan Deskar-Škrbić, Saša Drezgić and Hrvoje Šimović (2018), Urban, Čok and Miroslav Verbič (2019), Bezeredi, Vjekoslav Bratić and Urban (2022), Urban (2023). On progressivity, see: Marko Ledić, Ivica Rubil and Urban (2023). On redistributive effects, see: Čok and Urban (2007), Čok, Urban and Verbič (2013), Urban (2019).

taxation of top labour income to calculate the optimal top marginal tax rate and compare it to the actual rates.

The related studies deal with optimal taxation top earners in multiple countries: the US (Jonathan Gruber and Saez 2000, 2002; Peter Diamond and Saez 2011; Piketty, Saez and Stephanie Stantcheva 2014), the UK (Brewer, Saez and Shephard 2010), France (Pierre-Yves Cabannes and Camille Landais 2008), Germany (Stefan Bach, Giacomo Corneo and Viktor Steiner 2012), Finland (Marja Riihelä, Risto Sullström and Matti Tuomala 2014; Kaisa Kotakorpi and Tuomas Matikka 2017), the Netherlands (Bas Jacobs, Egbert L. W. Jongen and Floris T. Zoutman 2013), Hungary (Aron Kiss 2013), and South Africa (Johannes H. Kemp 2019, 2020).

The model underlying the optimal top marginal tax rate formula in all these papers is that of Emannuel Saez (2001), or a more extensive model building on Saez's. In Saez (2001), the optimal rate formula depends on three parameters, namely the ETI (capturing labour supply responses at the intensive margin), the social welfare weight (reflecting the government's redistributive preferences), and the Pareto parameter (describing the shape of the right tail of the income distribution). All the related studies use Saez's (2001) basic model as a base case, and some of them consider extensions.

An extension considered by Mike Brewer, Saez, and Andrew Shepherd (2010) adds to the basic model the possibility that top earners respond to taxation by international migration, a form of extensive-margin response. However, while the standard extensive-margin decision is to work or not to work, the international-migration response is to work at home or to move abroad. When taxpayers move abroad, their whole tax liability is lost to the host country. This type of response to taxation is especially pertinent for small EU countries like Croatia because of the free movement of workers across countries. For this reason, we consider this extension in the present paper.

Piketty, Saez, and Stantcheva (2014), Riihelä, Sullström, and Tuomala (2014), and Kotakorpi and Matikka (2017) consider an extension that allows for tax avoidance via income shifting between different sources, namely between labour and capital income. The underlying idea is that top earners may have more opportunities than others to "relabel" their compensation. If the tax treatments of labour and capital are different, which is often the case, it may pay for them to do so.

Another extension considered by Piketty, Saez, and Stantcheva (2014) allows top earners' compensation to differ from what it would be if their wages reflected their marginal labour productivities. The idea is that top earners, often occupying managerial positions, can use their bargaining power to negotiate compensation above the marginal productivity, at the cost of lower earnings for other employees. Their incentives to do so in principle depend on the marginal tax burden they face. Piketty, Saez, and Stantcheva (2014) also provide empirical evidence (international and for the US) supporting this possibility.

Bach, Corneo, and Steiner (2012) extend Saez's (2001) model to accommodate optimal taxation of couples instead of individuals only. This extension is pertinent for analysing optimal taxation in tax systems with joint taxation and income splitting for spouses, like in Germany or France.

When it comes to the results of the related studies, comparisons of the optimal to the actual top marginal tax rates show that in most cases, the optimal rate is above the current actual rate. However, results vary, and there are studies suggesting the opposite. Uncertain about the true values of the parameters, it is standard that authors consider multiple values of the parameters to explore the sensitivity of the optimal rates, and depending on the considered ranges of parameter values, the optimal-actual comparisons vary even within one study.

2. Optimal top marginal tax rate

This section presents Saez's (2001) basic model and Brewer, Saez, and Shepherd's (2010) extensions of it. For other presentations of the basic model and the extension, see Diamond and Saez (2011) and Piketty and Saez (2013).

2.1 Model and optimal tax formula

Saez (2001) derived a simple formula for the top marginal tax rate that depends on three factors: (i) how taxpayers respond to taxation by adjusting their labour supply and/or the extent of tax evasion; (ii) the government's redistributive preferences, that is, the willingness to redistribute from top earners to the overall population; and (iii) the shape of the top of the income distribution. The optimal top marginal tax rate will be higher the weaker the taxpayers' response to taxation is, the more the government is willing to redistribute from top earners, and the fatter the top tail of the income distribution.

Denote pre-tax income by z, and let $z = z^*$ be the threshold income level of the top tax bracket, above which the top marginal tax rate τ applies. The number of earners above z^* is normalised to one. Denote by $\overline{z}$ the average income above z^*. Then, the average amount of tax paid on the part of the income above z^* equals $(\overline{z} - z^*) \cdot \tau$. Note that this is also the total income above z^*, because the number of top earners is normalised to one.

Now, consider a small reform by which the rate τ is increased by $\Delta\tau$. The reform has three effects. The first effect is the *mechanical revenue effect*, which measures the rise in tax revenue upon the increase in τ if individuals do not change their earnings in response:

$$M = (\overline{z} - z^*) \cdot \Delta\tau > 0 \,. \tag{1}$$

The second effect is the *welfare effect*, which measures the welfare loss incurred by the top tax bracket due to the higher tax liability:

$$W = -(\overline{z} - z^*) \cdot \Delta\tau \cdot g = -M \cdot g < 0 \,, \tag{2}$$

where $g > 0$ is the average social value of marginal consumption in the top tax bracket relative to the average social value of marginal consumption in the overall population of earners, where both averages depend on the chosen social welfare function. g reflects the government's preferences for redistributing one monetary unit from the top tax bracket to the population. If $g = 0$, the marginal consumption of the top tax bracket has no social value, so the welfare loss of taxation in the top tax bracket is entirely neglected, and the government's objective is to maximise the revenue collected from the top tax bracket. If $0 < g < 1$, the marginal consumption of the top tax bracket is valued less than the marginal consumption of the overall population, and the welfare loss of the top bracket is only partly considered. If $g \geq 1$, taxing top-bracket earners and redistributing towards the overall population is not warranted. If $g = 1$, the marginal consumption of the top tax bracket and the overall population are equally valued, so no redistribution is justified. And if $g > 1$, the fact that the marginal consumption of the top bracket is valued more than that of the entire population calls for redistribution towards the top bracket.

The third effect is the *behavioural effect*, which considers the impact of taxation on incentives to earn income (or report it to the tax authority). Upon an increase in the top marginal tax rate by $\Delta\tau$, top-bracket earners reduce their earnings on the margin, causing a revenue reduction given by the behavioural effect:

$$B = -\frac{\tau \cdot \Delta\tau \cdot \bar{z} \cdot \varepsilon}{1 - \tau} < 0\,. \tag{3}$$

ε is the so-called elasticity of taxable income (ETI) for top earners. It measures how, on average, top-bracket earners react to changes in the net-of-tax rate $1 - \tau$. To be precise, ε is the weighted average of the z-specific elasticities $\varepsilon(z) = \frac{\partial z}{\partial(1-\tau)} \frac{1-\tau}{z}$ over $z > z^*$, with $z/\bar{z}$ as the weights. Intuitively, the higher the earnings at level z, the more important the behavioural reaction at z for the total behavioural effect is, and the weight $z/\bar{z}$ attached to $\varepsilon(z)$ is also higher. Since Saez (2001) assumes there is no income effect, ε is both an uncompensated and compensated elasticity.

At the optimum, where the social welfare is maximised, M, W, and B must cancel one another, summing to zero, $M + W + B = 0$. Otherwise, the rate would not be optimal. Solving this equation for τ gives the optimal top marginal tax rate:

$$\tau^* = \frac{1 - g}{1 - g + a \cdot \varepsilon}, \tag{4}$$

where $a = \frac{\bar{z}/z^*}{\bar{z}/z^* - 1} = \frac{\bar{z}}{\bar{z} - z^*} > 1$. Empirically, a tends to be constant for any sufficiently high threshold z^*, a stylised fact well known since Vilfredo Pareto (1896) and verified across countries (see Anthony Atkinson et al. 2011 for a review). This means that the income distribution above z^* is well approximated by a Pareto distribution with the c.d.f. $F(z) = 1 - k \cdot z^{-a}$, where k is a constant.

The optimal rate in (4) is decreasing in g: the more the government values marginal consumption in the top bracket relative to that in the entire population, the lower the τ^*. τ^* is also decreasing in ε (if $g < 1$): the stronger the behavioural reaction to taxation in the top tax bracket, the larger the efficiency cost of taxation. Note that with no behavioural reactions ($\varepsilon = 0$), τ^* is the highest possible, $\tau^* = 1$. Finally, τ^* is decreasing in a, too (if $g < 1$): it can be shown that increasing a increases the strength of the negative (i.e., welfare-reducing) behavioural effect ($B < 0$) relative to the positive (i.e., welfare-increasing) sum of the mechanical and welfare effects ($M + W > 0$).

