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Jointly Optimal Taxes for Different Types of Income

Abstract

We develop and estimate a model of jointly optimal income taxes for different types of income. Compared to standard optimal tax formulas, optimal schedular income tax rates additionally depend on cross-elasticities between tax bases capturing fiscal externalities. We discuss two applications: the taxation of different income sources such as labor or capital income and the taxation of couples. For these applications, we calculate income type-specific optimal tax rates for Germany using rich panel data from administrative tax records. We first estimate income-type specific elasticities with respect to the next-of-tax rate and show that responses to taxes differ substantially by income source and by gender. Second, we calculate social welfare weights implicit in the German personal income tax schedule which again differ between income sources and by gender. Using these estimates, we consider a tax simplification reform by calculating optimal schedular linear income tax rates. We find that optimal tax rates are significantly lower for labor income than for self-employment and capital income as well as for married women than men.

JEL-Codes: H210, H240, H260, D600.

Keywords: optimal taxation, income types, marginal social welfare weights, flat tax, administrative data.

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1 Introduction

Tax systems around the world have evolved to be quite complex entities resulting in recurring calls for simplification. In the academic and public debate, the discussion of tax simplification is closely linked to the flat tax idea (Hall and Rabushka 1985; Keen et al. 2008). And indeed, many countries have moved into the direction of "flatter" tax systems over time (Peter et al. 2010). A first step in such a direction is the so called "dual income tax" where capital income is taxed at a flat rate whereas labor income is taxed on a separate schedule (Boadway 2004). Such schedular tax systems are becoming increasingly popular around the world and are widely discussed in policy debates (Bastani and Waldenström 2018). However, the academic literature is lacking a proper tool to evaluate such reforms, as standard optimal income tax models are based on comprehensive income tax systems, where all income from different sources is added up to taxable income before the tax schedule is applied (Piketty and Saez 2013). In this paper, we close this gap by developing a simple model of optimal schedular taxes for different income types based on sufficient statistics that can be easily applied empirically. We estimate the ingredients of the model using German administrative tax data and calculate optimal tax rates for two applications: differential taxation of income sources (such as labor, capital or self-employment income) as well as differential taxation of spouses in couples.

In the first part of the paper, we set up an optimal tax model in the spirit of Sheshinski (1972), Diamond (1998) and Saez (2001). We extend the standard model to derive jointly optimal separate tax schedules for different types of income. In order to make the model tractable, we focus on optimal linear tax rates relating to the flat tax context. The rationale behind levying different taxes on different income types is twofold. First, different types might vary in their responsiveness to taxation, enabling the government to exploit differentials in the efficiency costs of taxation. Second, welfare weights might differ between different types of income making redistribution across income types desirable.[1] A key issue for determining the joint optimality of schedular taxes is accounting for fiscal externalities occurring through differentials in tax

[1] Note that different social welfare weights for different types of income do not imply that the social planner has an inherent preference to favor one type of income over another. Instead, welfare weights can differ if the concentration of different income types varies along the distribution of aggregate taxable income.

rates (for instance, shifting between tax bases). This feature creates an interdependency of optimal tax rates so that the the optimal tax vector is given by a system of equations. We take a sufficient statistics approach and derive the equilibrium vector of optimal linear tax rates as functions of income type-specific own- and cross-elasticities as well as income type-specific welfare weights. We show that optimal linear tax rates are increasing and convex in the proportion of cross-responses in the total income type-specific elasticity. Moreover, and in line with standard optimal tax theory, optimal linear tax rates are higher for lower overall responsiveness, lower marginal welfare weights, and a more concentrated income distribution.

In the second part of the paper, we consider two natural empirical applications of our model. Our main application concerns the differential taxation of different income sources such as labor or capital income (as in the dual income tax case). As a further application we consider the differential taxation of spouses in couples. We calculate optimal schedular linear tax rates for these applications for Germany. As it has one of the most complex income tax systems around the world, the case of Germany is of particular interest. During the 2000s, the period of our analysis, a big policy debate took place concerning tax simplification and the introduction of a flat tax or dual income tax system (Kirchhof 2005; Fuest et al. 2008). We inform this debate empirically from an optimal tax perspective.

To apply our model, we require three ingredients: the joint distribution of different income types, income type-specific measures of behavioral responses to taxation, and type-specific measures of welfare considerations. We obtain these statistics as follows. First, data on the joint income distribution is directly taken from German administrative tax return data. Second, we use this data to estimate heterogeneous elasticities of taxable income (ETI) with respect to the net-of-tax rate for different income types to capture their differential responsiveness. To do so, we employ the estimation strategies proposed by Gruber and Saez (2002) and Weber (2014). Third, we estimate the distribution of marginal social welfare weights (MSWW) inherent in the current German income tax schedule by applying an inverse optimal tax procedure. Using this approach, we obtain average type-specific welfare weights which we use for the calculation of optimal linear schedular taxes. When considering a tax simplification proposal, this procedure allows us to hold average welfare considerations constant relative to the status quo and determine the schedular linear tax system (allowing for differential taxation of different types of income) that is optimal given the implied welfare weights in the status quo.

We find that optimal tax rates are much lower for labor income than for capital and self-employment income. This result can be traced back to the ingredients of the optimal tax formula: while self-employment income is more responsive than labor income, it also exhibits much lower average welfare weights resulting from its concentration at the top of the overall taxable income distribution.

For our second application, the differential taxation of spouses in married couples, we find that optimal tax rates for married men are higher than for married women. Again, this can be traced back to the ingredients of the model: married women exhibit higher responsiveness to taxation and their income is less concentrated than that of men. In both applications, higher cross-elasticities (i.e. higher levels of fiscal externalities) lead to higher tax rates and smaller tax differentials between tax bases.

We make four contributions to the literature. First, we contribute to the literature on optimal taxation. Here, the literature on the taxation of different income types under the condition of joint optimality is relatively scarce.[2] Rothschild and Scheuer (2013) and Scheuer (2014) provide models of optimal income taxes for entrepreneurs in economies where individuals have different skills for different occupations. Ooghe and Peichl (2015) study the optimal (linear) taxation of different characteristics in the presence of unobserved ability and unobserved preference heterogeneity. A major challenge in modeling jointly optimal taxes is to incorporate cross-effects between tax bases which is not considered in the standard optimal income tax model.[3] Piketty et al. (2014) provide a formula for the optimal (linear) top income tax rate incorporating fiscal externalities due to income shifting. Saez and Stantcheva (2018) study optimal linear (and also

[2]Of course, a long literature on the (separate) optimal taxation of labor income (see, e.g., Piketty and Saez 2013 for a recent survey) and capital income (see, e.g., Kopczuk 2013 for a recent survey) exists.

[3]For instance, inter- and intra-temporal income shifting (Slemrod 1998; Kreiner et al. 2014; Harju and Matikka 2016) have been identified as an important component of the ETI (Saez et al. 2012). See Christiansen and Tuomala (2008) for a theoretical argument in favor of taxing capital income in the presence of income shifting and Selin and Simula (2017) for a recent analysis of the social welfare effects of income shifting between labor and capital.

non-linear) tax rates on capital.[4] We contribute to this literature by developing an empirically tractable and sufficient statistics-based model of jointly optimal linear income tax rates for different types of income accounting for fiscal externalities.[5]

Second, we add to the empirical literature estimating taxable income elasticities (see Saez et al. 2012 for a survey) and in particular to the literature investigating differential responsiveness across different types of income (Kleven and Schultz 2014; Bargain et al. 2014). We contribute to this literature by providing the first ETI estimates for Germany for different income sources as well as for married men and women separately. We find substantial heterogeneity in the responsiveness to taxation both across different sources of income such as labor, self-employment, and capital income as well as between spouses. Differentiating by income source for single taxpayers, we find an ETI of 0.13 for labor income, 0.22 for capital income and 0.43 for self-employment income. Differentiating by gender, we find ETIs of 0.39 for married men and 0.71 for married women.

Third, we derive and estimate MSWWs implicit in the German tax system similar to Lockwood and Weinzierl (2016) for the US and Jacobs et al. (2017) for the Netherlands.[6] In contrast to these earlier studies, we decompose the ETI into income type-specific elasticities to calculate MSWWs. Compared to the standard constant elasticity assumption, this allows the overall ETI to vary along the income distribution as income types can be concentrated at different points of the distribution. Moreover, we are the first to use the recovered social welfare weights to calculate optimal tax rates in an alternative tax system. This procedure allows us to consider tax (simplification) reforms which hold average welfare considerations constant (relative to the status-quo). We find that MSWWs are roughly constant for the bottom 60% of taxpayers, de-

[4]Saez and Stantcheva (2018) build a (dynamic) model of capital taxation including the accumulation of capital stock and income shifting between capital and labor income. A key difference of our approach is that we allow for arbitrarily many (undefined) income types. Our sufficient statistics formula captures substitutabilities and complementarities between income types without restricting the functional form of the underlying cost function for the generation and shifting of income.

[5]See also Kleven et al. (2009), Immervoll et al. (2011), Bach et al. (2012) or Cremer et al. (2012) for recent contributions and also the literature on gender-based taxation with different tax schedules for men and women (Cremer et al. 2010; Alesina et al. 2011; Bastani 2013). Our approach is also related to the "tagging idea" of Akerlof (1978); see, e.g., Mankiw and Weinzierl (2010), Weinzierl (2011) or Bastani et al. (2013) for recent contributions.

[6]See Bourguignon and Spadaro (2012), Bargain et al. (2014a,b) and Bastani and Lundberg (2017) for further applications of the optimal tax inversion procedure.

creasing for higher incomes until roughly the 95% percentile, and increasing thereafter. Implied average welfare weights are highest for labor income and lowest for self-employment income. Fourth, using these model ingredients, this paper is the first to estimate jointly optimal linear tax rates for different income sources as well as for spouses in couples. Our findings have implications for the current policy debate. Taking efficiency and equity considerations into account, our results indicate that the optimal labor income tax is lower compared to the one for self-employment or capital income. In practice, capital income in a dual income tax system is often taxed at a lower rate while labor and self-employment income are taxed at the same rate. Our results also suggest that differential taxes on spouses (with a lower rate on women) can be optimal. Although differential tax rates by gender are not typically legally feasible, an indirect implementation could involve differential taxes on primary and secondary earners (as in most countries women constitute the majority of secondary earners). A first step in such a direction is the introduction of an individual income tax in countries like the US and Germany where couples are currently assessed jointly and both spouses are assigned to the same marginal tax rate. Of course, some caveats remain. We focus on linear tax rates (as in the flat tax context) and use a static framework without capital accumulation. Hence, our findings should be seen as directions for reform rather than concrete proposals.

The remainder of this paper is structured as follows. In Section 2 we derive and characterize the conditions for jointly optimal income taxes for different types of income. Section 3 explains the institutional background of the German tax law as well as the data used in this paper. We then turn to our first application, the differential taxation of different income sources. In Section 4 we estimate ETIs by income source. Next, Section 5 presents estimates of MSWW and average type-specific welfare weights obtained from an inverse optimal tax approach. We then present estimates of income source-specific optimal tax rates in Section 6. Section 7 discusses the taxation of married couples as a second application. Section 8 concludes.

2 Jointly Optimal Income Taxes for Different Types of Income

We derive jointly optimal linear income taxes for different types of income in a model in the spirit of Sheshinski (1972), Diamond (1998) and Saez (2001). We use a sufficient statistics approach, in which behavioral responses are captured in terms of elasticities with respect to net-of-tax rates. Our model takes into account fiscal externalities occurring through differentials in tax rates across tax bases.

Tax units: Consider n distinguishable types of income on which the government can levy a tax. A tax unit earns income $\hat{z}_i$ of type i and reports an amount of z_i to the government that is taxed according to the tax rate τ_i. The difference between earned income $\hat{z}_i$ and reported income z_i represents the amount of income shifted from or to tax base i.[7] Each tax unit also obtains a lump-sum transfer D allowing for progressive (or regressive) taxes. Tax payers are heterogeneous in their consumption preferences and ability to generate and shift income. A tax unit's traits are captured by the vector $\mathbf{k}$ which is distributed across the population according to $F(\mathbf{k})$. Utility of a tax unit of type $\mathbf{k} \in \mathbf{K}$ reads

$$U(\mathbf{k}) = u^{\mathbf{k}}(c; \hat{z}_1, \ldots, \hat{z}_n; z_1, \ldots, z_n),$$

where consumption $c = \sum_{i=1}^{n}(z_i - \tau_i z_i) + D$ and $\frac{\partial U}{\partial c} > 0$ and $\frac{\partial U}{\partial \hat{z}_i} < 0$. We further assume that income shifting is costly, and thus $\frac{\partial U}{\partial z_i} < 0$ if $z_i > \hat{z}_i$ and $\frac{\partial U}{\partial z_i} > 0$ if $z_i < \hat{z}_i$. We denote the joint distribution of reported income by $H(z_1, \ldots, z_n)$ and the marginal distribution of income type i by $H_i(z_i)$.

