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Abstract. In many countries organized as federations, fiscal-equalization schemes have been implemented to mitigate vertical or horizontal imbalances. Such schemes usually imply that the member states of the federation can only partly internalize marginal tax revenue before redistribution. Aside from this internalized revenue, referred to as the marginal tax-back rate, the remainder is redistributed. We investigate the extent to which extent state-level authorities in such federation under-exploit their tax bases. By means of a stylized model we show that the member states have an incentive to align the effective tax rates on their residents with the level of the tax-back rate. We empirically test the model using state-level and micro-level taxpayer data, OLS regressions and natural experiments. Our empirical findings support the results from our theoretical model. Particularly, we find that states with a higher marginal tax-back rate exploit the tax base to a higher extent.

JEL-Codes: C21, H21, H77

Key words: fiscal federalism, fiscal externalities, natural experiment, treatment analysis, statistical matching

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1 Introduction

Fiscal equalization schemes are an important feature of public finance frameworks and are common in federal systems of government. Countries that have implemented fiscal equalization schemes include Canada, Switzerland, Australia and Germany. In the United States, there is no explicit federal equalization scheme for reducing fiscal disparities between the states. However, vertical federal-state transfers such as education programs aimed at the disadvantaged, food and nutrition programs and Medicaid have an equalizing component.

Theoretical research on the incentives of fiscal equalization schemes and federalism in general has a long tradition. Pioneering works on the assignment of functions to different governmental layers and appropriate fiscal instruments date back to Musgrave (1959) and Oates (1972). [1] The role of inter-regional spillover effects due to mobile tax bases or inter-regional externalities in the provision of public goods has been investigated in Oates (1972), Boadway and Flatters (1982), Inman and Rubinfeld (1992), or Manasse and Schultz (1999). Other scholars investigate asymmetric information over local preferences for public goods (e.g., Cremer et al., 1996; Bucovetsky et al., 1998), over technologies for the provision of public goods (e.g. Boadway et al., 1995; Raff and Wilson, 1997; Caplan et al., 2000; Breuillé and Gary-Bobo, 2007; Akai and Silva, 2009), and over local tax bases (Bordignon et al., 2001).

The present study investigates, both theoretically and empirically, the relationships between fiscal equalization and the enforcement of a uniform tax law in a federation where the member states are responsible for the enforcement of the tax and carry the related costs. In such a federation, tax enforcement might depend on the state-specific pecuniary returns of the enforcement activities. These pecuniary returns, at the margin, are determined by the state-specific marginal tax-back rates (TBR): TBR is how much they can keep of any additional taxes levied after fiscal equalization (as opposed to being redistributed to other states or the federal government through fiscal equalization schemes). Even in the presence of a uniform de jure tax tariff, states also have de facto instruments to steer tariffs. These may include a varying incidence and intensity of tax audits, differing interpretations of complex tax issues,[2] and the use of vague formulations in the tax code.[3] Using such instruments create inefficiencies, violates the equal treatment of equals, and in all likelihood undermines the tax morality of tax payers.

[1] For a game theoretic analysis see De Figueiredo (2005).
[2] For the interplay between accuracy and complexity of income taxation see also Kaplow (1998).
[3] For example, in Germany, the level of expenses exceeding blanket allowances and qualified as deductible, despite some guidelines, is a decision *ex aequo et bono* of the auditing tax agent. An overview of several norms in the German income tax code with vague legal terms is provided in Bönke et al. (2011), Table A1 in the Appendix.

In the light of the above, we make a theoretical and an empirical contribution to the literature. On the theoretical side, we set up a stylized Samuelson (1954) type model that reflects the characteristics of the federation described above, taking the German system as a real-world example. The model reveals that benevolent state-level planners align the effective tax burdens on their taxpayers with the internalized marginal tax revenue (IMR) collected from the taxpayers. The IMR is how much a state can keep from a marginal increase in the tax base after fiscal equalization. It is the product of two variables: the marginal tax rate of a tax unit and the state-specific TBR. The model shows that the effective tax burden of a given taxpayer will systematically vary with the tax-back rate of the state where the taxpayer lives: Provided that the substitution effect dominates the income effect, states with a higher IMR exploit the tax base to a higher extent.