Saez's (2001) model does not consider that top earners may react to taxation through outward migration (i.e., moving abroad). Brewer, Saez, and Shepherd (2010) and Piketty and Saez (2013) consider this possibility. They extend Saez's (2001) optimal tax formula by introducing the *emigration effect*:

$$E = -\frac{\tau \cdot M \cdot \eta}{1 - \tau}, \tag{5}$$

where η is the migration elasticity for top-bracket earners, measuring the strength of their reaction to $\Delta\tau$ throughout migration. See Appendix (Section A1) for a derivation of equation 5, which we provide because Brewer, Saez, and Shepherd (2010) and Piketty and Saez (2013) do not offer it, although the derivation is not apparent.

In the extended model, at the optimum, M, W, B, and E must add up to zero: $M + W + B + E = 0$. Solving this equation for τ gives the optimal rate:

$$\tau^* = \frac{1 - g}{1 - g + a \cdot \varepsilon + \eta}. \tag{6}$$

The only difference from Saez's (2001) formula (equation 5) is the presence of η. τ^* is decreasing in η (if $g < 1$): the stronger the emigration response to taxation of top earners (i.e., the more revenue is lost due to emigration), the lower the optimal rate.

2.2 Model limitations

Even the extended model has certain limitations. Here we point to five of them, without aiming for a comprehensive review, which is beyond the scope of this paper (see, e.g., Kaplow 2024).

First, the model is static, thus leaving out dynamic considerations. For example, the dynamic Mirrlees approach considers the possibility that individual productive abilities evolve stochastically over time due to shocks to health, skills, labour market conditions, or luck, which calls for optimal taxation to achieve, among other things, optimal consumption smoothing (i.e., saving) over time. For a review of dynamic optimal taxation, see, for example, Stantcheva (2020).

Second, unlike the model in Piketty, Saez, and Stantcheva (2014), this one does not consider the possibility of transforming top labour income into a more lightly taxed income type like capital income, or the possibility that top earners' earnings are partly based on their bargaining power (at the cost of the rest of employees) rather than their marginal productivities.

Third, the model does not consider "behavioural" – as opposed to entirely rational – agents who misperceive the actual tax schedule and use simplifying decision heuristics, which affect the optimal tax formula (e.g., Alex Rees-Jones and Dmitry Taubinsky 2018; Emmanuel Farhi and Xavier Gabaix 2020).

Fourth, in the model we use, the shape of the income distribution is considered only through the Pareto parameter as the measure of how thin the right tail is, determining the strength of the behavioural effect relative to the mechanical and welfare effects. However, income inequality may be relevant to optimal taxation because inequality may have negative externalities, such as higher crime rates or lower social cohesion.

Fifth, the model assumes the social objective is welfarist, that is, maximising a function of individual utilities, thus ignoring that the social objective might be non-welfarist, such as, for example, minimising poverty (Timothy Besley and Stephen Coate 1992; Ravi Kanbur, Michael Keen and Tuomala 2006).

Despite these and other conceivable limitations, which can affect the optimal rate, the model we use still captures the main factors that should be considered. Using a richer model that would capture additional factors possibly relevant for optimal taxation would compromise the tractability of empirical analysis. In addition, such an analysis requires knowledge of the appropriate parameters, which are difficult to obtain.

3. Data, analysed population, income concept, and top earners

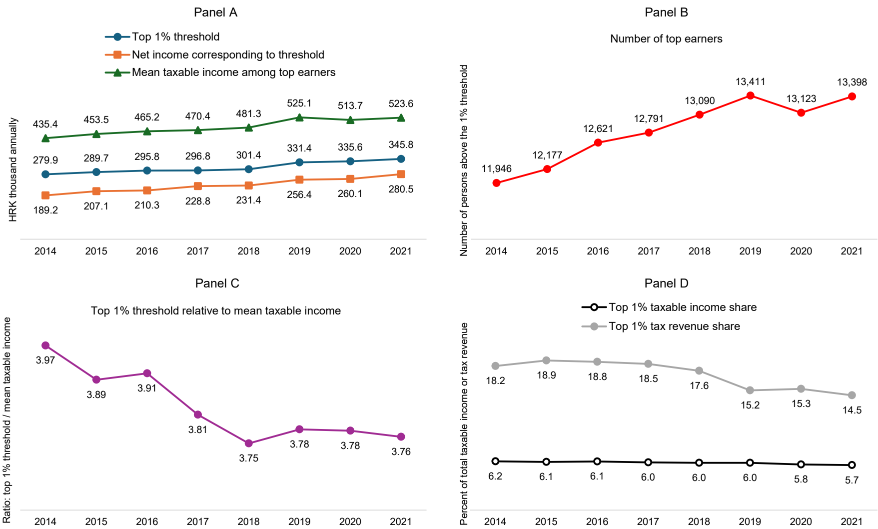
We use a dataset of individual tax records covering 2014–2021, obtained from the Tax Administration of the Croatian Ministry of Finance. Variables in the dataset refer to annual amounts of income from all sources, both gross and net of personal income tax (PIT) and social security contributions (SSCs), and the amounts of personal income tax and social security contributions. There are also variables referring to the taxpayer characteristics relevant for the tax liability, such as the place of residence, the place where a receipt comes from, the number of dependants, disability status, birth date, NACE sector of activity, work hours during the year, and others.

We consider only individuals with income from dependent employment (i.e., working for an employer). However, not all employees are considered. Depending on the year, the entire population of employees ranges from about 1.50 to about 1.65 million individuals, with an average of 1.58 million (see Table A1 in Appendix Section A2). To get the analysed population, we restrict this population as follows. We first exclude those for whom more than 30 per cent of annual total gross income derives from sources other than employment (primarily self-employment, service contracts, and pension income). Next, we exclude those with more than 10 per cent of employment income earned abroad, as a significant share of their employment income may be taxed abroad. Further, we drop those with an annual gross employment income lower than three times the average gross monthly wage because they are presumably individuals who work only occasionally. We also exclude persons with disabilities since they are not fully flexible in labour supply, as well as everyone younger than 18 or older than 65. Finally, after excluding individuals with missing data, we get the *analysed population*. Depending on the year, this population is 17.9–20.1 per cent (18.9 per cent on average) smaller than the population of all employees. The optimal taxation analysis focuses on this population.

For the estimation of the ETI (Section 4), the analysed population is further restricted to those with an annual *taxable income* (the income concept we adopt for the analysis, defined in the next paragraph) of at most HRK 1 million. The reason for this restriction is discussed in Section 4.1. On average, only about 0.04 per cent of the analysed population is excluded this way, with slight variation over the years.

The income concept that we use is arrived at as follows. The starting point is total gross employment income, where *total* refers to the sum of taxed (subject to PIT and SSCs) and non-taxed items. We consider only the taxed items. *Gross* means including the employees' SSCs (pension contributions) and PIT. Our income concept, the *taxable income*, is obtained by subtracting the SSCs from gross taxed employment income. To derive net income, one must subtract the amount of PIT, calculated as a proportion of the tax base, where the tax base equals taxable income minus personal tax allowance. One must also subtract the surtax, calculated as a proportion of the PIT liability, where the proportion equals the surtax rate (determined at the municipality/town level). With this income concept, the relevant marginal PIT rate depends on the personal allowance, the PIT schedule, and the surtax rate. The tax records contain all the necessary information to calculate the marginal tax rate for every earner of employment income.

Figure 1 Selected statistics describing the top one per cent, 2014–2021



Notes: The average HRK/EUR exchange rate over 2014–2021 was 7.519, and the year-specific average ranged from 7.418 (in 2019) to 7.643 (in 2014).

Source: Own calculations based on the tax records data.

We consider as top earners those with a taxable income above the 99th percentile (i.e., the top one per cent) of the distribution of annual taxable income. Thus, z^* is the 99th percentile. Table 1 shows the evolution of selected statistics for the top earners over 2014–2021. The threshold z^* (panel A) rises over the whole period. A similar evolution is exhibited by the net income (after PIT, surtax, and SSCs for a taxpayer with one dependent child and residing in the City of Zagreb, the capital) corresponding to z^* and the mean taxable income above z^*. The number of top earners (panel B) also rises almost continuously. The ratio of z^* to the mean income above it (panel C) tends to fall over time. The income share of top earners (panel D) (total taxable income above z^* as a percentage of aggregate taxable income of the analysed population) is relatively stable, falling slightly over the period. Finally, the tax shares (total PIT paid by top earners as a percentage of the aggregate PIT paid by the analysed population) are substantially larger than the income shares in all years and tend to fall over the period.

4. Parameters of the optimal tax formula

This section describes how we obtain the values of the four parameters in the optimal tax formula (equation 6): the ETI (ε), the Pareto parameter (a), the social welfare weight (g), and the migration elasticity (η).

4.1 Elasticity of taxable income (ETI), ε

Identification and estimation. To identify and estimate the ETI, ε, we rely on the new tax responsiveness approach, pioneered by Feldstein (1995) and extended by Gruber and Saez (2002) and others. Saez, Joel Slemrod, and Seth H. Giertz (2013) review the ETI literature, and Carina Neisser (2021) provides a meta-analysis of ETI estimates.