Behavioral responses of reported income to marginal tax rates are captured by the total elasticity of tax base j with respect to the net-of-tax rate of tax base i defined by $\zeta_{ji} = \frac{\partial z_j}{\partial(1-\tau_i)} \frac{(1-\tau_i)}{z_j}$ which takes into account responses in real income as well as income shifting. For simplicity (and in line with standard optimal tax literature), we assume that income effects and extensive margin responses are zero. We call ζ_{ii} the own-elasticity of tax base i and ζ_{ji} the cross-elasticity of tax base j with respect to the net-of-tax rate of tax base i. We quantify the interdependency

[7] Following the standard assumption in the literature, we assume that taxpayers cannot evade taxes. We therefore require $\sum_{i=1}^{n} z_i = \sum_{i=1}^{n} \hat{z}_i$.

of tax bases according to the parameter $\beta_{ji} = -\frac{\partial z_j}{\partial(1-\tau_i)} \Big/ \frac{\partial z_i}{\partial(1-\tau_i)}$ which can be interpreted as the share of the cross effect on tax base j of the total effect on tax base i due to a change in the net-of-tax rate of tax base i. In principle, the sign of this parameter is ambiguous: if income types are substitutes (complements), an increase in the *earned* income of type i is accompanied by a fall (rise) in income of type j, which results in a positive (negative) β_{ji}. Furthermore, we have to consider that tax differentials induce taxpayers to shift part of their *reported* income across tax bases as a form of tax avoidance. Therefore, an increase in the net-of-tax rate of tax base i may draw income from another tax base j to tax base i resulting in a positive β_{ji}. Empirical evidence on this parameter is scarce. Existing work by Romanov (2006), Pirttilä and Selin (2011), Kleven and Schultz (2014), and Mortenson (2016) provides evidence on positive cross-effects between tax bases indicating that the empirically relevant assumption on cross effects is $\beta_{ji} > 0$. Further, we denote the aggregate elasticities as well as cross-base effects as $\bar{\zeta}_{ji} = \frac{\partial Z_j}{\partial(1-\tau_i)} \frac{(1-\tau_i)}{Z_j}$ and $\bar{\beta}_{ji} = -\frac{\partial Z_j}{\partial(1-\tau_i)} \Big/ \frac{\partial Z_i}{\partial(1-\tau_i)}$, where $Z_i = \int z_i dH_i(z_i)$.

The government's problem: The government maximizes social welfare according to a social welfare function $S(\cdot)$ facing an exogenous revenue requirement of E.[8] The maximization problem reads

$$\max_{\{\tau_i(\cdot)\}_i} \int_{\mathbf{k}\in\mathbf{K}} S(U(\mathbf{k}))dF(\mathbf{k})$$

$$s.t. \quad \int_{\mathbf{k}} \sum_{i=1}^{n} (\tau_i z_i(\mathbf{k}) - D)dF(\mathbf{k}) \geq E.$$

The marginal social welfare weight for a tax payer of type $\mathbf{k}$ is given by $S'(U(\mathbf{k}))U'_c(\mathbf{k})/\lambda$, where λ is the multiplier on the government's budget constraint. We define the income type-specific average marginal social welfare weight as a function of z_i as $g_i(z_i) = \int_{\mathbf{k}\in\mathbf{K}} S'(U(\mathbf{k}))U'_c(\mathbf{k})dF(\mathbf{k}|z_i)/\lambda$. Intuitively, $g_i(z_i)$ measures the average value of giving one dollar to a person with z_i in terms of public funds.

[8]Note that the social welfare function does not depend directly on income type k, i.e. we do not need to assume that the social planner has a preference for a specific income type over another. Rather, heterogeneity in average social welfare weights across income types arises in the model as a result of different income types being concentrated at different points in the income distribution. This argument is related to the one put forward in Jacquet and Lehmann (2018) who study optimal income taxation with composition effects and obtain an optimal tax formula by averaging the sufficient statistics of individuals who earn the same income.

The following result characterizes the optimal linear tax system:

Optimal linear tax rates. *The optimality condition for the tax vector* $\boldsymbol{\tau} = (\tau_1, \ldots, \tau_n)'$ *in a linear income tax system is given by:*

$$\begin{pmatrix} \mathbf{m_1} \\ \vdots \\ \mathbf{m_i} \\ \vdots \\ \mathbf{m_n} \end{pmatrix} \times \boldsymbol{\tau} = \begin{pmatrix} (1-\bar{g}_1) \\ \vdots \\ (1-\bar{g}_i) \\ \vdots \\ (1-\bar{g}_n) \end{pmatrix}$$

where

$$\begin{aligned}
\mathbf{m_i} &= (-\bar{\beta}_{1i}\zeta_{ii},\ \ldots,\ -\bar{\beta}_{i-1i}\bar{\zeta}_{ii},\ (1+\bar{\zeta}_{ii}-\bar{g}_i),\ -\bar{\beta}_{i+1i}\bar{\zeta}_{ii}, \ldots, -\bar{\beta}_{ni}\bar{\zeta}_{ii}), \\
\bar{\beta}_{ji} &= -\frac{\partial Z_j}{\partial(1-\tau_i)} \Big/ \frac{\partial Z_i}{\partial(1-\tau_i)}, \\
\bar{g}_i &= \int \frac{z_i}{Z_i} g_i(z_i) dH_i(z_i).
\end{aligned}$$

Derivation:

Setting up the Lagrangian, we obtain:

$$\begin{aligned}
L &= \int_{\mathbf{k}\in\mathbf{K}} S\Big(u^{\mathbf{k}}((1-\tau_1)z_1 + \cdots + (1-\tau_n)z_n + D; \hat{z}_1, \ldots, \hat{z}_n; z_1, \ldots, z_n)\Big) dF(\mathbf{k}) \\
&\quad +\lambda\Big(\int_{\mathbf{k}\in\mathbf{K}} \tau_1 z_1 + \cdots + \tau_n z_n - D dF(\mathbf{k}) - E\Big).
\end{aligned}$$

Applying the envelope theorem on the individual utility maximization problem the first-order condition of the government's optimization problem for tax base i reads

$$\begin{aligned}
\frac{\partial L}{\partial(1-\tau_i)} &= \int_{\mathbf{k}\in\mathbf{K}} z_i(\mathbf{k}) S'(U(\mathbf{k})) U_c'(\mathbf{k}) dF(\mathbf{k}) \\
&\quad +\lambda\Big(\int_{\mathbf{k}\in\mathbf{K}} \tau_1 \frac{\partial z_1(\mathbf{k})}{\partial(1-\tau_i)} + \cdots + \tau_n \frac{\partial z_n(\mathbf{k})}{\partial(1-\tau_i)} - z_i(\mathbf{k}) dF(\mathbf{k})\Big) = 0.
\end{aligned}$$

Making use of the definitions of the aggregate own elasticity $\bar{\zeta}_{ii} = \frac{\partial Z_i}{\partial(1-\tau_i)} \frac{(1-\tau_i)}{Z_i}$ and the share of cross-responses $\bar{\beta}_{ji} = -\frac{\partial Z_j}{\partial(1-\tau_i)} \Big/ \frac{\partial Z_i}{\partial(1-\tau_i)}$, it follows that

$$
\begin{aligned}
& (1-\tau_i) \cdot \int_{\mathbf{k}\in\mathbf{K}} z_i(\mathbf{k}) S'(U(\mathbf{k})) U'(\mathbf{k}) dF(\mathbf{k})/\lambda \\
- \quad & \tau_1 \bar{\beta}_{1i} \bar{\zeta}_{ii} Z_i - \cdots - \tau_{i-1} \bar{\beta}_{i-1i} \bar{\zeta}_{ii} Z_i + \tau_i \bar{\zeta}_{ii} Z_i - \tau_{i+1} \bar{\beta}_{i+1i} \bar{\zeta}_{ii} Z_i - \cdots - \tau_n \bar{\beta}_{ni} \bar{\zeta}_{ii} Z_i - (1-\tau_i) Z_i = 0.
\end{aligned}
$$

Introducing the average welfare weight of income type i as $\bar{g}_i = \int_{\mathbf{k}\in\mathbf{K}} z_i(\mathbf{k}) S'(U(\mathbf{k})) U'(\mathbf{k}) dF(\mathbf{k})/(\lambda Z_i) = \int z_i \int_{\mathbf{k}\in\mathbf{K}} S'(U(\mathbf{k})) U'(\mathbf{k}) dF(\mathbf{k}|z_i)/(\lambda Z_i) dH_i(z_i) = \int \frac{z_i}{Z_i} g_i(z_i) dH_i(z_i)$, we obtain

$$
-\bar{\beta}_{1i} \bar{\zeta}_{ii} \tau_1 - \cdots - \bar{\beta}_{i-1i} \bar{\zeta}_{ii} \tau_{i-1} + (1 + \bar{\zeta}_{ii} - \bar{g}_i) \tau_i - \bar{\beta}_{i+1i} \bar{\zeta}_{ii} \tau_{i+1} - \cdots - \bar{\beta}_{ni} \bar{\zeta}_{ii} \tau_n = 1 - \bar{g}_i
$$

and arrive at the proposition since this condition has to hold in an optimal linear tax equilibrium $\forall i$. The optimal tax equilibrium consists of a system of equations capturing fiscal externalities arising from tax differentials. As we show in the Appendix, optimal tax rates are increasing and convex in the share of cross-responses $\bar{\beta}_{ji}$. In the plausible case where income types are substitutes and hence $\bar{\beta}_{ji} > 0$, optimal tax rates will be higher than without considering cross-effects. In contrast, if income types are complements and hence $\bar{\beta}_{ji} < 0$, optimal tax rates will be lower than without considering cross-effects. If there are no cross responses between tax bases and hence $\bar{\beta}_{ji} = 0 \ \forall j \neq i$, the standard formula for the optimal linear tax rate is nested in the system of equations as $\tau_i = \frac{1-\bar{g}_i}{1+\bar{\zeta}_{ii}-\bar{g}_i}$.

Comparative statics. For illustrative purposes, Figures 1a-c show comparative statics for optimal linear tax rates for the case of three separate tax bases with own-elasticities of 0.5 for type 1, 0.75 for type 2, and 0.25 for type 3.

Figures 1a-b plot optimal tax rates as functions of the total share of cross responses where we assume the same level of cross-responses for each pair of tax bases (i, j), or formally $\bar{\beta}_{ij} = \bar{\beta}$. Figure 1a assumes income type-specific average welfare weights of 0, which corresponds to the revenue maximizing case, Figure 1b assumes income type-specific average welfare weights of 0.7. Optimal tax rates increase with higher levels of cross responses and approach one when behavioral responses are fully offset by fiscal externalities. The differential in tax rates decreases with the strength of cross responses.

In Figures 1c-d, we relax the assumption of uniform cross-effects between tax bases. We plot optimal tax rates for the special case where fiscal externalities only take place between tax bases 1 and 2. Intuitively, optimal tax rates for income base 1 and 2 are increasing with the level of cross-elasticities while the optimal tax rate for income base 3 remains unaffected.

Figures 1e-f show comparative statics in the own-elasticities holding the share of cross responses constant. We assume that cross-responses between tax bases are of same magnitude across all tax bases and aggregate to 0.4. Compared to the case with zero cross-responses (dashed lines), optimal tax rates decrease less due to a rise in own-elasticities when cross-responses are accounted for.

In the next sections, we consider two natural empirical applications of the model for the case of Germany: first the separate taxation of different income sources (such as labor or self-employment income), and second the differential taxation of spouses.