On the empirical side, we use administrative German data to test the model implication that states with a higher IMR exploit the tax base to a higher extent. We perform two types of testing. The first type uses aggregated state-level data, and studies how differences in average IMRs alter tax enforcement. Tax enforcement is measured by an input variable, the staffing of tax administrations in the states. The analysis is also motivated by a report of the German Federal Audit Office (2006, p. 78f.) according to which differences in the personnel endowments of tax offices undermine the "uniformity of taxation" (Federal Audit Office, 2006, p. 122). Consistent with the model, we find a positive statistical association between average IMR and staffing. The second type uses micro data on taxpayers and an output variable as the tax enforcement indicator: the amount of income tax deductions granted to the tax units. The use of micro data allows us to disentangle the two components of IMR, the TBR and the taxpayer-specific marginal tax rates. Particularly we exploit several natural experiments to provide causal evidence of the states' incentive problem. This experiments are based on observed discontinuities in the TBRs of some German states. Consistent with the model, we find that an exogenous increase of the TBR in one state lowers its tax-enforcement activities compared with states that have a constant TBR.

This is not the first study on the interplay between fiscal equalization and taxation. Previous studies include Oates (1999); Zhuravaskya (2000); Bordignon et al. (2001); Mikesell (2003); Esteller-Moré (2005); Martinez-Vazquez and Timofeev (2005); Buettner and Wildasin (2006); Libman and Feld (2013); Egger et al. (2009); or Mogues et al. (2009).[4] Blöchliger et al. (2007)

[4] Another strand of literature focuses on tax enforcement and tax administration. Influential studies include Slemrod and Yitzhaki (1991) and Mayshar (1991).

argue that equalization rates are “one of the most debated issues in fiscal equalization” (p. 16), and continue: “Lenient tax effort, especially if tax administration is under sub-central control, may (...) be a result of high equalisation rates” (p. 16). In the same spirit, Zhuravaskya (2000) argue that high equalization rates in Russia leave little incentive for sub-national authorities to exert tax-generating efforts when transfers increase. Buettner and Wildasin (2006) find that in the USA sub-national authorities lower own-revenue generation in response to an increase in external grants. Mogues et al. (2009) find that in Ghana, own-revenue generation of sub-national authorities is negatively related to the level of past external transfers.

Most of the previous literature deals with fiscal equalization and taxes passed at the local level. Our research, in contrast, focuses on de-centrally determined enforcement activities in a federation with a uniform tax law. We are aware of only two studies with a similar focus: a theoretical work by Traxler and Reutter (2008) and largely empirical work by Baretti et al. (2002). Neither of the two provides causal evidence on the interplay between IMR / TBR and tax enforcement. With the present paper, we seek to fill this gap in the literature.

In a general sense, the issue studied is not only relevant to federal countries, but also to unitary countries that have decentralized over the last decades. Also, it is relevant for (supra)national entities with transfer schemes but decentralized tax systems such as the European Union or the United States. Finally, even though the German constellation of a highly equalizing fiscal equalization scheme, a uniform tax law, and decentralized tax enforcement might be unique at present, historically the case of China prior to the tax sharing reform of 1994 is a quite perfect match for the same set of conditions, even though China was not then and is not currently a federal state.

In sum, our major contribution is, that we provide causal evidence on the fiscal incentives of member states of a federation and identify significant effects, something that the literature has been lacking. The results of our examination are highly policy relevant: in the presence of incentive effects there are strong arguments in favor of centralized tax enforcement.

The remainder of the paper is organized as follows. Section 2 briefly introduces Germany’s federal system and income-tax law. Section 3 presents our theoretical model. Our database is described in Section 4. Section 5 provides the econometric analysis. Finally, Chapter 6 offers some concluding remarks.