The marginal tax rate is denoted by $\tau_{i,t}$ and the corresponding marginal net-of-tax rate for an individual i in year t is denoted by $1-\tau_{i,t}$. Following much of the ERI literature, we specify the following regression equation relating changes in earnings to changes in the net-of-tax rate:

$$\Delta \ln z_{i,t} = \text{constant} + \varepsilon \cdot \Delta \ln\left(1-\tau_{i,t}\right) + \boldsymbol{\beta}'\textbf{IncomeControls}_{i,t} + \boldsymbol{\gamma}'\textbf{OtherControls}_{i,t} + \Delta v_{i,t}\,, \tag{7}$$

where $\Delta \ln z_{i,t} \equiv \ln z_{i,t+\mathrm{s}} - \ln z_{i,t}$, $\Delta \ln\left(1-\tau_{i,t}\right) \equiv \ln\left(1-\tau_{i,t+\mathrm{s}}\right) - \ln\left(1-\tau_{i,t}\right)$, and $\Delta v_{i,t} \equiv v_{i,t+\mathrm{s}} - v_{i,t}$ are changes from year t to year $t+s$, and v is an error term. The parameter of interest is ε, the ETI. Income effects are assumed away, and thus ε is both compensated and uncompensated elasticity.

An OLS estimate of ε is biased. In multi-bracket tax schedules, where the marginal rate increases with the tax base, the marginal tax rate is endogenous to the choice of taxable income: $\Delta \ln(1-\tau_{i,t})$ and $\Delta v_{i,t}$ are correlated. The standard approach (Gerald Auten and Robert Carrol 1999; Saez 2002) is to instrument $\Delta \ln(1-\tau_{i,t})$ with the "mechanical" change $\Delta^{\text{mech}} \ln\left(1-\tau_{i,t}\right)$, determined solely by changes in tax rules:

$$\Delta^{\text{mech}} \ln\left(1-\tau_{i,t}\right) \equiv \ln\left(1-\tau_{i,t+s}\left(z_{i,t}\right)\right) - \ln\left(1-\tau_{i,t}\left(z_{i,t}\right)\right), \tag{8}$$

where $\tau_{i,t}\left(z_{i,t}\right) \equiv \tau_{i,t}$, and $\tau_{i,t+s}\left(z_{i,t}\right)$ is the marginal tax rate that a person i faces in year $t+s$ if they earned in $t+s$ the same taxable income as in t (i.e., if $z_{i,t+s} = z_{i,t}$ held). Thus, $\tau_{i,t+s}\left(z_{i,t}\right)$ can differ from $\tau_{i,t}\left(z_{i,t}\right)$ only if tax rules change. Using this instrument, the identification of ε is based on tax reforms. The instrument is by construction exogenous to post-reform earnings $z_{i,t+s}$. However, the instrument depends on pre-reform income $z_{i,t}$, and if the latter is correlated with the error term $\Delta v_{i,t}$, the instrument will also be correlated with the error term, biasing the estimate of ε.

In principle, there are two reasons for the non-zero correlation between pre-reform income and the error term. First, income changes between years t to $t+s$ may not be driven by changes in tax rates only, and the other factors may not operate uniformly, causing pre-tax incomes at different levels to change at differing rates. For example, due to skill-biased technological change, relatively high incomes may grow faster than the rest. Second, there is a phenomenon of mean reversion. In year t, some taxpayers may have very high incomes driven by the transitory (as opposed to permanent) component of income, which tends to fade away by year $t+s$, reducing temporarily high incomes to levels determined by the permanent component. Thus, without controlling for heterogeneity in income trend and transitory income components, the estimate of ε would be biased.

To control for heterogeneous income trends, the standard practice is to control for a function of the base-year (t) income: Auten and Carroll (1999) use log base-year income, while Gruber and Saez (2003) also add a spline in log base-year income. Alternatively, Wojciech Kopczuk (2005) considers log income from one year before the base year ($t-1$) and a spline of it. To control for transitory income components, Kopczuk (2005) adds the growth in income from $t-1$ to t: $\widetilde{\Delta} \ln z_{i,t} \equiv \ln z_{i,t} - \ln z_{i,t-1}$. Moreover, a set of additional controls are standardly added, including personal and job characteristics in the base year (t) and base-year-specific (i.e., period-specific) fixed effects.

Following these practices, in equation 7, the vector $\mathbf{IncomeControls}_{i,t}$ contains either (i) log base-year (year t) income, (ii) a cubic spline of the log base-year income, or (iii) a cubic spline of log income in the year $t-1$ and the difference in log income between t and $t-1$. These three options characterise three separate specifications. In all specifications, the vector $\mathbf{OtherControls}_{i,t}$ contains the following base-year controls: taxpayer's age (in years), unemployment rate in taxpayer's county of residence, dummies for having a dependent child and living with a dependent adult, and dummies for county of work, county of residence, and sector of employment (NACE classification, first level).

The coefficients in equation 7 are estimated by 2SLS, with $\Delta^{\text{mech}} \ln(1-\tau_{i,t})$ as an instrument for $\Delta \ln(1-\tau_{i,t})$. The first-stage equation reads:

$$\begin{aligned} \Delta \ln(1-\tau_{i,t}) = \text{constant} + \pi \cdot \Delta^{\text{mech}} \ln(1-\tau_{i,t}) + \boldsymbol{\psi}' \mathbf{IncomeControls}_{i,t} \\ + \boldsymbol{\theta}' \mathbf{OtherControls}_{i,t} + \xi_{i,t}\,, \end{aligned} \tag{9}$$

where $\mathbf{IncomeControls}_{i,t}$ and $\mathbf{OtherControls}_{i,t}$ are as above.

Since ε is defined (Section 2.1) as a weighted average of z-specific elasticities $\varepsilon(z)$, with $z/\bar{z}$ as weights, all regressions are weighted by $z_{i,t}/\bar{z}_t$. However, this makes a few individuals at the very top so influential that the rest of the estimation population becomes practically irrelevant. Thus, we restrict the estimation population to those with an annual income of at most HRK one million. As stated in Section 3, this reduces the estimation population by 0.04 per cent only.

Specifications for three-year periods (s = 3) are standardly considered as a baseline, with shorter or longer periods as robustness checks. Thus, we consider s = 2, 3, 4. We also explore heterogeneity across subpopulations by estimating the ETI for the top 10 and 20 per cent of earners according to annual taxable income.

Table 1 Personal income tax parameters

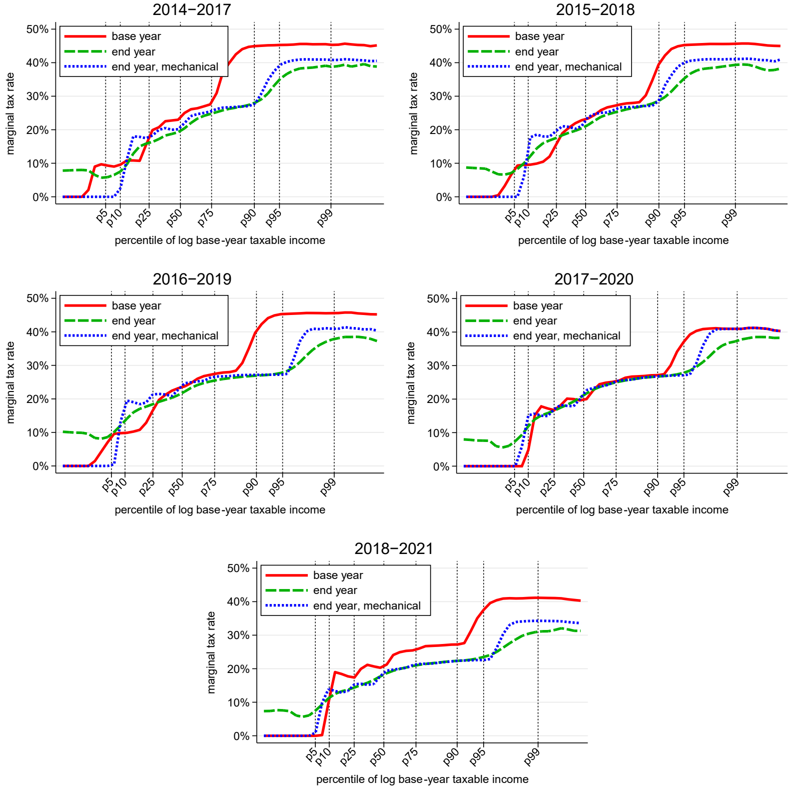
	Year							
	2014	2015	2016	2017	2018	2019	2020	2021
Tax bracket 1								
Lower threshold	0	0	0	0	0	0	0	0
Upper threshold	26,400	26,400	26,400	210,000	210,000	360,000	360,000	360,000
Tax rate	12%	12%	12%	24%	24%	24%	24%	20%
Tax bracket 2								
Lower threshold	26,400	26,400	26,400	210,000	210,000	360,000	360,000	360,000
Upper threshold	105,600	158,400	158,400	∞	∞	∞	∞	∞
Tax rate	25%	25%	25%	36%	36%	36%	36%	30%
Tax bracket 3								
Lower threshold	105,600	158,400	158,400					
Upper threshold	∞	∞	∞					
Tax rate	40%	40%	40%					
Personal allowance								
Basic	26,400	31,200	31,200	45,600	45,600	45,600	48,000	48,000
For 1st child	13,200	15,600	15,600	21,000	21,000	21,000	21,000	21,000
For 2nd child	31,680	37,440	37,440	51,000	51,000	51,000	51,000	51,000
For 3rd child	58,080	68,640	68,640	93,000	93,000	93,000	93,000	93,000

Notes: Amounts are in HRK per year. The average HRK/EUR exchange rate over 2014–2021 was 7.519, and the year-specific average ranged from 7.418 (in 2019) to 7.643 (in 2014). The lower and upper limits refer to the tax base amounts (taxable income minus personal allowance). Allowances for 4th and further children are not shown; they changed at the same percentage rate as those for the 1st, 2nd, and 3rd child.