3 Institutional Background and Data

3.1 The Personal Income Tax in Germany

All individuals in Germany are subject to personal income taxation. As the first step in determining a tax unit's broad gross income, income from different sources is allocated to seven different types of income that are distinguished by German tax law: (i) income from agriculture and forestry, (ii) (non-corporate) business income (this includes dividends and capital gains from closely held corporations, i.e. with an ownership share of at least 1%), (iii) entrepreneurial income, (iv) salaries and wages from employment, (v) investment income (i.e. interest and dividends), (vi) rental income, and (vii) other income (including, for example, pensions, annuities and capital gains).[9] For our empirical analysis, we group income from those seven sources into three categories: labor, capital and self-employment income. Labor income consists of salaries and wages from employment (category iv), self-employment income comprises income from agriculture and forestry, business income and entrepreneurial income (categories i-iii), whereas

[9] The following types of income are tax exempt: payments from health insurance, accident insurance and insurance for disability and old age, welfare benefits and scholarships.

capital income comprises investment income, rental income, and other income (categories v-vii). Second, for each type of income, all expenses that are necessary to obtain, maintain or preserve the income from a given source are deductible. These include, for instance, commuting costs, expenses for work materials or costs of training. The sum of broad income minus income-related expenses yields the adjusted gross income. As a third step, further deductions, including expenses for education, child care costs, donations to charity or political parties and church tax payments, are taken into account and subtracted from adjusted gross income yielding taxable income.

Finally, the income tax is calculated by applying the rate schedule to taxable income. In contrast to almost all other countries that use a bracket system with constant marginal tax rates within a bracket, Germany uses a formula (which is quadratic in income) to compute the tax liability.[10] As a consequence, marginal tax rates increase linearly in income (up to a top marginal tax rate of 42%, plus an additional top tax bracket of 45% for very high incomes above 250,000€). The formula for the years 2007 and 2008 is defined as follows[11]:

$$T = \begin{cases} 0 & \text{if } TI \leq 7,664 \\ (883.74\frac{TI-7{,}664}{10{,}000} + 1,500)\frac{TI-7{,}664}{10{,}000} & \text{if } 7,664 < TI \leq 12,739 \\ (228.74\frac{TI-12{,}739}{10{,}000} + 2,397)\frac{TI-12{,}739}{10{,}000} + 989 & \text{if } 12,739 < TI \leq 52,151 \\ 0.42TI - 7,914 & \text{if } 52,151 < TI \leq 250,000 \\ 0.45TI - 15,414 & \text{if } TI > 250,000. \end{cases}$$

In addition to the personal income tax, households additionally pay the "*Solidaritätszuschlag*", a tax supplement originally introduced to finance the German reunification. During the period of interest, 2000 - 2008, the supplement amounts to 5.5% of the income tax liability.

Reforms. Figure 3 shows the marginal tax rate schedule for the years 2001-03, 2004 and 2005-08. Between 2000 and 2005, a major reform of the German personal income tax took place, which we exploit to estimate income elasticities by income source. The basic tax allowance was

[10]The reason for using such a formula for the German tax schedule instead of tax brackets was "to avoid bunching at kink points" (see, e.g., Riebesell 1922, Chapter 5).

[11]For married taxpayers filing jointly, the tax is twice the amount of applying the formula to half of the married couple's joint taxable income: $T(TI_1, TI_2) = 2 \cdot T\left(\frac{TI_1+TI_2}{2}\right)$.

increased in several steps from €6902 in 2000 to €7206 in 2001, €7235 in 2002/03, and finally to €7664 (2004–2008). The lowest marginal tax rate decreased from 22.9% in 2000 to 15% (2005–2008) with 19.9% (2001–03) and 16% (2004) in between. The top marginal tax rate was reduced from 51% in 2000 to 42% in 2005 with 48.5% (2001-03) and 45% (2004) in between. The threshold where the top marginal tax rate kicks in was reduced from €58,643 in 2000 to €52,151 in 2004 with values of €55,007 (2001-03) in between. In 2007, an additional tax bracket at the top (for taxable income above €250,000) was introduced with a top marginal tax rate of 45%. Tax rates in the medium range of the schedule were lowered as well.

3.2 Data

Data set: We use use two different versions of administrative tax return data for Germany, which are both provided by the German Federal Statistical Office. In both cases, the unit of observation is the taxpayer, i.e. either a single individual or a couple filing jointly. Both datasets contain all information necessary to calculate a taxpayer's annual income tax (and taxable income). This includes detailed information on all seven income sources, tax base parameters such as work-related expenses and claimed and realized deductions as well as basic socio-demographic characteristics such as age, gender, marital status and number of children.

The two datasets differ in their availability, sample size and sample selection. First, the German Taxpayer Panel is a 5% balanced panel of all tax units filing tax returns in each year for the period 2001 to 2010 (Kriete-Dodds and Vorgrimler 2007). We use this data set and the panel information to estimate elasticities of taxable income. Second, to obtain marginal social welfare weights, we use the "*Faktisch anonymisierte Daten aus der Lohn- und Einkommensteuerstatistik (FAST)*" (Merz et al. 2006) which is a 10% random sample of all taxpayers. This data is, unfortunately, only available every 3 years. We use the data for the years 2001, 2004 and 2007. The big advantage of this dataset (in addition to the larger sample size) – and the reason why we use this version of the data for our main analysis – is that it is a stratified sample of the full population and not only of those filing tax returns for 10 consecutive years. In both cases, we employ the respective sample weights provided by the Statistical Office.

Summary statistics: Table 1 shows summary statistics for the key variables of the analysis. The sample consists of 2,253,691 million tax units with mean taxable income of €17,854.[12] Labor income is the predominant income source with roughly 70% percent of tax units reporting a non-zero amount and mean of €18,552. It is especially concentrated at the bottom and in the middle of the income distribution. Capital income accounts only for a small share with a mean of €6,659 and is least unequally distributed. Self-employment income is most unequally distributed and concentrated at the top with a 99% percentile of €213,052, which is more than twice as high as the corresponding value for labor income and four times for capital income. Figure 2a illustrates visually the fraction of taxpayers according to their main source of income (capital, labor, or self-employment) as a function of taxable income. Complementarily, Figure 2b shows for each point in the taxable income distribution a taxpayer's average fraction of a particular income source.

An interesting observation from Table 1 and Figure 2 is that capital income (from interest and dividends) is relatively evenly distributed across the income distribution. One reason for this potentially surprising finding is that many of the low taxable income individuals with capital income are pensioners as most (public) pensions in the period of analysis were not or only little taxable. Another reason is that a large share of "capital" income (in the macroeconomic sense) is labeled "self-employment income" in the German tax law (e.g. receipts from closely held corporations). This self-employment income is much more concentrated at the top of the distribution whereas investment and rental income is more evenly spread.

4 Estimation of Income Source-Specific Elasticities

4.1 Empirical Model

To estimate ETIs, we follow the approaches proposed by Gruber and Saez (2002) and Weber (2014) as applied in Doerrenberg et al. (2017). Technically, for taxpayer p in year t, we regress the change in taxable income, $\Delta Y_{p,t}$, on the change in the marginal net-of-tax rate, $\Delta(1-\tau)$.

[12] Note that, as it is common for tax return data, the data only includes individuals who are liable to the income tax, i.e. households without market income are missing from our analysis. Their share corresponds to about 20% of the total population. Hence, the bottom of the taxpayer distribution starts in the second quintile of the overall income distribution, which should be taken into account when interpreting the results.

The operator Δ indicates the difference between year t and base-year $t-k$. In the baseline, we estimate the model given below in 2-year differences:

$$\Delta \ln Y_{p,t} = \zeta \Delta \ln(1-\tau_{p,t}) + f(GI_{p,t-k}) + \phi \mathbf{X}_{p,t} + \gamma_t + \eta_{p,t}, \qquad (1)$$

where $f(GI_{p,t-k})$ is a function of individual base-year gross income, $\mathbf{X}_{p,t}$ a vector containing standard demographic variables (dummies for joint filing / marital status, number of children, age, and West- vs. East-Germany), γ_t a set of year fixed effects and $\eta_{p,t}$ an individual error term.[13] The coefficient of interest, ζ, measures the (uncompensated) elasticity of taxable income with respect to the net-of-tax rate. To estimate income source-specific elasticities, we classify each tax unit according to its predominant income source. We then interact $\Delta \ln(1-\tau_{p,t})$ with a categorical variable indicating whether the predominant income source is either labor, self-employment, or capital income. The coefficients on the interactions are the measures for income source-specific elasticities.

As Doerrenberg et al. (2017), we follow standard practice in the literature to address potential threats to identification (Saez et al. 2012). First, we use panel data and estimate the model in differences to wipe out time-invariant individual confounders. Second, we account for mean reversion and secular trends in income inequality by controlling for gross income (Auten and Carroll 1999). We follow Kopczuk (2005) and Kleven and Schultz (2014) by including 10-piece splines in log $t-k-1$ income (as a control for permanent income) as well as 10-piece splines in the difference between log income in $t-k$ and log income in $t-k-1$ (controlling for transitory income).[14]

Third, we have to account for the mechanical relationship between taxable income and the net-of-tax rate. An increase in income automatically changes the net-of-tax rate because in progressive systems higher incomes are taxed at higher marginal tax rates. This mechanical relationship requires one to find an instrument for the net-of-tax rate that is unrelated to the

[13]Note that in our empirical specification we abstract from estimating income effects as this is common in the literature (Saez, Slemrod, and Giertz 2012). See, e.g., Blomquist and Selin (2010) for a study allowing for income effects.

[14]Doerrenberg et al. (2017) show that gross income grew differently across income deciles over the period of our data sample, suggesting that heterogeneous income trends have to be addressed in our context. They also show that results are robust to using different income splines and difference lengths.

error term in the above regression model. Following Gruber and Saez (2002), most studies in the literature use an instrument based on predicted changes in tax rates that are solely due to legislative tax reforms abstracting from mechanical tax-rate changes due to changing income (e.g., Chetty et al. 2011; Kleven and Schultz 2014). In addition to the standard Gruber and Saez (2002) approach, we also employ the modification proposed by Weber (2014), which we use as our baseline estimates. Here, the synthetic instrument is a function of lagged base-year income. That is, the instrument we use is constructed by applying the tax schedule of year t to income in the year before the base-year, $t - k - 1$.[15]

Fourth, mechanical effects induced by simultaneous tax-rate and tax-base reforms may have important implications for the definition and construction of variables for our analysis. To circumvent this complication, the literature uses the broadest definition of the tax base (see Saez et al. 2012). We follow this approach in our paper.

4.2 ETI Estimates

We use changes in tax rates induced by all tax reforms between 2001 and 2008 for identification of elasticities of taxable income for different income types. We estimate regression model (1) using two-stage least squares and cluster standard errors on the individual level. First-stage regressions (not shown) of $\Delta \ln(1 - \tau_{i,t})$ on $\Delta \ln(1 - \tau_{i,t}^{synth})$ are strong with large $F-$statistics exceeding at least 400 in all our estimations. Online Appendix Figures A.1 and A.2 provide graphical evidence of the first stage and the reduced-form regressions, respectively. The graphs plot fourth-order polynomial regressions, based on regression model (1) for 2-year differences, excluding income controls and other control variables. Online Appendix Figure A.1 visualizes the first stage; as expected, the instrument and the variable of interest, the net-of-tax rate, are positively related. As depicted in Online Appendix Figure A.2, we observe a mild positive relationship between the instrument and taxable income. This reflects the positive elasticities that we estimate using the full model.

Table 2 and Online Appendix Table A2 display the regression estimates. We report the effect

[15]Lehmann et al. (2013) propose a similar approach and use both types of instruments simultaneously to have overidentification.

of two-year net-of-tax rate changes for taxable income using the Gruber and Saez (2002) and Weber (2014) approaches. Table 2 reports ETI estimates for the full sample of individual taxpayers and by income source.[16] The baseline estimates for the ETI for the full sample are 0.35 using the Weber (2014) estimator and 0.30 using the Gruber and Saez (2002) approach.[17] Next, we differentiate by income source. Using the Weber (2014) estimator, we find a low elasticity of 0.13 for labor income. Elasticities are higher for capital income with a level of 0.22 and self-employment income with a level of 0.43. Using the Gruber and Saez (2002) approach leaves the estimate for labor income unchanged but yields slightly lower elasticities for capital and self-employment income.