2 Fiscal Equalization and Taxation

2.1 The basic mechanisms of fiscal equalization in Germany

Germany's federal structure is reflected by three levels of governmental: the federal (*Bund*), the state (*Bundesländer*), and the local (*Gemeinde*) level. Since German reunification in 1990, sixteen *Laender* have comprised the state level and about 11,500 municipalities the local level. Germany's federal system is cooperative: All the fiscally important taxes are set by the central government, and redistributive horizontal and vertical transfers are used to mitigate regional fiscal imbalances. As a result, the provision of (local) public goods and services is relatively similar across regions (Art. 107, Para. 2, 1, German Federal Constitution).

Basically, the fiscal equalization system has four stages summarized in Table 1 and detailed in the Appendix. The first stage is the vertical assignment of tax revenue to the federal level and the states, with fixed shares assigned to each level. For example, 42.5% of the income tax revenue is assigned to the federal, and 57.5% to the state and local level. The stages 2 and 3 determine the horizontal equalization. At these stages, tax revenue is distributed between rich and poor states, determined by the state specific "fiscal capacity" and "fiscal needs." Basically, fiscal capacity is determined by tax return per inhabitant (before equalization), fiscal needs by average tax return per inhabitant across all of the 16 states: any increase in a state's tax revenue either lowers the transfer entitlement (states with a below-average fiscal capacity) or increases the contribution obligation (states with an above-average fiscal capacity). Stage 4 determines particular vertical transfers from the federal to the state level.[5]

In sum, Germany's fiscal equalization system drives a substantial wedge between state tax revenues before and after fiscal equalization. As an example, at the margin, in case of the income tax, state-specific tax-back rates on state income tax revenues (TBR) are usually less than 25 percent. The remainder, the marginal rate of loss ($1 - TBR$), is redistributed horizontally or vertically (42.5%).

Table 1 about here

2.2 Determining the tax-back rates

Due to the complexity of the legal regulations governing the fiscal equalization system, it is not feasible to express TBR by means of a simple closed form, say as a function of tax revenue, type of tax revenue, and number of inhabitants. All variations of these and other determinants are of relevance also in stages 2 to 4 of the transfer system (also Baretti et al., 2002, p. 646).[6] Official data on state-specific TBRs are not available. Hence, we have set up an accounting

[5] See Appendix Section 4 for details.
[6] Appendix 1 in Baretti et al. (2002) for details.

model that captures all the rules of Germany's fiscal equalization law. The model is based on official statistics on the relevant information also used by the governmental institutions to assess the equalization transfers (tax revenue, population size, etc.) provided by the German Ministry of Finance. Based on this data, the model derives the actual horizontal and vertical transfer flows. The TBRs are determined by computing the change in a state's actual tax revenue after fiscal equalization and in a hypothetical situation where the tax revenue before fiscal equalization is marginally increased – keeping everything else constant.

The obtained TBRs for the years 1998, 2001, and 2004 are summarized in Table 2. The selection of the years is guided by the availability of the micro-level taxpayer data. Table 2 reveals several patterns. First, TBRs are quantitatively small, usually around 10-30 percent. Hence, the German states can internalize only a small fraction of marginal income tax revenue. This is because of the fixed proportion of tax revenue to be transferred to the central level, and the dependence of net transfer entitlements/obligations to fiscal capacity. Second, some states have a higher TBRs than others: As an example, in 2004, the TBR of North Rhine-Westphalia is 30 percent, compared to eight percent in Saarland. The reason is that the TBR increases with the absolute difference between a state's fiscal capacity and average capacity over all 16 states. Third, TBR usually exhibits very little inter-temporal variation. There is, however, a prominent exception: Schleswig-Holstein's TBR drops from 57 percent in 1998 to twelve percent and then remains constant.[7] This TBR discontinuity has a straight forward explanation: In 1998 Schleswig-Holstein's fiscal situation was such that its fiscal capacity was almost the same as the average fiscal capacity across all German states. This constellation implies that Schleswig Holstein's horizontal net transfer was zero, and its TBR was determined solely by the initial assignment rule of the joint taxes (stage 1). This is the only constellation in which a state can experience a major swing in its TBR. Note, that this major swing occurred despite hardly any changes in Schleswig-Holstein's per capita GDP (see Table A1). Instead, the swing occurred from a coincidence: that Schleswig Holstein's fiscal capacity in 1998 was equal to the 16 states' average. Another state with a sizeable change in TBR is Bavaria. Between 1998 and 2001, its TBR fell by more than four percentage points. In contrast to Schleswig Holstein, Bavaria's GDP increased in the same period (see Table A1).