Source: Own calculations based on the tax records data.

Tax reforms and identifying variation. Before presenting the estimation results, we consider the variation in marginal tax rate over the three-year periods within 2014–2021 and the underlying changes in the statutory tax rules. Table 1 shows the evolution of the PIT parameters. There were several changes. During 2014–2016, there were three tax brackets with the rates of 12/25/40 per cent for the first/second/third brackets. In 2015, the threshold separating the second and third bands, as well as the personal allowances, was increased. As of 2017, the number of tax brackets was reduced to two. The new rates were set to 24 and 36 per cent for the first and second bands, respectively, and the threshold between the bands was set above the highest threshold in 2016. The threshold between the first and second bands was further increased in 2019. In 2021, the tax rates were reduced to 20 and 30 per cent. All personal allowances increased in 2017, and the basic allowance rose further in 2019.

Figure 2. Marginal personal income tax rate



Notes: Base and end years are years t and $t+3$, respectively. The lines are smoothed by local polynomial smoothing.

Source: Own calculations based on the tax records data.

These parameter changes provide variation for identifying the ETI, depicted in Figure 2 for each three-year period in 2014–2021. Each graph plots the marginal tax rates (MTRs) in the base and end years of a three-year period, namely $\tau_{i,t}(z_{i,t})$ and $\tau_{i,t+3}(z_{i,t+3})$, respectively, against the percentiles of the log base-year taxable income. The MTRs are obtained by simulation of the increase in tax liability upon a 3-per-cent increase in taxable income. For example, denoting by $T_{i,t}$ the total tax liability of individual i in year t, the base-year MTR is obtained as $\tau_{i,t}(z_{i,t}) = \frac{T_{i,t}(z_{i,t} \cdot 1.03) - T_{i,t}(z_{i,t})}{z_{i,t} \cdot 1.03 - z_{i,t}}$. The MTRs $\tau_{i,t+3}(z_{i,t+3})$ and $\tau_{i,t+3}(z_{i,t})$ are obtained analogously. The difference between these MTRs underlies $\Delta \ln(1-\tau_{i,t})$. Also plotted (labelled *end year, mechanical*) is the end-year MTR derived under the assumption that taxable income remains as in the base year, namely $\tau_{i,t+3}(z_{i,t})$. The difference between this MTR and the base-year MTR underlies the instrument $\Delta^{\text{mech}} \ln(1-\tau_{i,t})$. Figure 2 shows that the changes to the tax parameters provide variation in every three-year period. Not the whole variation is depicted, since the lines are obtained by local smoothing of the MTRs (using the Stata command LPOLY with the Epanechnikov kernel and a bandwidth determined by the in-built rule of thumb). The figure suggests that differences $\tau_{i,t+3}(z_{i,t}) - \tau_{i,t}(z_{i,t})$ are mostly due to reductions in MTR at relatively high levels of taxable income. There are also some reductions at the bottom of the distribution, while increases are limited to between the 10th and 25th percentiles. The period 2018–2021 is exceptional because of increases in MTR at all levels of taxable incomes above the 10th percentile.

Estimation results. Table 2 reports the first-stage estimates. The reported coefficients on the instrument and the F-statistic for the test show that all coefficients jointly equal zero. The results indicate that, regardless of the estimation sample, the set of income controls, and the period length, the coefficient on the instrument is positive and highly statistically significant, suggesting a strong positive correlation between the actual and mechanical changes in the MTR. In addition, the null hypothesis that all coefficients are zero is rejected in all cases.

Table 2 First-stage regression results

Period length		Income controls		
		Log base-year (t) income	Spline of log base-year (t) income	Spline of log income in year $t-1$ and log-difference in income b/w years $t+s$ and t
		(1)	(2)	(3)
		Panel A. Whole estimation sample		
$s = 2$	Estimate	0.657***	0.665***	0.644***
	F-statistic	18,819	21,848	17,062
$s = 3$	Estimate	0.605***	0.619***	0.610***
	F-statistic	17,622	20,410	14,945
$s = 4$	Estimate	0.572***	0.586***	0.586***
	F-statistic	13,543	16,151	11,573
		Panel B. Top 20 per cent earners		
$s = 2$	Estimate	0.781***	0.784 ***	0.783***
	F-statistic	6,105	6,040	3,961
$s = 3$	Estimate	0.779***	0.785 ***	0.774***
	F-statistic	8,992	8,898	5,337
$s = 4$	Estimate	0.770***	0.777***	0.775***
	F-statistic	7,208	7,123	4,199
		Panel C. Top 10 per cent earners		
$s = 2$	Estimate	0.806***	0.798***	0.813***
	F-statistic	5,055	5,035	3,357
$s = 3$	Estimate	0.820***	0.811***	0.809***
	F-statistic	8,154	8,106	4,908
$s = 4$	Estimate	0.814***	0.803***	0.814***
	F-statistic	7,208	7,123	4,199

Notes: Based on equation 9. Reported are the estimates of π and the F-statistic for testing the hypothesis that all coefficients are equal to zero. Panel A excludes individuals with a taxable income above HRK one million. Panel B (C) includes 10 (20) per cent of individuals with the highest taxable incomes among those in panel A. ***/**/* indicates statistical significance at the 0.1/1/5 per cent level.

Source: Own calculations based on the tax records data.

The ETI estimates are given in Table 3 (other coefficients are not shown but are available on request). There is a considerable heterogeneity in estimates across income controls, estimation samples, and period lengths. First, the ETI tends to increase with the period length s. This stands to reason since the longer the period, the more time taxpayers have to react to tax changes. Two years may be too short for a reaction, which may explain the negative estimates in panel A. Second, the ETIs for the top 20 per cent (panel C) and those for the 10 per cent (panel B), even more, are smaller than the ETIs for the whole estimation sample (panel A), suggesting that behavioural reaction is lower for taxpayers with higher incomes. Third, the ETIs from the specification where log base-year income (column 1) is the only income control are in most cases higher than those from the other two specifications (columns 2 and 3). Heterogeneity of ETI estimates across alternative specifications is often found in the ETI literature (with Kleven and Schultz 2014 as a notable exception).

Table 3 Estimates of elasticity of taxable income

Period length	Income controls		
	Log base-year (t) income	Spline of log base-year (t) income	Spline of log income in year $t-1$ and log-difference in income b/w years $t+s$ and t
	(1)	(2)	(3)
	Panel A. Whole estimation sample		
$s = 2$	0.024***	–0.026***	–0.018***
$s = 3$	0.109***	0.005	0.030***
$s = 4$	0.196***	0.062***	0.085***
	Panel B. Top 20 per cent earners		
$s = 2$	0.033***	0.013	0.023*
$s = 3$	0.058***	0.020*	0.052***
$s = 4$	0.097***	0.041***	0.066***
	Panel C. Top 10 per cent earners		
$s = 2$	0.022**	0.001	0.018
$s = 3$	0.035**	–0.018	0.039**
$s = 4$	0.059***	–0.016	0.035*

Notes: The table reports the estimates of the coefficient ε from different specifications based on equation 7. ***/**/* indicates statistical significance at the 0.1/1/5 per cent level.

Source: Own calculations based on the tax records data.

Considering only positive and statistically significant estimates (19 estimates), the ETI ranges from 0.023 (panel B, $s = 2$, column 3) to 0.196 (panel A, $s = 4$, column 1), with a mean of 0.057. This range is within the range of estimates in other studies using the same income concept, as evidenced by Neisser (2021). Given that there are many low estimates and that the mean is low, we believe it unlikely that we overestimated the true ETI. If our estimates are biased, we think it is more likely that we underestimated the true ETI. Based on this, in our optimal tax calculations, we will assume the following values of the ETI: 0.05, 0.15, and 0.25.

4.2 Pareto parameter, a

The Pareto parameter is also estimated from the tax records data. As established in Section 2, $a = \frac{\bar{z}/z^*}{\bar{z}/z^* - 1}$. Assuming that z at the top is approximately Pareto distributed, with the cumulative distribution $F(z) = 1 - k \cdot z^{-a}$, the ratio $\bar{z}/z^*$ (and thus a) is approximately constant for high values of z^*. To estimate a, we take an informal estimation approach. We plot $\bar{z}/z^*$ against z^*, where the latter takes on values across the entire distribution of z, and observe whether $\bar{z}/z^*$ stabilises beyond some level for z^* in the right tail.