The relatively low elasticity of capital income might be surprising at first. Note, however, as discussed in Section 3, some income components that are capital income in a macroeconomic sense (and often seen as very responsive) are attributed to self-employment (e.g. income from closely held corporations) by the German income tax. Capital income contains income from interest and dividends but also rental income and income from pension funds which are less elastic. As a consequence, in the German context, capital income turns out to be less responsive than self-employment income but still more responsive than labor income.[18]

5 Estimation of Marginal Social Welfare Weights

5.1 Derivation

Using the ETI estimates as well as the distribution of income types, we employ an inverse optimal tax approach to calculate marginal social welfare weights implicit in the German income tax system similar to Lockwood and Weinzierl (2016) for the US and Jacobs et al. (2017) for the Netherlands. In contrast to these earlier studies, we derive and estimate MSWWs in the presence of heterogeneous responsiveness across income types. To do so, we decompose the

[16] The results for couples are presented in Section 7.

[17] Note that the results are different compared to those in Doerrenberg et al. (2017) as they use both singles and couples jointly for their analysis whereas we differentiate between single and joint filers.

[18] One potential issue in the elasticity estimations is whether or not the data captures international capital mobility. The ETI estimates would reflect such mobility if – as a response to a reform – capital leaves or enters the country. They are, by construction, not able to capture income from wealth which is hidden abroad and hence never appeared in the tax data.

ETI into income type-specific elasticities. We then, for each point in the taxable income distribution, calculate the overall ETI as a function of constant income type-specific elasticities and corresponding income shares. Compared to the standard constant elasticity assumption, our approach allows the aggregate elasticity to vary along the taxable income distribution (shown in Online Appendix Figure A.3) since shares of income types change along the income distribution.

The inverse optimal tax approach yields welfare weights $g(z)$ that support the observed tax system as optimal. To derive these weights, consider a social planner with a standard welfare function $S(\cdot)$ introducing a non-linear tax schedule $T(z)$ to maximize social welfare. We assume that she is restricted to levy the same tax amount $T(z)$ from every taxpayer with a level of taxable income z. Therefore, the tax schedule solely depends on total taxable income z and ignores the decomposition of single income sources z_i as it pertained to German tax in the period of our analysis.

Since mechanical effects through tax changes do not depend on the responsiveness of single income sources, the mechanical effect (net of welfare loss) due a marginal increase $d\tau$ in a small band $z + dz$ is the same as derived by Saez (2001). However, the social planner will take into account the differentials in the elasticities between different types of income. For a taxpayer with total income of z the average behavioral response in reported income of type i is given by $(\int_0^z h_i(z_i'|z)z_i'\zeta_{ii}dz_i')/(1-\tau(z))$, and it follows that the elasticity effect is given by

$$-d\tau dz \sum_{i=1}^{n} \Big(\int_0^z h_i(z_i'|z)z_i'\zeta_{ii}dz_i' \Big) h(z) \frac{\tau(z)}{1-\tau(z)}.$$

Optimality implies that mechanical, welfare, and elasticity effects offset each other, and thus

$$\int_z^\infty g(z')dH(z') = 1 - H(z) - \sum_{i=1}^{n} \Big(\int_0^z h_i(z_i'|z)z_i'\zeta_{ii}dz_i' \Big) h(z) \frac{\tau(z)}{1-\tau(z)}.$$

Taking the derivative with respect to z yields the MSWW at taxable income level z as

$$g(z) = -\frac{1}{h(z)} \frac{d}{dz} \Big(1 - H(z) - \sum_{i=1}^{n} \Big(\int_0^z h_i(z_i'|z)z_i'\zeta_{ii}dz_i' \Big) h(z) \frac{\tau(z)}{1-\tau(z)} \Big).$$

5.2 Empirical Results

Figure 4 shows estimates of MSWW implicit in the German tax law as a function of the taxable income fractile. We present estimates for the years 2001, 2004 and 2007, which correspond to the different stages of the German income tax reform during the 2000s (see Figure 3). We distinguish MSWW estimates using income source-specific elasticities for labor, self-employment, and capital income obtained from either the Gruber and Saez (2002) (yellow lines) or Weber (2014) (red lines) estimation approach. For the analysis by income source, the estimation sample consists of single tax payers with a level of taxable income higher than the tax exempt amount.[19]

The distribution of MSWWs is almost identical for both elasticity scenarios except at the very top. This is due to almost identical elasticity estimates for labor income, which is the predominant income source for most of the distribution (see Figure 2). In all regimes the distribution of MSWWs is qualitatively similar: in the bottom half of the income distribution, MSWW are greater than one and fairly stable, but fall below one around the 6th decile. They then decrease moderately, followed by a more strongly pronounced decline starting between the 90th and 95th percentile. In the top 5%, the decrease in MSWWs decelerates and even reverses for Gruber and Saez (2002) elasticities. The latter is due to the fact that the Gruber and Saez (2002) estimate for the elasticity of self-employment income is much smaller than the Weber (2014) estimate. As self-employment income gains importance at the top, MSWWs diverge.[20] Comparing the estimates for 2001, 2004 and 2007 we find qualitative similarity of MSWWs across tax regimes. However, the decrease in tax progressivity reduced the overall variance in MSWW: estimates in the bottom half of the distribution decreased, while those in the upper half increased. The increase is most pronounced for the top 10% percent of the income distribution as the reform particularly decreased the top tax rate.

[19]The results for couples are presented in Section 7.

[20]This intuition is further visualized in Online Appendix Figure A.4 which presents MSWW for three hypothetical scenarios of elasticities: uniform elasticities (blue line), low elasticities (brown line), high elasticities (orange line). Higher elasticities increase the variance of MSWWs. Furthermore, a lower elasticity for self-employment income (relative to the one for labor income) leads to a stronger reversal at the top (see blue line).

In Table 3, we show aggregate and income source-specific average welfare weights. Before the tax reforms, average welfare weights are highest for labor income and moderate for capital income. Levels are lowest for self-employment income due to the higher elasticity in combination with its concentration at the very top of the income distribution. In course of the reforms, average welfare weights stay constant for labor income, and increase for self-employment, and in particular capital income. Intuitively, the increase in MSWWs at the top predominantly benefited self-employment and capital income.

6 Optimal Tax Rates for Different Income Sources

We calculate optimal linear tax rates for different income sources using the estimates of income source-specific ETIs and implicit MSWW in 2001, 2004 and 2007. By using the estimates of implicit average welfare weights, this approach linearizes the tax system but allows for differential taxation of different income sources holding average welfare considerations constant. As before, we assume constant income source-specific elasticities and cross-responses independent of the level of taxable income. We make two further assumptions on the cross-elasticities between tax bases. First, for each tax base j the share of cross-responses in the total income type-specific elasticity is the same. Second, all income sources $i \neq j$ account for the same proportion in the cross-elasticities for tax base j. Formally, both conditions can be expressed as $\beta_{ji} = \beta \ \forall i, j, \ i \neq j$.

To benchmark our estimates of income source-specific optimal schedular tax rates, we first provide a value for the optimal income source-independent flat tax (see Online Appendix Table A1). Applying the standard optimal linear income tax formula (Piketty and Saez 2013) and using Weber (2014) elasticity estimates, we obtain an optimal tax rate of 0.39 using 2001 welfare weights. Optimal tax estimates decrease to 0.37 for 2004, and 0.36 for 2007 estimates. Using Gruber and Saez (2002) elasticities yields almost identical optimal flat tax rates (see Online Appendix Table A1). The tax rates are so close as the decrease in the ETI is offset by an increase in the average MSWW.

Next, we consider optimal income source-specific linear income taxes. Figure 5 shows the estimates as functions of the level of cross-elasticities between tax bases.

We first focus on the results using Weber (2014) ETI estimates in the right-hand side panels. Absent any cross-responses ($\beta_{ji} = 0$), we find optimal tax rates of 0.33 for labor, 0.37 for self-employment, and 0.42 for capital income using 2001 welfare weights. Despite the high elasticity for self-employment income, the low average welfare weight (due to its concentration at the top) induces a much higher optimal tax rate relative to labor income. Increasing the proportion of cross-elasticities yields higher optimal tax rates due to lower efficiency costs of taxation. Hence, compared to uniform taxation, labor income benefits while self-employment and especially capital income face a higher tax burden.

Turning to evolution over time, we find that the changes of implicit average welfare weights from 2001 to 2007 decrease optimal tax rates for self-employment income and particularly for capital income but not for labor income. Intuitively, the reduction in tax progressivity led to an increase in welfare weights for capital and self-employment income, ultimately reducing implied optimal schedular taxes for these sources.

Estimates employing Gruber and Saez (2002) ETIs in the left-hand side panels of Figure 5 are qualitatively similar but provide higher values for self-employment and capital income tax rates but not for those on labor income. Intuitively, when using the Gruber and Saez (2002) instead of the Weber (2014) estimation strategy, elasticity estimates for self-employment and capital income decrease more strongly relative to those for labor income.

7 Further Application: Optimal Taxation of Couples

As a further application, we consider the optimal taxation of married couples. Why might the government desire to set differential tax rates on income earned by wives and husbands? Online Appendix Figure A.5 visualizes the distribution of income earned by spouses. The figure reveals that the importance of husband's income rises in a couple's overall income. Hence, from an equity perspective, this suggests scope for higher tax rates on husbands' income. Turning to efficiency concerns, Online Appendix Table A2 presents taxable income elasticities for spouses separately. In our preferred specification using Weber (2014) instruments, we find elasticities of 0.71 for wives and 0.39 for husbands compared to an overall elasticity of 0.54 for the couple.[21] Hence, from an efficiency perspective, it might be desirable to tax husbands at a higher rate.

To investigate this issue more systematically, we derive MSWWs for married couples and calculate optimal differential linear tax rates for husbands' and wives' income taking into account differential responsiveness between spouses. Online Appendix Figure A.6 shows implicit MSWWs for married couples as a function of the taxable income fractile for 2001, 2004, and 2007. MSWWs are greater than one and moderately declining until the 7th decile of the taxable income distribution. In the upper part of the income distribution, MSWW are declining faster, reaching a minimum at roughly the 95th percentile and are increasing thereafter. The decrease in tax progressivity over the 2000 tax reforms slightly decreased the variance of MSWW, leading to a mild increase in average welfare weights (see Online Appendix Table A3).

Online Appendix Figure A.7 presents optimal linear tax rates on wives' and husbands' income as a function of the share of cross-elasticities. Using the 2001 welfare weights, we find – absent any cross-responses between tax bases – an optimal tax rate of 0.38 for husbands' income and 0.21 for wives' income using Gruber and Saez (2002) elasticities, which compare to an optimal spouse-independent flat tax of 0.35 (Online Appendix Table A4). Higher cross-elasticities lead to higher schedular tax rates and smaller tax differentials between tax bases. The moderate increase in average welfare weights over time leads to a slight reduction of optimal tax rates. Although these results might be debatable from a fairness perspective, they indicate the theoretical scope for differential taxation of spouses.

8 Conclusion

When behavioral responses and welfare impacts due to taxation differ across income types, a comprehensive income tax system is suboptimal. Instead, a social planner may assign dis-

[21] Using the Gruber and Saez (2002) approach yields lower elasticity estimates of 0.58 for wives and 0.26 for husbands.

tinct tax rates to different income types in order to balance the trade-off between efficiency and redistribution across different types of income. In fact, some countries assign differential tax schedules to different income concepts. In the US, capital gains are taxed at a lower rate than income from labor and self-employment. Scandinavian countries apply a dual income tax system with a flat tax on capital income and a progressive schedule for other income sources.

Despite the empirical relevance, there is little theoretical and empirical work on the optimal differential taxation of different income types under joint optimality. In this study, we approach this problem by providing a simple model of jointly optimal income taxes for different income types. The model allows us to determine the optimal tax system as a function of sufficient statistics which are empirically easy to estimate. In the model, we take into account fiscal externalities due to cross-effects between tax bases. These can stem from income shifting as the predominant form, but also include cross-effects arising from substitutability and complementarity of different income types. We show that optimal linear tax rates are increasing and convex in the proportion of cross-responses in the total income type-specific elasticity with respect to the net-of-tax rate.