The constancy of TBR in most states and its variability in two states means that the incentives for tax enforcement are constant over time in the former and change in the latter. This distinction

[7] The sharp fall of Schleswig-Holstein's TBR from 1998 to 2001 is also documented in Lichtblau and Huber (2000). In contrast to the TBR, Lichtblau and Huber (2000) report marginal rates of loss, which corresponds to $1 - TBR$. Simulations for marginal rate of loss instead of TBR are also provided in Bönke et al. (2011).

will serve as the basis for our treatment analysis. For a rigorous treatment analysis, it is important that the TBR is an exogenous variable that cannot be purposely influenced by the state governments or tax administrations. As we will explain below, this is the case.

Table 2 about here

The key variable that determines a state's TBR is its fiscal capacity relative to the average capacity of all states. However, the relationship between a state's TBR and its fiscal capacity is highly non-linear with several kinks. This is the first reason why the states cannot purposely influence TBR. For example, in 1998, the TBR of a "poor" net-recipient state like the Saarland and the "rich" net-contributor state Hamburg hardly differ. For "rich" states, TBRs are low because payment obligations increase sharply if tax revenue increases. For 'poor' states, TBRs are low because transfer entitlements are reduced sharply if tax revenue increases.[8] As explained above, only when a state's fiscal capacity is close to the average fiscal capacity of all sixteen states, its TBR high (about 57 percent) because then its horizontal net transfer position is zero, and its TBR is determined by the initial assignment rule of the joint taxes (stage 1).

The second reason that makes it difficult to control TBR is that it usually requires sizeable variations in per capita tax revenue before fiscal equalization to change the TBR. The relationship between changes in a state's per capita tax revenue before fiscal equalization and its TBR is depicted in Figures 1a-c. Each figure relates to one of the three observation periods 1998, 2001, and 2004, and provides sixteen graphs, one for each state. An abscissa value of zero indicates a state's actual fiscal situation, and the corresponding value on the ordinate its TBR. Negative (positive) values on the ordinate indicate hypothetical variations in the capita tax revenue before fiscal equalization (compared to the state's actual situation; everything held constant). The graphs reveal that it usually requires substantial changes in per capita tax revenue before fiscal equalization to change TBR, and several kinks in the relationships even make it difficult to foresee the effect ex ante. There is always one peak in the TBR: it jumps to 57.5% if the state's fiscal capacity complies with the average fiscal capacity over all states, meaning its horizontal net-transfer position is zero.

The interpretation of TBR as an exogenous variable is further justified for the reason that the TBR of a particular year is always determined *before* the tax declarations for the same year are audited. This is because horizontal and vertical transfers in a particular year, say assessment

[8] Plachta (2008) provides a detailed description of the German financial constitution.

year 1998, hinge upon *cash* tax revenues. Income tax declarations from 1998, however, have been handled by the tax authorities since spring 1999.