Table 4 Pareto parameter over 2014–2021

	Year							
	2014	2015	2016	2017	2018	2019	2020	2021
a	2.78	2.78	2.76	2.79	2.83	2.88	2.94	3.00

Notes: Calculated as $a = \frac{\bar{z}/z^*}{\bar{z}/z^* - 1}$, based on $\bar{z}/z^*$ beyond the 95th percentile of the taxable income distribution.

Source: Own calculations based on the tax records data.

Using the tax records data, we find that the top of the taxable income distribution for all years is well approximated by a Pareto distribution above the 95th percentile. Table 4 shows a for every year from 2014 to 2021. The parameter varies only slightly over time. Nevertheless, we let a vary over time. Unlike other parameters, we hold the Pareto parameter fixed for a given year in optimal tax calculations. This is because it is not normative and there are no concerns about the credibility of estimates.

4.3 Social welfare weight, g

To obtain g, we use the Atkinson social welfare function (Anthony B. Atkinson 1970) and use the tax records data to compute g according to the definition from Section 2.1. The social welfare function is:

$$\Psi = \begin{cases} \int_{\text{all } z} \frac{c(z)^{1-\rho} - 1}{1-\rho} \, \mathrm{d}H(z) & \text{if } \rho \neq 1\,, \\ \int_{\text{all } z} \ln c(z) \, \mathrm{d}H(z) & \text{if } \rho = 1\,, \end{cases} \tag{10}$$

where $c(z) = z - T(z)$ is consumption (net income) and $H(z)$ is the cumulative distribution function of z (over the whole support). ρ is an inequality-aversion parameter, whose higher values reflect a higher aversion to inequality. Then, the social value of marginal consumption is $\partial\Psi/\partial c = c(z)^{-\rho}$, and according to the definition in Section 2.1, g is given by

$$g = \frac{\text{mean } c(z)^{-\rho} \text{ over } z \text{ above } z^*}{\text{mean } c(z)^{-\rho} \text{ over all } z}\,. \tag{11}$$

The numerator is the average social value of marginal consumption above the 99th percentile of taxable income, while the denominator is the same statistic for the whole distribution. For given ρ, this can be computed form the tax records data. In these calculations, we do not exclude those with a taxable income above HRK 1 million but instead use the whole analysed population (see Section 3).

Our choice of ρ is informed by the only two estimates that can be found in the literature (Richard Layard, Guy Mayraz and Stephen Nickell 2008; Caspar Kaiser 2023). Both estimate ρ using parametric models of subjective well-being (life-satisfaction or happiness) as functions of income and other covariates. Layard, Mayraz, and Nickell (2008) use data from more than 50 countries from 1972 to 2005. Their overall robust estimate is 1.26 (95-per-cent confidence interval: 1.16–1.37). Kaiser (2023), using the 2013 and 2018 EU-SILC surveys for the EU and a few other countries, estimates ρ at 0.88 (95-per-cent confidence interval: 0.85–0.91).

We use Layard, Mayraz, and Nickell's (2008) estimate, $\rho = 1.26$, and one-half of it, $\rho = 0.63$. For $\rho = 1.26$, we compute the mean of g across years to be 0.355 (range: 0.348–0.364), and for $\rho = 0.63$, the mean is 0.122 (range: 0.115–0.125). In our optimal tax calculations, we use $g = 0.35$ and $g = 0.12$, and add a third one, $g = 0$. The g associated with Kaiser's (2023) $\rho = 0.88$ falls between 0.12 and 0.35, so we do not consider it specifically.

The literature on optimal taxation of top incomes standardly considers $g = 0$ (individually or along with other values), and on purely normative grounds. Since g is a normative parameter, there is nothing wrong with setting it to zero or, for that matter, any other value.

4.4 Migration elasticity, η

This is the only parameter we have taken from the literature, rather than estimated from the tax records data. However, the literature on international mobility of individuals is very scarce (see Kleven et al. (2020) for a review). As discussed by Kleven et al. (2020) and Muñoz (2023), the scarcity can be explained by two empirical challenges: (i) a lack of international (as opposed to national) individual-level data with information on both residential choices and taxes (potentially) paid in the home country vs. abroad; and (ii) difficulties with identifying the causal impact of taxes on migration decisions, as the correlation between them may be due to non-tax factors. The available estimates addressing these challenges are of limited relevance for us. They either focus on specific populations (or "occupations") like football players (Kleven, Landais, and Saez, 2013) and inventors (Ufuk Akcigit, Salome Baslandze and Stantcheva, 2016), or consider just one country (Kleven et al., 2014).

The only study that fits our needs is Muñoz (2023), who studies international mobility and focuses on the top 10 per cent earners of no specific occupation from 21 European countries in the period 2009–2015. The identification strategy relies on the differential impact of tax reforms on the top 10 per cent of earners versus lower-income groups. This identification strategy and rich data allow controlling for many confounding factors and yield reasonably credible estimates of migration elasticity.

Considering Muñoz's (2023) preferred specification and the standard errors of the estimates (see her Table 3, column 3), the migration elasticity ranges from 0.07 to 0.32. The figure 0.07 is the lower limit of the 95-per-cent confidence interval around the lowest estimate (0.15, se = 0.04), and 0.32 is the upper limit of the 95-per-cent confidence interval around the highest estimate (0.24, se = 0.04). In our optimal tax calculations, besides $\eta = 0.07$ and $\eta = 0.32$, we use an intermediate value, $\eta = 0.2$.

Muñoz's (2023) elasticity estimates stand to reason, based on comparisons with other estimates. First, the estimates are reasonable considering they combine tax-induced international migration of both domestic people and foreigners. As shown by Muñoz (2023) and others (see Kleven et al. (2020) for a review), migration elasticities are considerably smaller for domestic people than for foreigners. For example, if we used Muñoz's (2023) elasticities for foreigners, we would have the range 0.16–2.05. Second, the estimates are reasonable when compared with the estimates for specific populations of "superstars," like footballers (Kleven, Landais, and Saez, 2013) and inventors (Akcigit, Baslandze, and Stantcheva, 2016), whose elasticities are substantially higher (reaching 1 and above) than those for a general population of top earners, due to the nature of their "occupation." Third, the estimates are reasonably compared to those estimated from within-country (as opposed to international) mobility. The latter elasticities are also considerably larger (above 1) (see Kleven et al., 2020, for a review), since within-country migrations face fewer barriers.

However, the question remains open whether the elasticities we consider are suitable for Croatia in the period 2014–2021. Migration elasticity is not a structural parameter but a context-dependent one, depending on the population stock and migration flows. As such, it is not straightforwardly transferable from one context (space and time) to another. In the absence of estimates specific to Croatia or a comparable country, we consider the elasticities that we chose based on Muñoz's (2023) estimates to be reasonably sensible for three reasons. First, Muñoz's (2023) estimates pertain to international migration of a general population of top earners (both residents and foreigners), which fits our purpose. Second, her estimates are based on data for several countries and thus are not country-specific, which reduces the risk of relying on estimates hinging on a country's specific context. Third, the estimates pertain to a period close to the one we consider.

5. Optimal tax calculations

5.1 Optimal top marginal tax rates for the year 2021

Table 5 shows the optimal rates τ^* for all combinations of parameters (we use *parameter combination(s)* and *case(s)* interchangeably). Panel A displays the rates based on equation 6, which combines the marginal burden of both PIT (including the surtax; we use only *PIT* for brevity) and indirect taxes (value-added tax and excises). Panel B shows the corresponding optimal PIT rates, obtained from panel A by removing from τ^* the marginal burden of indirect taxes. Denoting the optimal PIT rate by τ^*_{PIT} and the indirect tax rate by τ_{IND}, we have:

$$\tau_{\mathrm{PIT}}^{*} = \frac{\tau^{*} - \tau_{\mathrm{IND}}}{1 - \tau_{\mathrm{IND}}}. \tag{12}$$

τ_{IND} is expressed in terms of its tax-inclusive base, that is, as a ratio of indirect taxes to consumption expenditures, including the tax. Equation 12 derives from $\tau = \tau_{\mathrm{PIT}} + (1 - \tau_{\mathrm{PIT}})\tau_{\mathrm{IND}}$, where $(1 - \tau_{\mathrm{PIT}})\tau_{\mathrm{IND}}$ is the marginal burden of indirect taxes, namely the indirect taxes paid on what is left of one unit of income after paying PIT (see Bach, Corneo, and Steiner 2012). Section A3 in the Appendix describes how we calculated τ_{IND} and provides its values in Table A3. Our presentation here and in Section 5.2 considers τ_{PIT}^{*} only, treating τ_{IND} as fixed.

Table 5 Optimal top marginal tax rate (%), 2021

	Panel A. Optimal marginal tax rate, τ^*			*Panel B. Optimal marginal PIT rate, τ_{PIT}^**		
	$\varepsilon = 0.05$ (low)	$\varepsilon = 0.15$ (middle)	$\varepsilon = 0.25$ (high)	$\varepsilon = 0.05$ (low)	$\varepsilon = 0.15$ (middle)	$\varepsilon = 0.25$ (high)
	$g = 0$ (low)			$g = 0$ (low)		
$\eta = 0.07$ (low)	82	66	55	77	57	43
$\eta = 0.2$ (middle)	74	61	52	67	50	39
$\eta = 0.32$ (high)	68	57	49	60	45	35
	$g = 0.12$ (middle)			$g = 0.12$ (middle)		
$\eta = 0.07$ (low)	80	63	52	75	53	39
$\eta = 0.2$ (middle)	72	58	48	64	46	35
$\eta = 0.32$ (high)	65	54	45	56	41	31
	$g = 0.35$ (high)			$g = 0.35$ (high)		
$\eta = 0.07$ (low)	75	56	45	68	44	30
$\eta = 0.2$ (middle)	65	50	41	56	37	25
$\eta = 0.32$ (high)	58	46	38	47	32	22

Notes: The rates in panel A are based on equation 6, and those in panel B are computed using equation 12.