In the empirical part of this paper, we calculate jointly optimal linear taxes for two natural applications of our model in the context of Germany: (i) income from different sources (labor, capital, self-employment) and (ii) income of spouses in couples. By estimating the ingredients of our model, we provide the following pieces of empirical evidence. First, behavioral responses to taxation differ strongly across income types: we find significantly higher elasticities for self-employment income compared to labor income as well as for married women than for married men. Second, we calculate marginal social welfare weights inherent in the German tax code. Implied average welfare weights are highest for labor income and lowest for self-employment income and lower for married men than for women. We use our estimates of income type-specific ETIs and average welfare weights to calculate optimal linear tax rates. We find substantially lower optimal tax rates for labor income relative to capital income and self-employment income as well as lower optimal tax rates for married women than married men. Optimal tax rates increase and converge with higher levels of fiscal externalities.

Our findings have implications for the current policy debate – not only in Germany but also for other countries with similarly complex tax systems. Accounting for efficiency and equity considerations, our results suggest that the optimal tax rate on labor income is lower compared to self-employment and capital income. In practice, many countries feature a comprehensive income tax system assigning the same tax rate to all income sources. In contrast, countries with a dual income tax system tax capital at a lower rate and labor and self-employment income equally at a higher rate. For our second application, we find that optimal tax rates for married women are lower than for married men. Differential taxation of men or women might not be legally feasible due to anti-discrimination laws. However, differential taxation of primary and secondary earners (the latter being mostly women in most developed countries) would be legally and politically implementable. Countries featuring joint taxation of married couples (such as Germany and the US) may introduce an individual tax system as a first step in this direction.

Of course, some caveats apply. We focus only on linear tax rates and use a static framework without capital accumulation. Dynamic effects for instance could increase the efficiency costs of taxing capital (and potentially also self-employment) income and lead to ceteris paribus lower tax rates on these income sources. Therefore, our findings should be seen as directions for reform rather than concrete proposals. Future research should try to overcome these limitations.

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Appendix

Comparative Statics of Optimal Tax Rates

This section provides a brief discussion of comparative statics of optimal tax rates with regards to the share of cross responses. For illustrative purposes consider the case of $n = 2$ tax bases. The optimality conditions for the optimal tax vector (τ_1^*, τ_2^*) read

$$\begin{aligned} \tau_1^*(1+\bar{\zeta}_{11}-\bar{g}_1) - \tau_2^*\bar{\beta}_{21}\bar{\zeta}_{11} &= (1-\bar{g}_1) \\ -\tau_1^*\bar{\beta}_{12}\bar{\zeta}_{22} + \tau_2^*(1+\bar{\zeta}_{22}-\bar{g}_2) &= (1-\bar{g}_2). \end{aligned}$$

Without loss of generality, we can solve for the optimal τ_1^* and analyze its comparative statics in $\bar{\beta}_{21}$ (the magnitude of the fiscal externality of tax base 1 on tax base 2) as well as $\bar{\beta}_{12}$ (the magnitude of the fiscal externality of tax base 2 on tax base 1). The optimal τ_1^* reads

$$\tau_1^* = \frac{(1-\bar{g}_1)(1+\bar{\zeta}_{22}-\bar{g}_2) + (1-\bar{g}_2)\bar{\beta}_{21}\bar{\zeta}_{11}}{(1+\bar{\zeta}_{11}-\bar{g}_1)(1+\bar{\zeta}_{22}-\bar{g}_2) - \bar{\beta}_{12}\bar{\zeta}_{22}\bar{\beta}_{21}\bar{\zeta}_{11}}.$$

Now define $f_1 := (1-\bar{g}_1)(1+\bar{\zeta}_{22}-\bar{g}_2)$, $f_2 := (1-\bar{g}_2)\bar{\zeta}_{11}$, $f_3 := (1+\bar{\zeta}_{11}-\bar{g}_1)(1+\bar{\zeta}_{22}-\bar{g}_2)$, $f_4 := \bar{\zeta}_{22}\bar{\zeta}_{11}$ and assume that $\forall i,\ f_i > 0$. This condition always holds if the social planner assigns a positive average welfare weight to each tax base and the own-elasticities for each tax base are positive. We also assume that $\bar{\beta}_{ji} \geq 0\ \forall j \neq i$.

Comparative statics in $\bar{\beta}_{21}$:

$$\begin{aligned} \frac{\partial \tau_1^*}{\partial \bar{\beta}_{21}} &= \frac{f_2 f_3 + f_4 \bar{\beta}_{12} f_1}{(f_3 - f_4\bar{\beta}_{12}\bar{\beta}_{21})^2} > 0 \\ \frac{\partial^2 \tau_1^*}{\partial \bar{\beta}_{21}^2} &= \frac{2 f_4 \bar{\beta}_{12}(f_3 - f_4\bar{\beta}_{12}\bar{\beta}_{21})(f_2 f_3 + f_4\bar{\beta}_{12} f_1)}{(f_3 - f_4\bar{\beta}_{12}\bar{\beta}_{21})^4} \geq 0 \end{aligned}$$

In intuitive terms, the optimal tax rate for a given tax base is increasing and convex in the share of the fiscal externality of this tax base on the other tax base.

Comparative statics in $\bar{\beta}_{12}$:

$$\frac{\partial \tau_1^*}{\partial \bar{\beta}_{12}} = \frac{f_4 \bar{\beta}_{21}(f_1 + f_2 \bar{\beta}_{21})}{(f_3 - f_4 \bar{\beta}_{21} \bar{\beta}_{12})^2} \geq 0$$

$$\frac{\partial^2 \tau_1^*}{\partial \bar{\beta}_{12}^2} = \frac{2 f_4^2 \bar{\beta}_{21}^2 (f_3 - f_4 \bar{\beta}_{21} \bar{\beta}_{12})(f_1 + f_2 \bar{\beta}_{21})}{(f_3 - f_4 \bar{\beta}_{21} \bar{\beta}_{12})^4} \geq 0$$

In intuitive terms, the optimal tax rate for a given tax base is increasing and convex in the share of the fiscal externality of the other tax base on this tax base.

In the last step we can analyze the comparative statics in $\bar{\beta}_{21}$ and $\bar{\beta}_{12}$ jointly by assuming $\bar{\beta}_{ji} = \bar{\beta} \; \forall j \neq i$. This condition implies that the cross-elasticity is independent of the considered tax bases.

Comparative statics in $\bar{\beta}$:

$$\frac{\partial \tau_1^*}{\partial \bar{\beta}} = \frac{f_2 f_3 + 2\bar{\beta} f_4 f_1 + \bar{\beta}^2 f_4 f_2}{(f_3 - f_4 \bar{\beta}^2)^2} > 0$$

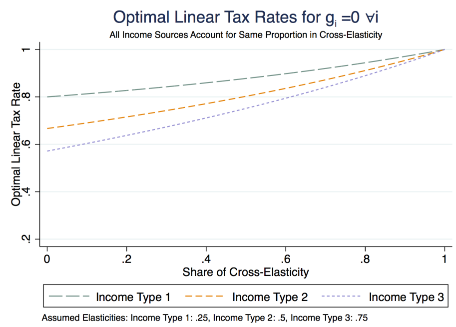
$$\frac{\partial^2 \tau_1^*}{\partial \bar{\beta}^2} = \frac{(2 f_4 f_1 + 2\bar{\beta} f_4 f_2)(f_3 - f_4 \bar{\beta}^2)^2 + 4 f_4 \bar{\beta}(f_3 - f_4 \bar{\beta}^2)(f_2 f_3 + 2\bar{\beta} f_4 f_1 + \bar{\beta}^2 f_4 f_2)}{(f_3 - f_4 \bar{\beta}^2)^4} > 0$$

In intuitive terms, the optimal tax rate for a given tax base is increasing and convex in the share of the fiscal externality between tax bases.

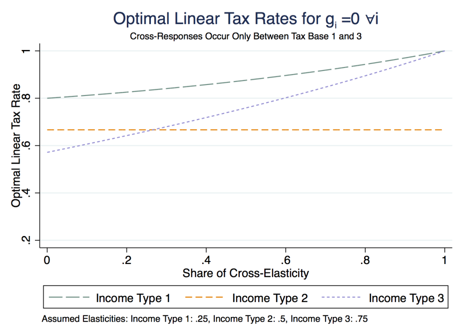
Figures and Tables

Figure 1: Optimal Linear Income Tax Rates as Functions of Cross- and Own-Elasticities

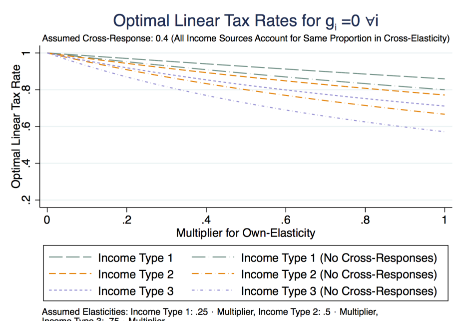
(a)



(b)



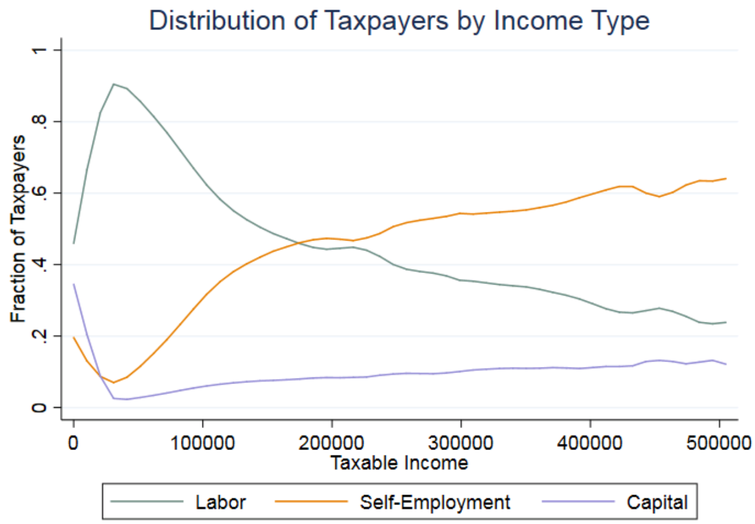
(c)



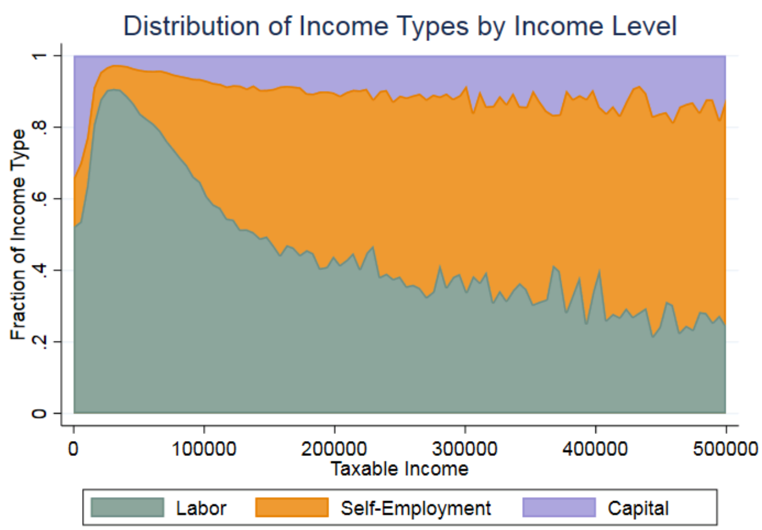
Notes: Figure 1 shows comparative statics of optimal linear tax rates as functions of cross- and own-elasticities. Assumed own-elasticities are 0.5 (income type 1), 0.75 (income type 2), 0.25 (income type 3). A welfare weight of 0 is assumed for each income type. Panels a and b display optimal linear income tax rates as functions of the share of the cross-elasticity in the total elasticity of each income type. Given a certain share β, the own-elasticity of each income type can be decomposed in a real response of size $1 - \beta$ and a fiscal externality of size β. Panel a assumes that each income type exhibits the same β and accounts for the same proportion in the cross-elasticity of the other income types. Panel b assumes that cross-responses occur only between tax bases 1 and 3. Panel c displays optimal linear income tax rates as functions of the own-elasticity. Dashed lines display optimal tax rates assuming cross-responses in a magnitude of .4 of the level of own-elasticities. (All income sources are assumed to account for the same proportion in the cross-elasticities.) Dashed-dotted lines display optimal tax rates assuming no cross-responses.