Figures 1a-1c about here

2.3 The process of income taxation

The legislation and the enforcement responsibility of the income tax (and the other joint taxes) are assigned to different governmental levels. The tax-setting authority is assigned to the federal government. It defines both tax tariffs and tax bases. The tax schedule is progressive: the average tax rate increases monotonically with increasing taxable income. During the period 1998 to 2004, the marginal income tax rate, depending on the assessment year, ranged from 0% to 53%. The tax base, taxable income, is gross income minus numerous tax deductions and allowances. As the states have no tax-setting authority, even where "pure" state taxes are concerned,[9] the states' ability to control the income tax revenues *directly* are severely restricted. The responsibility for tax enforcement, however, is delegated to the states.

The de-centralized enforcement of tax law at the state level and the monocracy of state financial executives open up opportunities for politically motivated application and interpretation of tax laws. This is because there are only basic standards in place to guide tax enforcement activities at the state level. Effectively, the state governments are free to decide on the funding of personnel and IT resources they will provide to their state tax agencies as well as on the training of tax agents. The state governments also give internal guidelines to their tax agents for how to deal with particularly vague paragraphs in the income tax law. Indeed, a report of the Federal Audit Office (2006, p. 78f.) remarks: "some states give the impression that the hiring of tax auditors is not interesting due to fiscal equalization; net contributor states had to pay the dominant part of eventual additional tax revenue in the fiscal equalization system, while transfers were reduced for the net recipient state." In a summarizing statement in the same report it is argued that differences in the personnel endowments of tax offices[10] undermine the "uniformity of taxation in Germany" (Federal Audit Office, 2006, p. 122).

Further indications of politically motivated tax practices have been cited in previous literature:

1. Vogel (2000, 128-155) as well as Schick (2011) find systematic differences in tax revenue per audit and state-specific tax auditing frequencies. The city state[11] of Hamburg, for example, has a relatively high number of income millionaires whose

[9] Except the rate of the property acquisition tax that can be determined by the states since 2006.
[10] See Table A1 in the Appendix for details.
[11] Three German cities (Berlin, Bremen, Hamburg) are also independent federal states.

income tax returns are audited at a substantially lower rate than in other states (Schick, 2011).

2. A report of the Federal Audit Office (2006, p. 13) documents that in a random sample of 21 tax offices the number of tax audits per tax agent and year varies between 972 and 2,720. It is also documented that the complete and equal auditing of tax declarations is no longer ensured, and that systematic errors are made in the audits of special expenses in Hamburg (p. 35f.). According to the Audit Office of Berlin (2001), tax returns of employees are not audited with sufficient care, and tax agents fail to examine tax declarations carefully in an effort to meet thresholds regarding the number of daily audits.
3. To harmonize tax audits, recently a risk management system has been implemented in all tax offices across Germany. The system evaluates roughly 2,500 items on income tax returns and indicates potential incongruities between the items. Harmonization was not achieved because the states modified the detection algorithms independently, and because tax offices responded differently to potential incongruities (Federal Audit Office, 2009, p. 176-179; Federal Audit Office 2012, p. 30). If the system selects a tax return for special audit, it is not ensured that the auditing is conducted appropriately. Instead, according to several State Audit Offices, error rate range between 12 percent (North Rhine Westphalia) and 52 percent (Brandenburg).
4. Vogel (2000) provides evidence that some states treat certain tax payers by generous interpretation of amortization rules and the postponement of tax payments.

In sum, the states bear the full costs of enforcing the income tax law (e.g., costs of operating state-level tax offices), but they internalize only part of the resulting tax revenues (due to the redistributive fiscal equalization scheme). The decentralization of administration results in limited means available to the federal government for controlling the tax collection process. The states therefore have both the opportunity and the incentive to align tax enforcement activities with their own objectives, and in this respect TBR may play a prominent role. As outlined above, several state-level indicators suggest differences in state-specific tax enforcement levels. However, the empirical evidence is basically anecdotal and also lacks a rigorous econometric testing.

3 A stylized model

To understand the interplay between a de-centralized tax administration and transfer schemes in a federation with a uniform tax law, we have set up a static public good model in the spirit of Samuelson's (1954). The model has strong assumptions but should be considered as a useful tool to introduce the empirical analysis.