Source: Own calculations based on the tax records data.

We compare τ_{PIT}^{*} with the highest possible actual marginal PIT rate, the one that applies to those in the top tax band (where the rate is 30 per cent), residing in the City of Zagreb (which has the highest surtax rate of 18 per cent), and are not entitled to any PIT relief. This rate is 35.4 per cent, which we round to 35 per cent and refer to as the *maximal possible actual* rate or the *actual* rate. For comparison, the mean marginal rate among the top one per cent of earners is lower (29 per cent), for three reasons. First, for a small fraction of the top one per cent, the tax base does not reach the top tax band, so the relevant marginal rate is 20 per cent instead of 30 per cent. Second, not all top earners reside in the City of Zagreb, which has the highest surtax rate. Third, there are special tax reliefs for certain types of taxpayers.

As discussed in Section 2.1, the optimal rate is decreasing in all parameters. Consider first the optimal rates for the low g ($g = 0$), which are the revenue-maximising rates. For the combination [high ε, high η] the revenue-maximising rate is 35 per cent and equals the actual rate. All other revenue-maximising rates are higher than the actual one, ranging from 39 per cent for [high ε, middle η] to as high as 77 per cent when both elasticities are low. Even when both elasticities are at the middle values, the optimal PIT rate is 50 per cent, quite above the maximum possible actual rate.

Next, we consider the optimal rates for the middle and high g (0.12 and 0.35, respectively). For the middle g, the optimal rates are somewhat lower than the revenue-maximising ones. Now the combination [high ε, high η] gives an optimal rate of 31 per cent, below the actual rate. The combination [high ε, middle η] yields an optimal rate equal to the actual one. The optimal rate for all other elasticity combinations is higher than the actual one.

Turning to the high g, the optimal rates go further down. In all cases with the high ε, the rate is lower than the actual one. If η is high too, then the optimal rate is as low as 22 per cent (just slightly above the rate applying to the lower tax bracket). Reducing ε to the middle value, the optimal rate falls below the actual one for the η only. In all other cases, a rate above the actual rate is optimal, ranging from slightly above the actual rate to as high as 68 per cent when both elasticities are low.

To summarise the results, for most (20 out of 27) parameter combinations, the optimal rate exceeds the maximum possible actual rate of 35 per cent.

If we compared the optimal rates with the mean marginal rate among the top one per cent (29 per cent) instead of the maximum possible rate, then the optimal rate would be higher than the actual one for almost all (25 out of 27) parameter combinations.

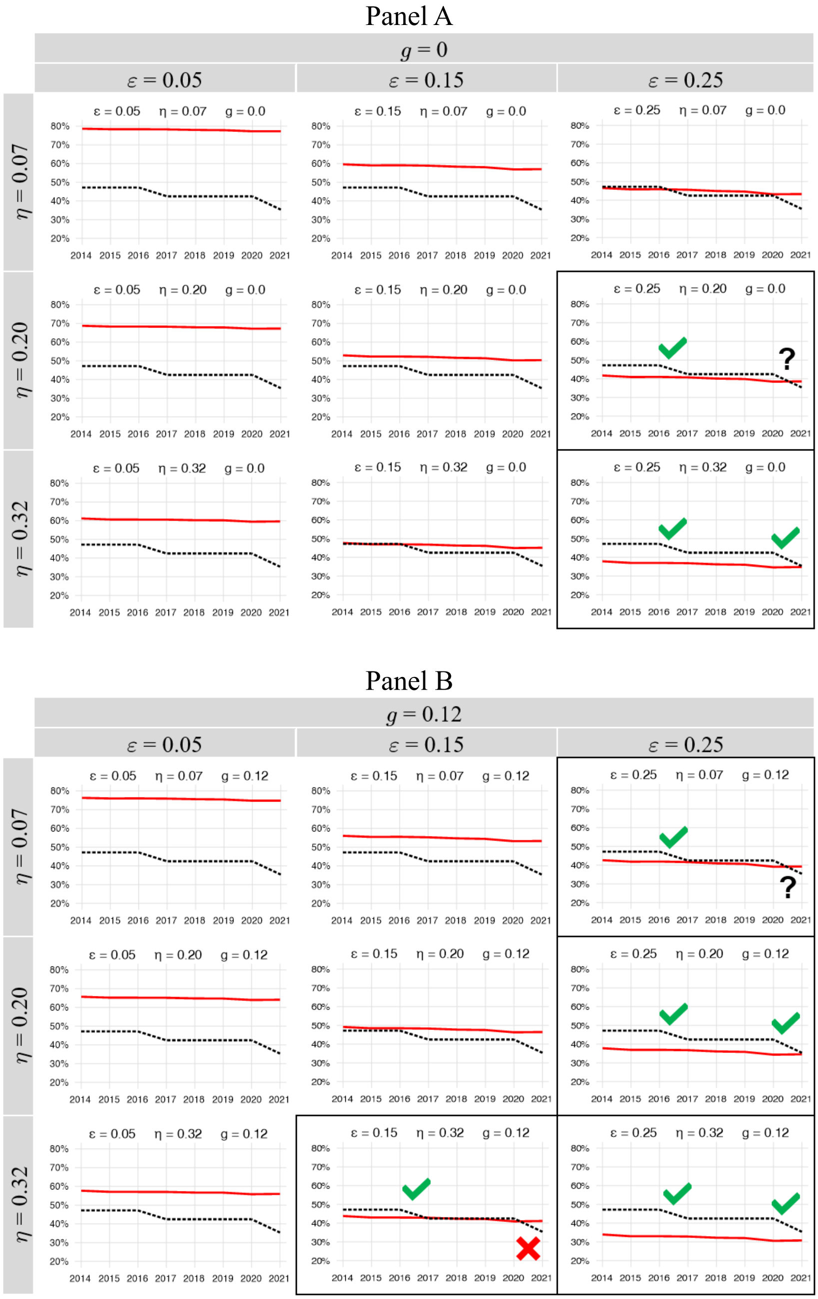
5.2 Optimal top marginal tax rates over 2014–2021

We now turn to the whole period 2014–2021, when several reforms took place (see Table 1). Among other changes, the highest marginal PIT rate was reduced twice. Over 2014–2016, the rate was 40 per cent, falling to 36 per cent as of 2017 and 30 per cent as of 2021. Considering top earners without PIT reliefs and residing in Zagreb, the highest possible actual rate was 47.2 per cent over 2014–2016, falling to 42.5 per cent as of 2017 and 35.4 per cent as of 2021. Here we investigate whether the optimal taxation theory justifies these reductions.

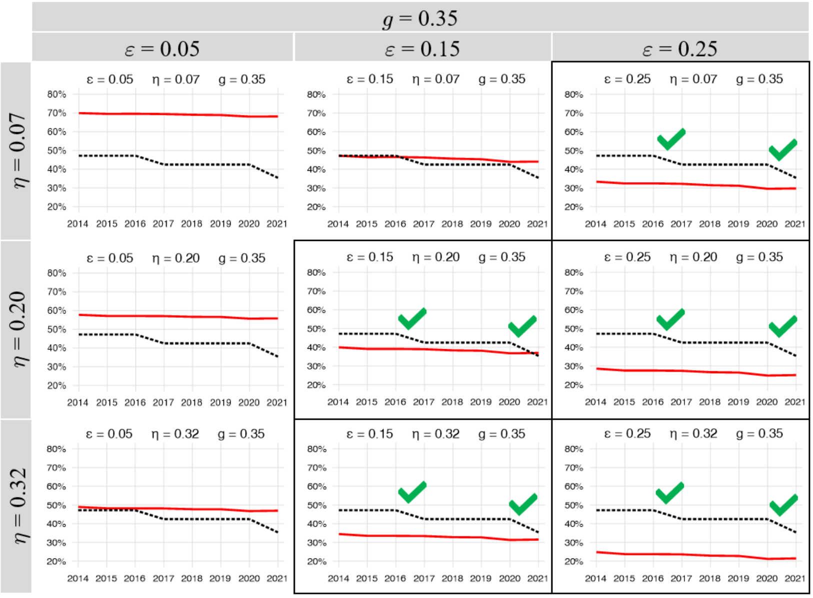
Figure 3 depicts the optimal and actual rates over 2014–2021 for all parameter combinations. The three panels refer to the three values of g, and in each panel, we have all combinations of ε and η. The parameters g, ε, and η are fixed over time; only the Pareto parameter a varies.