Figure 2: Distribution of Income Sources

(a)

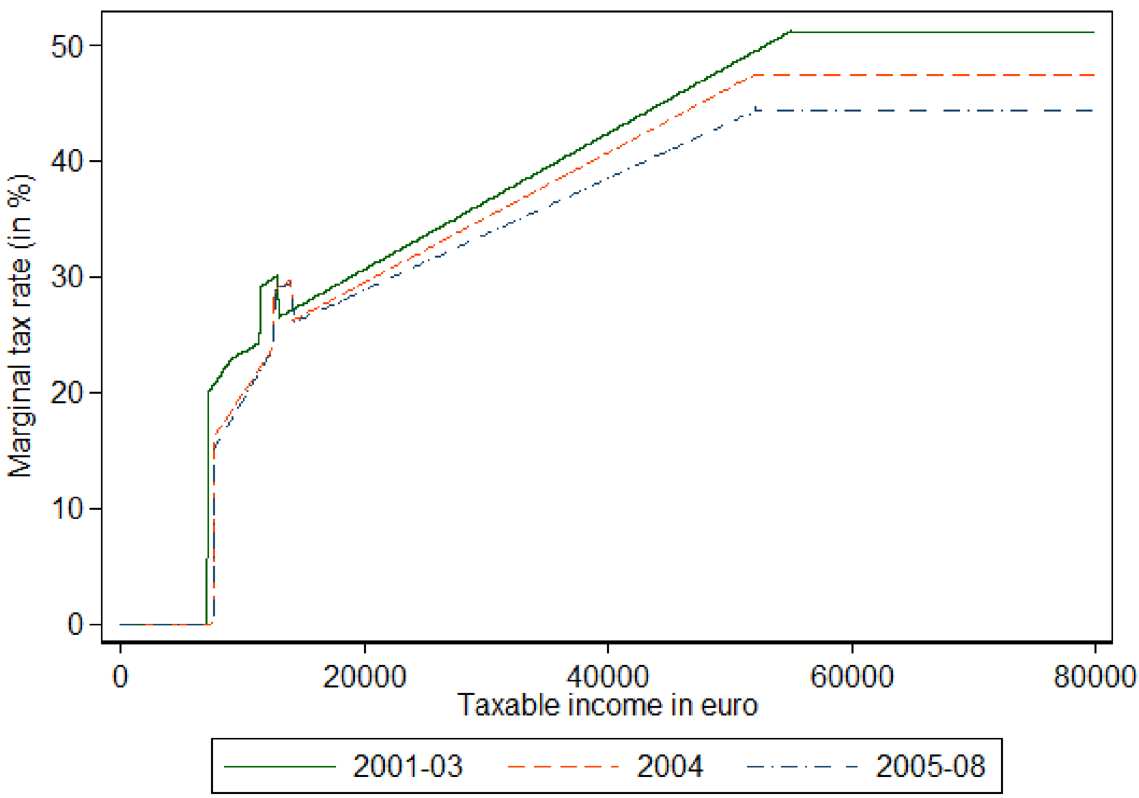


(b)



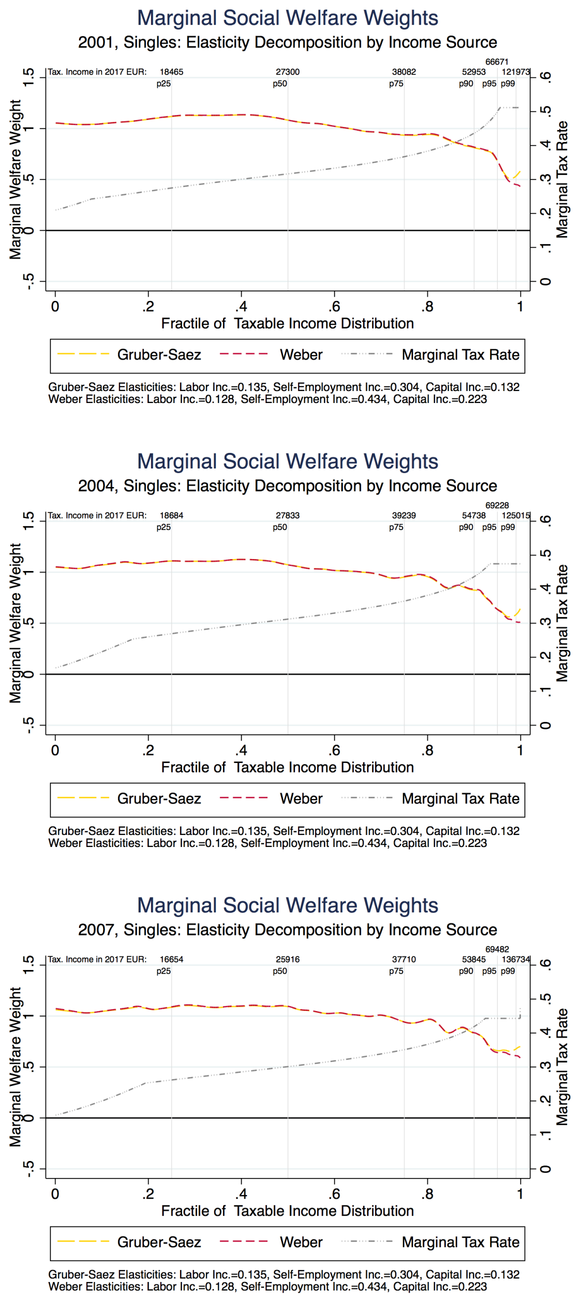
Notes: Figure 2 provides graphical evidence on the distribution of labor, self-employment and capital income for single filers in Germany as of 2007. Panel a displays the fraction of taxpayers according to their main source of income as a function of the level of taxable income. The figure is obtained from local polynomial regressions with Epanechnikov kernel of the fraction of taxpayers according to their reported main income source on taxable income. Panel b reports the average fractions of labor, self-employment and capital income as functions of the level of taxable income. The figure is obtained from local polynomial regressions with Epanechnikov kernel of the fraction of a taxpayer's source of income on taxable income.

Figure 3: Marginal Tax Rates



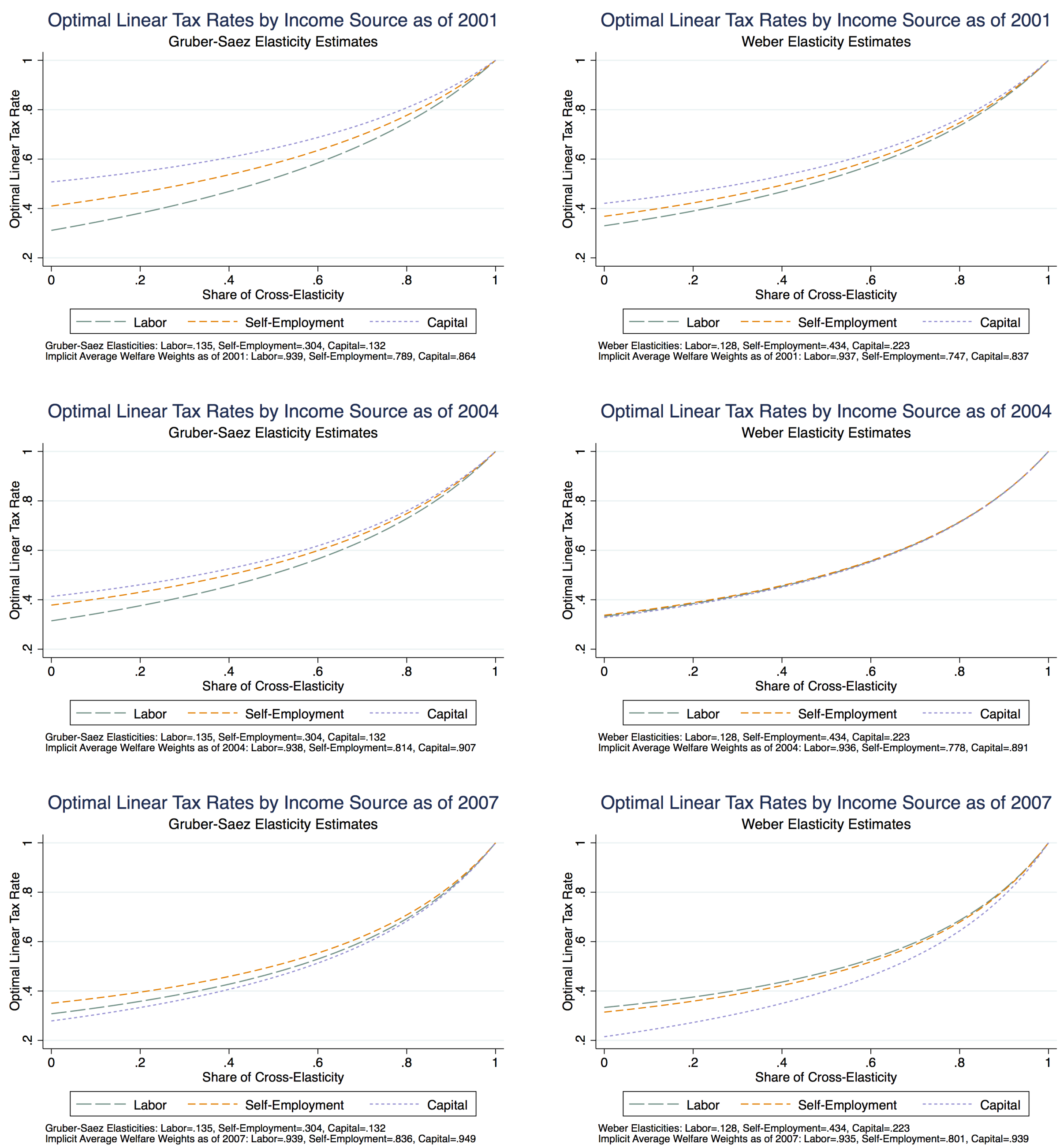
Notes: Figure 3 shows marginal tax rates as a function of taxable income for Germany from 2001 to 2008. Additional to the income tax the government levies a surcharge of 5.5% of the tax liability. Hence, the effective marginal tax rate is given by $1.055 \cdot \tau$.

Figure 4: Marginal Social Welfare Weights: Elasticity Decomposition by Income Source



Notes: Figure 4 shows marginal social welfare weights for single filers implicit in the German tax system as functions of the taxable income fractile for 2001, 2004 and 2007. The figures consider two scenarios for income source-specific elasticities estimated by either the Gruber-Saez (yellow lines) or the Weber approach (red lines) (see panel notes). Gray lines indicate the effective marginal tax rate for a given fractile in the taxable income distribution.

Figure 5: Optimal Linear Tax Rates: by Income Source



Notes: Figure 5 displays optimal linear tax rates for single filers for labor, self-employment and capital income. All income sources are assumed to account for same proportion in the cross-elasticities. The figures use income sources-specific average welfare weights implicit in the German tax system as of 2001, 2004 and 2007. Left-sided panels employ income sources-specific elasticities estimated by the Gruber-Saez approach. Right-sided panels employ income type-specific elasticities estimated by the Weber approach (see figure notes).

Table 1: Summary Statistics

	Taxable Income	Labor Income	Capital Income	Self-employment Income
Mean	17,854	18,552	6,589	20,559
p25	3,460	3,528	542	474
p50	11,736	13,873	3,216	5,741
p75	25,541	27,889	9,531	20,000
p90	38,083	40,563	15,102	46,415
p95	48,831	50,478	21,693	75,863
p99	90,170	82,283	56,243	213,052
N	2,253,691	1,509,876	802,892	728,996

Notes: Table 1 reports summary statistics for the key variables in our analysis. Distribution parameters are weighted with the sampling weights provided by the German Statistical Office. All statistics are conditional on whether a non-missing amount was reported.

Table 2: Elasticities of Taxable Income by Income Source

	Gruber-Saez	Weber
Overall	0.299***	0.347***
	(0.020)	(0.024)
	By income source	
Labor income	0.135***	0.128***
	(0.013)	(0.018)
Self-employment income	0.304***	0.434***
	(0.030)	(0.038)
Capital Income	0.132*	0.223*
	(0.074)	(0.120)
No. obs.	1,241,029	

Notes: Table 2 reports elasticities of taxable income with respect to the net-of-tax rate estimated for single tax filers with the Gruber and Saez (2002) and Weber (2014) approaches. We distinguish between the overall elasticity and income source-specific elasticities.