We observe that the optimal rate is declining slightly over time. There are two underlying drivers. First, a is slightly increasing over time. Second, the indirect tax rate τ_{IND} (used in formula 12) is slightly increasing over time (see Table A3 in the Appendix). For any combination of the parameters, the optimal rate declines less steeply than the actual rate. To see a consequence of this, consider the graphs without a black frame, which represent the parameter combinations for which, for 2014, the optimal rate is greater than or equal to the actual rate. In these cases (16 out of 27), the steeper decline in the actual rate causes this rate to diverge over time from the optimal rate: the gap between them rises. Expectedly, this is more likely the lower the parameters g, ε, and η are.

Figure 3 Optimal top marginal tax rates over 2014–2021, compared to the actual rate



Panel C



Notes: The solid (dashed) line depicts the optimal (actual) rate. On framed (unframed) graphs, the 2017 and 2021 reforms may (cannot) be justified by the optimal tax model that we use. The check (cross) sign indicates that a reform is justified (unjustified), and a question mark marks unclear cases.

Source: Own calculations based on the tax records data.

On the framed graphs (11 out of 27), the optimal rate in 2014 is below the actual one. In these cases, the marginal rate reduction associated with the 2017 or the 2021 reform may have brought the actual rate closer to the optimal one (although this need not be the case for both reforms). In principle, the two reductions may have been too large, causing divergence from the optimal rate. On each framed graph, we mark the reforms with a check mark where the actual rate came closer to the optimal one. These reforms are considered justified (or approved) from the optimal taxation perspective. Where reforms are unjustified (or disapproved), that is, where they increase the gap between the actual and optimal rates, we mark them with a cross-out. Finally, unclear situations (neither justified nor unjustified) are marked with a question mark.

The 2017 reform can be justified for all parameter combinations. Before the reform, the actual rate was sufficiently above the optimal rate, so the reform reduced the gap between them, and in some cases, the gap vanished completely. When it comes to the further reduction in the actual rate within the 2021 reform, it is justified for most parameter combinations. It is justified in all cases with the high g (framed graphs in panel C), which means that, for a sufficiently high valuation of top earners' marginal consumption, the 2021 reform is justified irrespective of the considered levels of ε and η. Unjustified or unclear cases appear only for the low g (panel A) and middle g (panel B). The reform is unjustified in one case: [middle g, middle ε, high η]. In this case, the

2017 reform achieved optimality (i.e., equalled the two rates), while the 2021 reform opened a gap again by reducing the actual rate to below the optimal one. The cases [middle g, high ε, low η] and [low g, high ε, middle η] are unclear. In both cases, in 2020, the actual rate was somewhat above the optimal one, and reform reduced the actual rate to somewhat below the optimal one. These cases are judged unclear as there is no *a priori* reason to prefer actual above optimal over actual below optimal, or the opposite.

Lastly, we wanted to find out whether there is room for further reforms in the same direction as those in 2017 and 2021. Further reductions might be justified only for some parameter combinations on the framed graphs. Among them, a further reduction is not justified in cases with the low g, since the actual rate is already equal to or below the optimal one. For the middle g, a further reduction would be justified only if both ε and η are high, and a reduction of about five percentage points would be justified. However, there is one case, [middle g, middle ε, high η], where an increase in the actual rate (of about 5–6 percentage points) would be justified. Such an increase would cancel out the unjustified 2021 reform. Finally, for the high g, a further reduction would be justified in all cases except the one with the middle ε and middle η. Of course, the larger the parameters, the larger the reduction in the actual rate would be justified, ranging from about 5 to 15 percentage points.

To summarise, considering all 27 parameter combinations, the 2017 reform cannot be justified for 16 of them. The 2021 reform cannot be justified for 17 combinations, with two unclear cases. Moreover, a further reform to reduce the actual rate can be justified for only five parameter combinations, where at least one parameter must be high.

6. Concluding discussion

Based on tax records data and using a simple sufficient-statistic formula for the optimal top marginal tax rate, derived from an extension to Saez's (2001) model, we analysed optimal taxation of the top one per cent of labour income earners in Croatia over the period 2014–2021. Our contribution is threefold. First, we provide estimates of the ETI for a Southeast European country, addressing a gap in the literature where such estimates are currently scarce. Second, analyses of optimal taxation are also lacking for Southeast European countries, and we have provided one. Third, we assess a part of the Croatian tax system from the optimal taxation perspective, while previous research dealt predominantly with the tax wedge, progressivity, and redistribution.

The results show that in 2021, the optimal top marginal tax rate is larger than the actual rate (represented by the maximum possible actual rate) for most combinations of the parameters. The optimal rate is at or below the actual one only for a few parameter combinations featuring high elasticities (ETI and migration elasticity) and the top earners' social welfare weight. Regarding the tax reforms that reduced the actual rate in 2017 and 2021, we found that for most parameter combinations (16 out of 27), the reductions cannot be justified from the perspective of optimal taxation of top incomes.

The plausibility of the findings should be assessed considering, first, the plausibility of the optimal tax model we used and second, insofar as the model reasonably captures the relevant concerns, the plausibility of the choice of the parameter values.

Concerning the plausibility of the optimal tax model, it arguably does not capture all conceivably relevant factors. That said, the Saez (2001) model, extended to take account of migration as a behavioural response, considers factors that are undoubtedly important and perhaps even more important than other relevant factors. This is especially important when one seeks a relatively simple model to capture the main factors at work. Even such a parsimonious model requires knowledge of plausible values for several parameters (four in our case). A more extensive model would feature more parameters, and it is questionable whether one can arrive at plausible values for all of them: estimating them credibly is full of issues related to identification and data availability, and for the same reason, the possibility of relying on other researchers' estimates is limited as credible and robust estimates are lacking. In this context, sticking to a simple model, like the one we used, seems warranted. In addition, from the policy-making perspective, relying on a simple model of optimal taxation to inform tax policy design is perhaps as far as a real-world government would be ready to go. And this holds only if we explicitly rely on a formal model. But suppose governments design taxes by following a set of tacit presuppositions which could be only implicitly and roughly represented by an optimal taxation model, which is almost certainly the case for a typical government. In that case, the implicit model is likely even simpler than the one we used.

When it comes to the parameters, except for the Pareto parameter, which can be credibly estimated in a simple way from the tax records data, the choice of the other parameters' values is not a simple task. Although there is a rich literature estimating the ETI, new contributions keep coming, pointing to identification issues and the associated biases in the previous literature. Thus, the true value of the ETI remains highly uncertain. The literature on migration elasticity is still relatively scarce, usually providing estimates for specific populations (e.g., footballers, inventors) with questionable validity for a general population. And finally, the social welfare weight is a normative parameter, and thus one can hardly speak of its true value, even though there have been scarce attempts to estimate it.

In deciding on the parameter values, we opted to rely on our data as much as possible. Thus, we estimated the ETI, leveraging several personal income tax system reforms over 2014–2021, including the 2017 and 2021 reductions in the highest statutory tax rate. The estimates range from 0.02 to 0.2, which is within the range in the ETI literature. However, considering the possibility of a downward bias, we take 0.05 and 0.25 as the lower and upper bounds of a plausible range, respectively, and 0.15 as the middle value. Given the lack of ETI estimates for other Southeast European countries, we also consider our estimates a reasonable choice for other countries. We could not estimate migration elasticity because of the lack of information about the international migration of individuals in the tax records database that we use. Thus, we relied on Muñoz (2023), the only (to our knowledge) work estimating the elasticity of international migration for a general population of top earners, rather than a specific subpopulation such as footballers or inventors. While this paper has not been published yet, we find its identification strategy and data (covering 21 European countries over 2009–2015) credible enough to inform our choice of a plausible range of the migration elasticity parameter. Finally, when it comes to the social welfare weight for top earners, this is a normative parameter, and the range we considered, based on our data and the estimates of the parameter of the Atkinson social welfare function, corresponds to the ranges considered in other papers on optimal taxation of top earners. Overall, our set of parameter values seems plausible, and the number of parameter combinations (27 for a year) seems large enough to represent the space of plausible possibilities well.

Our work offers some policy recommendations. However, these depend on the choice of parameter combination from the set we consider. Depending on attaching no value to top earners' marginal consumption ($g = 0$), a further reduction in the top PIT rate below the 2021 level (still relevant at the time of writing) is not warranted, as the actual rate is either (nearly) equal to the optimal rate or below it, in which case an increase is warranted. However, if one accepts the middle g (0.12), then a reduction in the actual rate of about five percentage points is warranted, but only conditional on high ETI (0.25) and migration elasticity (0.32). For other combinations with the middle g, either no change or an increase is recommended. Finally, if one accepts the high g (0.35), it is recommended to reduce the actual rate only if the ETI is high. Thus, an increase is recommended for most parameter combinations rather than a further reduction in the actual rate.

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Appendix

A.1 Derivation of the emigration effect

Let $P(c,z)$ be the share of top earners who have earnings z and who decide *not* to emigrate when their disposable income is $c(z) = z - T(z)$, where $T(z)$ is their total tax liability. Initially, before the reform, $\int_{z \geq z^*} P(c,z)\,\mathrm{d}z = 1$, since the number of individuals above z^* is normalised to one. $P(c,z)$ is increasing in $c(z)$ or, equivalently, decreasing in $T(z)$. When consumption decreases by Δc, $P(c,z)$ decreases by $\frac{\partial P(c,z)}{\partial c} \cdot \Delta c$. If someone who earns z emigrates, the government loses the total tax liability $T(z)$. Thus, when $\frac{\partial P(c,z)}{\partial c} \cdot \Delta c$ such persons emigrate, the government loses this much of tax revenue:

$$E(z) = \frac{\partial P(c,z)}{\partial c} \cdot \Delta c \cdot T(z) = -\frac{\partial P(c,z)}{\partial c} \cdot (z - z^*) \cdot \Delta\tau \cdot T(z)\,, \tag{13}$$

where the second equality is because, upon the reform $\Delta\tau$, the reduction in consumption is $\Delta c = -(z - z^*) \cdot \Delta\tau$. The total emigration effect E sums these losses $E(z)$ over the whole top tax bracket (i.e., over all $z \geq z^*$):

$$E = \int_{z \geq z^*} E(z)\,\mathrm{d}F(z) = -\Delta\tau \cdot \int_{z \geq z^*} \frac{\partial P(c,z)}{\partial c} \cdot (z - z^*) \cdot T(z)\,\mathrm{d}F(z)\,. \tag{14}$$

Now, we define the migration elasticity at a taxable income level z,

$$\eta(z) = \frac{\partial P(c,z)}{\partial c / c(z)}\,, \tag{15}$$

and substitute $\frac{\eta(z)}{c(z)}$ for $\frac{\partial P(c,z)}{\partial c}$ in equation 14 to obtain

$$\begin{aligned} E = -\Delta\tau \cdot \int_{z \geq z^*} \frac{\eta(z)}{c(z)} \cdot (z - z^*) \cdot T(z)\,\mathrm{d}F(z) \\ = -\Delta\tau \cdot \int_{z \geq z^*} \frac{T(z)}{c(z)} \cdot (z - z^*) \cdot \eta(z)\,\mathrm{d}F(z) \\ = -\Delta\tau \cdot \int_{z \geq z^*} \frac{T(z)}{z - T(z)} \cdot (z - z^*) \cdot \eta(z)\,\mathrm{d}F(z)\,, \end{aligned} \tag{16}$$

where we use $c(z) = z - T(z)$. Now, note that for a large z (i.e., for $z \to \infty$) the fraction $\frac{T(z)}{z - T(z)}$ becomes

$$\lim_{z\to\infty} \frac{T(z)}{z - T(z)} = \lim_{z\to\infty} \frac{T'(z)}{1 - T'(z)} = \frac{\tau}{1-\tau}, \tag{17}$$

where the first equality is due to the L'Hospital rule, and the second uses $\lim_{z\to\infty} T'(z) = \tau$. Substituting $\frac{\tau}{1-\tau}$ for $\frac{T(z)}{z-T(z)}$ in equation 17, the total migration effect can be rewritten as

$$\begin{aligned} E &= -\Delta\tau \cdot \frac{\tau}{1-\tau} \cdot \int_{z\geq z^*} (z - z^*) \cdot \eta(z)\, \mathrm{d}F(z) \\ &= -\Delta\tau \cdot \frac{\tau}{1-\tau} \cdot (\bar{z} - z^*) \cdot \int_{z\geq z^*} \frac{z - z^*}{\bar{z} - z^*} \cdot \eta(z)\, \mathrm{d}F(z) \\ &= -\frac{\tau}{1-\tau} \cdot M \cdot \int_{z\geq z^*} \frac{z - z^*}{\bar{z} - z^*} \cdot \eta(z)\, \mathrm{d}F(z)\,, \end{aligned} \tag{18}$$

where the second equality stems from multiplying the whole expression by $\frac{\bar{z}-z^*}{\bar{z}-z^*} \equiv 1$, and the third equality is due to $M = (\bar{z} - z^*) \cdot \Delta\tau$. Finally, assuming that the migration elasticity is constant (i.e., does not vary with z), $\eta(z) = z$, equation 18 turns into equation 8:

$$E = -\frac{\tau \cdot M \cdot \eta}{1-\tau}. \tag{19}$$

In a more general case, where the migration elasticity varies with z, η is a weighted mean of $\eta(z)$ above z^*, with $\frac{z-z^*}{\bar{z}-z^*}$ as the weights.

A.2 Total population, analysed population and population for estimation of ETI

See Table A1.

Table A1 From the population of all employees to the analysed population and the population used for the estimation of the ETI

Year	Population of all employees	Excluded from population of all employees to get analysed population		Analysed population	Employees with annual taxable income above HRK 1 million		Population for estimation of ETI
		Count	% of all employees		Count	% of the analysed population	
	(1)	(2)	(3)	(4) = (1) – (2)	(5)	(6)	(7) = (4) – (5)
2014	1,495,692	301,086	20.1	1,194,606	487	0.041	1,194,119
2015	1,515,507	297,806	19.7	1,217,701	535	0.044	1,217,166
2016	1,539,833	277,750	18.0	1,262,083	539	0.043	1,261,544
2017	1,557,608	278,480	17.9	1,279,128	479	0.037	1,278,649
2018	1,607,527	298,558	18.6	1,308,969	502	0.038	1,308,467
2019	1,654,325	313,216	18.9	1,341,109	529	0.039	1,340,580
2020	1,621,706	309,395	19.1	1,312,311	496	0.038	1,311,815
2021	1,654,299	314,521	19.0	1,339,778	560	0.042	1,339,218
Average	1,580,812	298,852	18.9	1,281,961	516	0.040	1,281,445

Notes: For the exclusion criteria applied in column 2, see Section 3. *Taxable income* is our income concept, defined in Section 3.

Source: Own calculations based on the tax records data.

A.3 Calculation of the indirect tax rate

The rate of indirect taxes τ_{IND} in equation 17 in the main text is calculated as follows. In general, we obtain it as the ratio of the aggregate amount of indirect taxes to the aggregate tax-inclusive consumption base. We consider the value-added tax, all excises, and the so-called consumption tax (proportional tax on alcoholic and non-alcoholic beverages in bars and restaurants). The consumption base is tax-inclusive because it is the sum of the actual consumption base on which the indirect taxes are paid, plus the indirect taxes paid on the actual consumption base.

τ_{IND} is calculated based on the following formula:

$$\tau_{\text{IND}} = \frac{\text{VAT} + \text{Excises} + \text{Consumption tax}}{\text{A} + \text{B} + \text{C} - \text{D} - \text{E} - \text{F}}. \tag{20}$$

All items in this formula and their data sources are described in Table A2. Item D is subtracted because the indirect taxes do not tax compensation of employees, but this item is included in item B. Items E and F are subtracted because the indirect taxes do not tax housing rent, but these items are included in item A. Table A3 gives the aggregate amount of indirect taxes, items A to F, and the resulting indirect tax rate τ_{IND}, according to the formula A7.

Table A2 Items used in the calculation of the indirect tax rate τ_{IND} using formula (20)

Item	Description	Source
VAT	Aggregate value-added tax revenue	Ministry of Finance: general government revenue statistics
Excises	Aggregate excises revenue	Ministry of Finance: general government revenue statistics
Consumption tax	Aggregate consumption tax	Ministry of Finance: general government revenue statistics
A	Aggregate final private consumption	Croatian Bureau of Statistics: national accounts statistics
B	Aggregate government consumption (includes compensation of employees)	Croatian Bureau of Statistics: national accounts statistics
C	Aggregate tourism revenue	Croatian National Bank: balance of payments statistics
D	Aggregate expenditure for compensation of employees by the general government	Ministry of Finance: general government expenditure statistics
E	Aggregate housing rent paid by tenants	Eurostat
F	Aggregate imputed rent for owner-occupied housing	Eurostat

Source: Own elaboration.

Table A3 Indirect tax rate and the data for its calculation according to the formula (20), 2014–2021

Year	Indirect taxes	Item A	Item B	Item C	Item D	Item E	Item F	Indirect tax rate, τ_{IND}
2014	54,006.11	200,327.56	73,897.06	49,308.73	34,129.80	168.80	3,122.40	0.189
2015	57,828.37	200,425.49	73,334.65	54,389.81	36,421.85	169.90	3,150.30	0.201
2016	60,332.33	204,415.82	74,236.37	61,011.91	37,957.02	170.90	3,183.10	0.202
2017	63,119.67	212,654.98	77,215.10	67,501.34	39,395.44	172.30	3,203.00	0.201
2018	67,611.80	222,904.37	81,141.02	71,581.91	41,802.36	176.80	3,258.00	0.205
2019	71,347.82	234,564.80	85,417.47	79,401.64	44,269.21	179.40	3,377.80	0.203
2020	63,635.84	223,860.24	91,291.58	35,762.72	50,427.93	157.10	3,469.90	0.214
2021	75,840.36	251,901.23	97,481.98	68,818.39	54,163.97	160.90	3,556.60	0.210

Notes: Indirect taxes and items A to F are expressed in HRK million. The average HRK/EUR exchange rate over 2014–2021 was 7.519, and the year-specific average ranged from 7.418 (in 2019) to 7.643 (in 2014). The indirect tax rate is computed using formula (20). For the data sources, see Table A2.

Source: Own calculations based on data from the sources stated in Table A2.