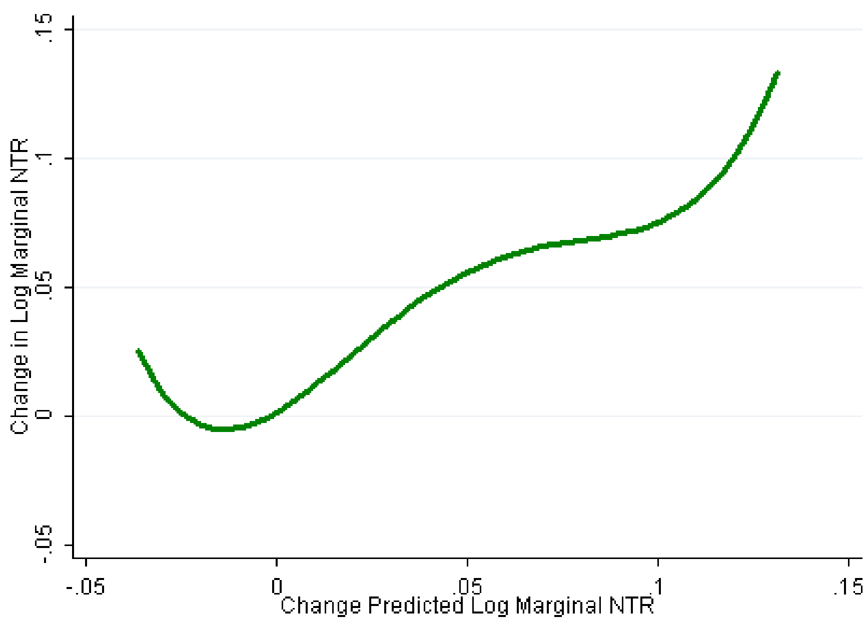
Table 3: Average Welfare Weights: by Income Source

	Using Gruber and Saez (2002) Elasiticities			
Year	Aggregate	Labor	Self-Employment	Capital
2001	0.911	0.939	0.789	0.864
2004	0.915	0.938	0.815	0.907
2007	0.919	0.939	0.836	0.949
	Using Weber (2014) Elasiticities			
Year	Aggregate	Labor	Self-Employment	Capital
2001	0.901	0.936	0.747	0.837
2004	0.907	0.936	0.778	0.891
2007	0.908	0.935	0.801	0.939

Notes: Table 3 reports aggregate and income source-specific average welfare weights for single filers. We report estimates for aggregate income as well as for labor, self-employment and capital income using elasticities estimated with the Gruber and Saez (2002) and Weber (2014) approaches.

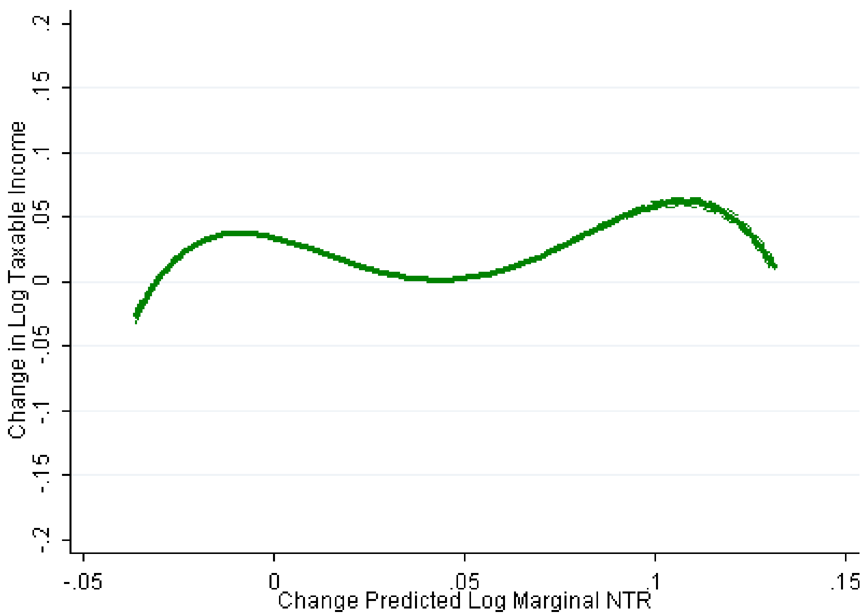
Online Appendix Tables & Figures

Figure A.1: First-stage of ETI Regression



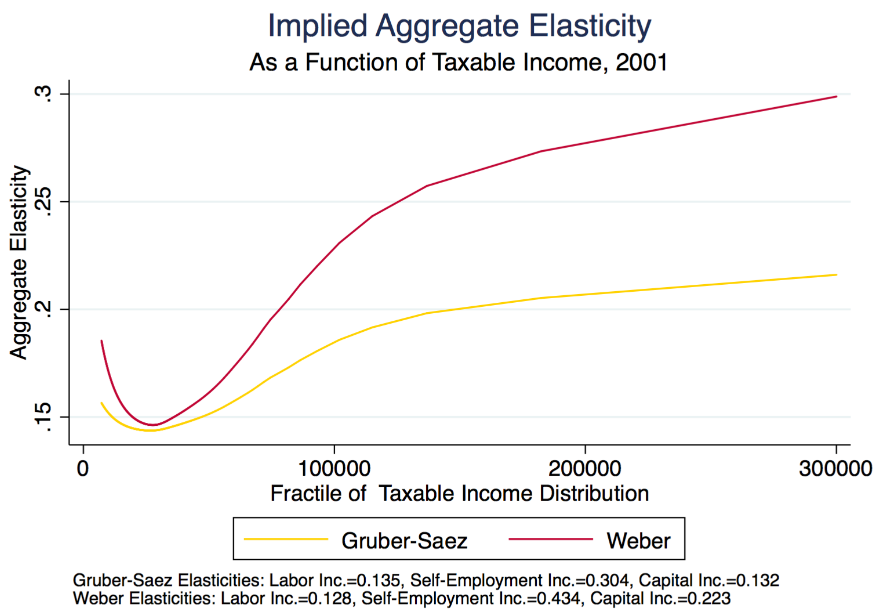
Notes: Online Appendix Figure A.1 illustrates the first-stage for the ETI estimation following Weber (2014) in Table 2. Source: German taxpayer panel for 2001-2008 as in Doerrenberg et al. (2017). Graph is based on a 5% sample of the universe of German taxpayers. The figure plots a fourth-order local polynomial regression of the change in the log marginal net-of-tax rate on the changes in the predicted log marginal net-of-tax rate. No control variables included. The dashed lines are 95% confidence intervals. The graphical illustration is based on Weber (2014) and Doerrenberg et al. (2017).

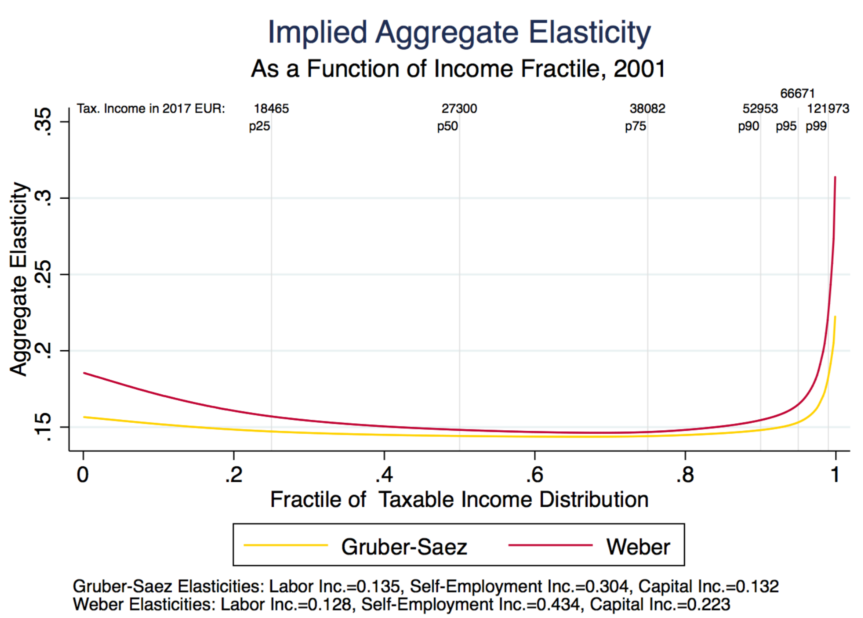
Figure A.2: Reduced Form of ETI Regression



Notes: Online Appendix Figure A.2 illustrates the reduced-form relationship for the ETI estimation following Weber (2014) in Table 2. Source: German taxpayer panel for 2001-2008 as in Doerrenberg et al. (2017). Graphs are based on a 5% sample of the universe of German taxpayers. The figure plots a fourth-order local polynomial regression of the change in log aggregated taxable income on the changes in the predicted log marginal net-of-tax rate. No control variables included. The dashed lines are 95% confidence intervals. The graphical illustration is based on Weber (2014) and Doerrenberg et al. (2017).

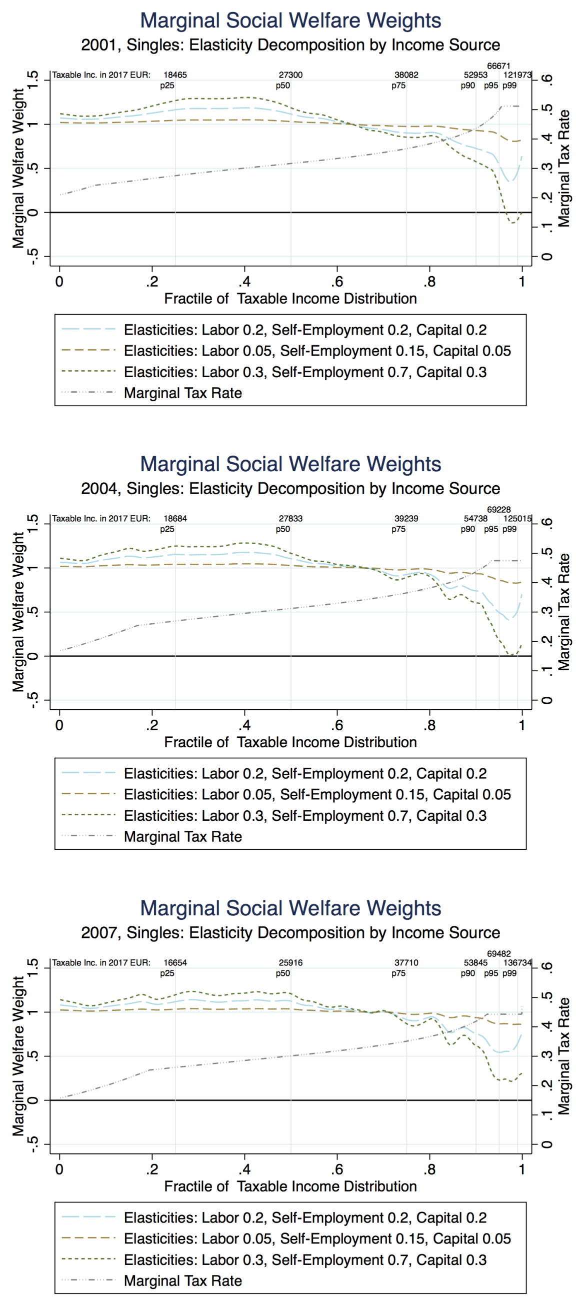
Figure A.3: Implied Aggregate Elasticities





Notes: Online Appendix Figure A.3 shows implied aggregate elasticities for single filers as a function of taxable income (Panel a) and the taxable income fractile (Panel b). Aggregate elasticities are given by the mean of income source-specific elasticities weighted by the respective income shares at a given point in the taxable income distribution. Income shares are as of 2001.

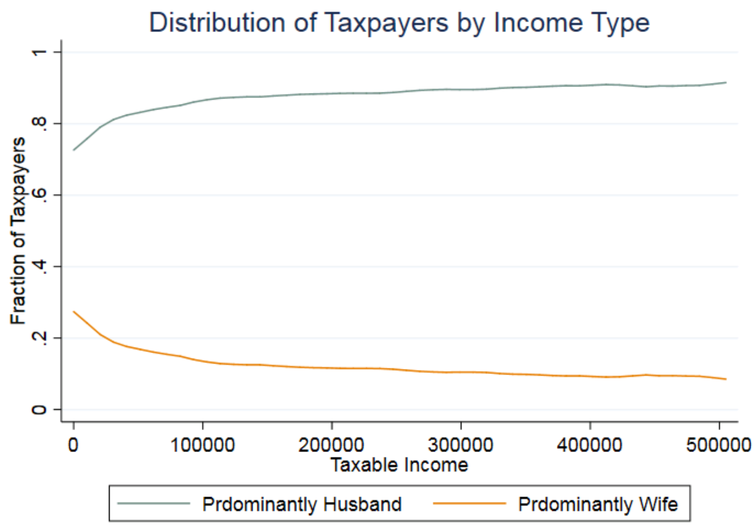
Figure A.4: Marginal Social Welfare Weights: Elasticity Decomposition by Income Source



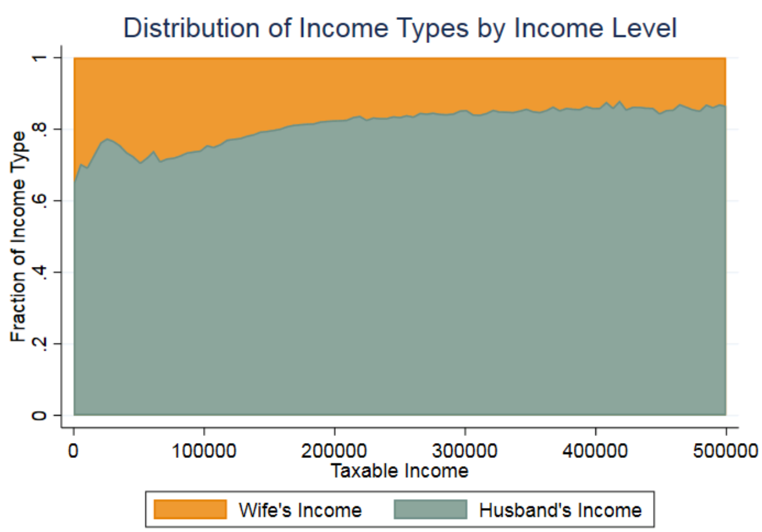
Notes: Online Appendix Figure A.4 shows marginal social welfare weights for single filers implicit in the German tax system as functions of the taxable income fractile for 2001, 2004 and 2007. The figures consider three hypothetical scenarios for income source-specific elasticities: uniform elasticities (blue line), low elasticities (brown line), high elasticities (orange line). Gray lines indicate the effective marginal tax rate for a given fractile in the taxable income distribution.

Figure A.5: Distribution of Income Sources

(a)

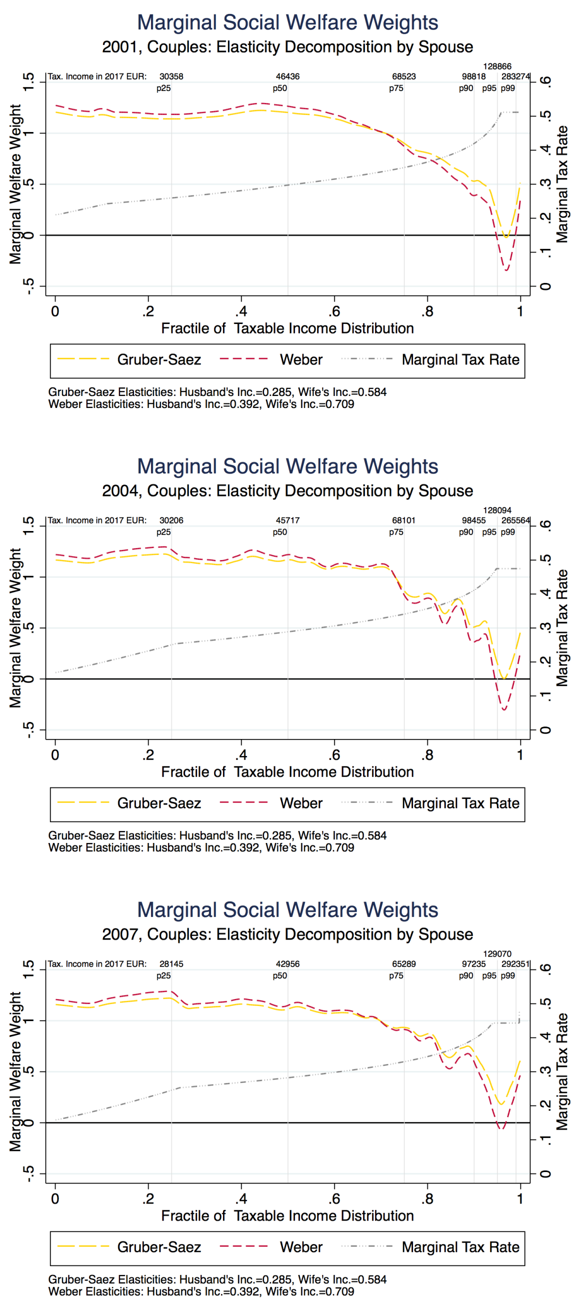


(b)



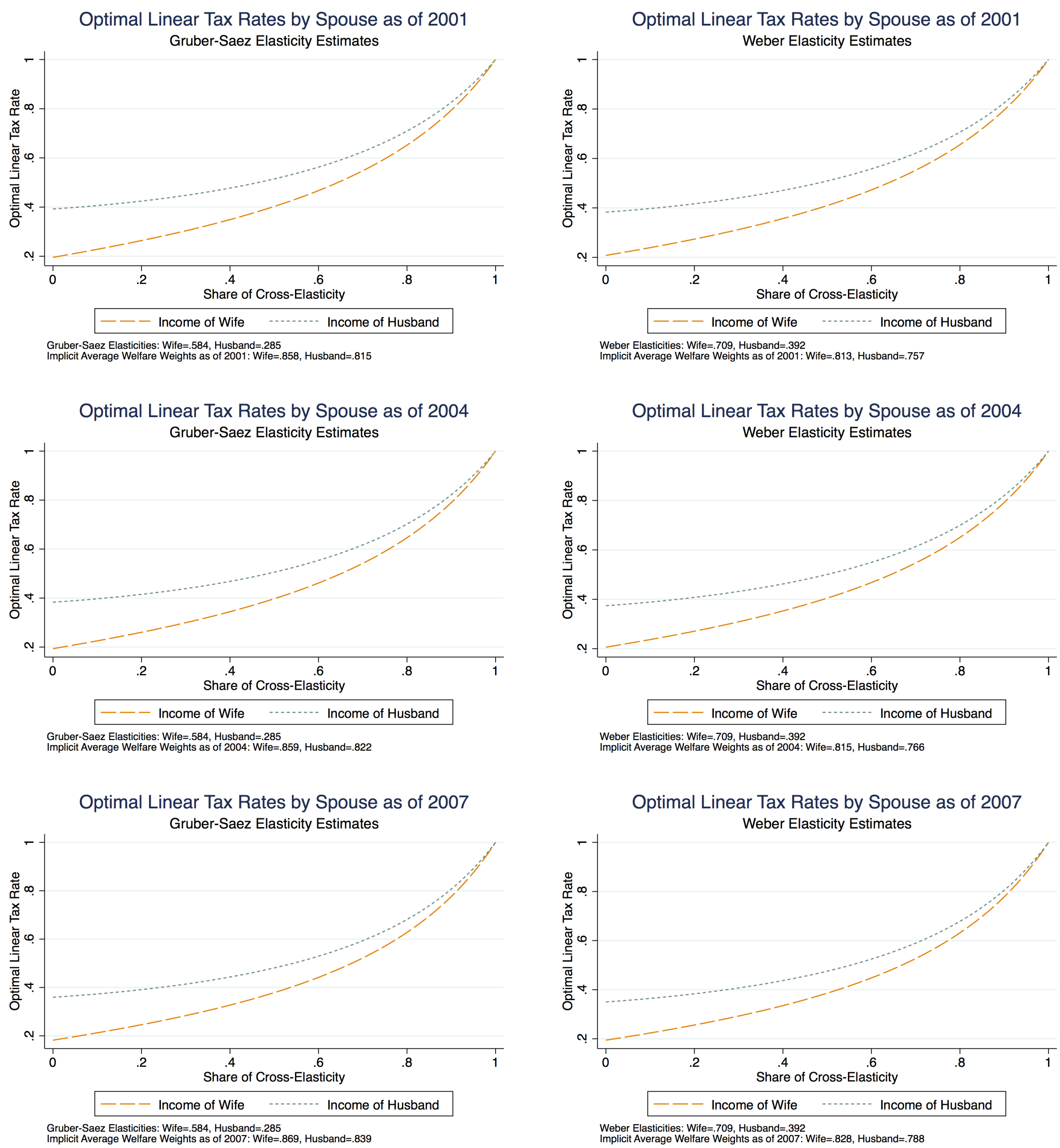
Notes: Online Appendix Figure A.5 provides graphical evidence on the composition of income in married couples earned by wives and husbands in Germany as of 2007. Panel a displays the fraction of couples with a female or male primary earner as a function of the level of taxable income. The figure is obtained from local polynomial regressions with Epanechnikov kernel of the fraction of couples according to their primary earner on taxable income. Panel b reports the average fractions of income earned by wives and husbands as functions of the level of taxable income. The figure is obtained from local polynomial regressions with Epanechnikov kernel of a couple's fraction of income earned by either the wife or husband on taxable income.

Figure A.6: Marginal Social Welfare Weights: Elasticity Decomposition by Spouse



Notes: Online Appendix Figure A.6 displays marginal social welfare weights for couples implicit in the German tax system as functions of the taxable income fractile for 2001, 2004 and 2007. The figures consider two scenarios for income type-specific elasticities estimated by the Gruber-Saez (yellow lines) and Weber approach (red lines) (see figure notes). Gray lines indicate the effective marginal tax rate for a given fractile in the taxable income distribution.

Figure A.7: Optimal Linear Tax Rates: by Spouse



Notes: Online Appendix Figures A.7 displays optimal linear tax rates for wives and husbands in married couples. Both income types are assumed to exhibit the same proportion in cross-elasticities. The figures use income type-specific average welfare weights implicit in the German tax system as of 2001, 2004, and 2007. Left-sided panels employ income type-specific elasticities estimated by the Gruber-Saez approach. Right-sided panels employ income type-specific elasticities estimated by the Weber approach (see figure notes).

Table A1: Optimal Linear Tax for Singles

	Gruber and Saez (2002) Elasticities	Weber (2014) Elasticities
2001	0.38	0.39
2004	0.37	0.37
2007	0.35	0.36

Notes: Online Appendix Table A1 reports optimal linear tax rates for singles using elasticities estimated with the Gruber and Saez (2002) and Weber (2014) approaches. Average welfare weights used for the calculation correspond to the average welfare weight implicit in the non-linear German tax schedule in 2001, 2004, or 2007.

Table A2: Elasticities of Taxable Income by Spouse

	Gruber-Saez	Weber
Overall	0.383***	0.537***
	(0.026)	(0.040)
	By Spouse	
Wives	0.584***	0.709***
	(0.064)	(0.103)
Husbands	0.285***	0.392***
	(0.031)	(0.042)
No. obs.	1,020,506	

Notes: Online Appendix Table A2 reports elasticities of taxable income with respect to the net-of-tax rate estimated for couples with the Gruber and Saez (2002) and Weber (2014) approaches. We distinguish between the overall elasticity and spouse-specific elasticities.

Table A3: Average Welfare Weights: by Spouse

	Using Gruber and Saez (2002) Elasticities		
Year	Aggregate	Wife	Husband
2001	0.800	0.859	0.816
2004	0.806	0.860	0.823
2007	0.825	0.825	0.840
	Using Weber (2014) Elasticities		
Year	Aggregate	Wife	Husband
2001	0.735	0.814	0.758
2004	0.745	0.816	0.766
2007	0.770	0.829	0.789

Notes: Online Appendix Table A3 reports aggregate and spouse-specific average welfare weights. We report estimates for aggregate as well as spouse-specific income for elasticities estimated with the Gruber and Saez (2002) and Weber (2014) approaches.

Table A4: Optimal Linear Tax for Couples

	Gruber and Saez (2002) Elasticities	Weber (2014) Elasticities
2001	0.35	0.35
2004	0.34	0.34
2007	0.31	0.32

Notes: Online Appendix Table A1 reports optimal linear tax rates for couples using elasticities estimated with the Gruber and Saez (2002) and Weber (2014) approaches. Average welfare weights used for the calculation correspond to the average welfare weight implicit in the non-linear German tax schedule in 2001, 2004, or 2007.