Consider a country with $j = 1, \dots, J$ federal states and let a state j have three sources of revenues: income tax revenue,[12] equalizing grants, and lump sum transfers, feasible for the provision of a state-wide public good provided at the level g_j. Transfer rules determining the equalizing grants, Z_j, and the lump sum transfers $\bar{B}_j$, and also the tax tariff, τ, are set by a central planner (whose goal might be the maximization of overall societal welfare). These rules, characterized by $[\tau, (Z_1, \dots Z_J), (\bar{B}_1, \dots \bar{B}_J)]$, are decided before taxes have actually been collected, and before public goods have been provided. Consistent with the situation in Germany we assume that tax enforcement is delegated to the federal states, which interpret $[\tau, (Z_1, \dots Z_J), (\bar{B}_1, \dots \bar{B}_J)]$ as exogenous (henceforth indicated by vertical bars). We further assume that the tax units resident in a state j, $i_j = 1, \dots I_j$, are immobile (and so are the incomes, tax bases).[13]

Using the public good as the numéraire, in a static one-period model the public budget constraint of state j is given by,

$$g_j \leq T_j + Z_j + \bar{B}_j, \tag{1}$$

with

$$T_j = \sum_{i_j=1}^{I_j} \bar{r} \cdot t_{i_j}\left(\tau, y_{i_j}, \Delta_{i_j}\right), \tag{2}$$

where T_j denotes income tax revenue after the initial assignment of taxes according to division rules in stage 1 of Germany's fiscal equalization system. The term $\bar{r} \approx 0.575$ gives the share from income tax revenue assigned to the state level (including the state's municipalities),[14] and $t_{i_j}\left(\tau, y_{i_j}, \Delta_{i_j}\right)$ is the effective tax burden imposed on tax unit i_j. The effective tax burden of i_j

[12] We abstain from modeling other tax types or the possibility of public debt to keep the analysis simple. The reasons and incentives for raising public debt are discussed in Jochimsen and Nuscheler (2011).

[13] The assumption that citizens do not change residences across state borders in response to moderate differences in effective income tax rates is supported by a recent empirical study for Switzerland (see Liebig et al., 2007). Young and Varner (2011) verify this claim for one state in the USA. However, Kleven et al. (2013) find evidence of high mobility of top income earners across borders. Such top-income households are not contained in the micro-data used in our empirical analysis. If tax units, however, are mobile, this offers another argument for the states to lower the effective tax rates.

[14] See Section 2.1 for details.

hinges on the progressive tax tariff, τ,[15] on i_j's gross taxable income, y_{i_j}, and the level of granted deductions, Δ_{i_j}. We assume that gross taxable income is exogenous from the tax agent's point of view.

The second term in the state's budget constraint is the net equalizing transfers,

$$Z_j = Z_j\left[(T_1(\cdot), I_1), (T_2(\cdot), I_2), \dots, (T_J(\cdot), I_J), \bar{F}\ \right]. \tag{3}$$

For net-recipient (net-contributor) states, i.e., for states with a below-average (above-average) per capita fiscal capacity, the net equalizing transfer is positive (negative). $\bar{F}$ accounts for further particular regulations inherent in Germany's fiscal equalization system, i.e. the lump-sum transfers as described in Section 2.1. Across the states, equalizing transfers add up to zero, i.e.,

$$\sum_{j=1}^{J} Z_j = 0. \tag{4}$$

The third term in the state's budget constraint (1), $\bar{B}_j$ are lump sum vertical transfers, i.e., special needs grants.

For a tax unit resident in state j, we assume that preferences are characterized by an additive utility function of the form,

$$u_{i_j} = f\left(c_{i_j}\right) + h(g_j), \tag{5}$$

with c_{i_j} denoting the level of a private good, the numéraire, and with g_j denoting the level of a state-level public good. Accordingly, we abstain from modeling public good spillover effects.

The budget constraint of a tax unit is,

$$c_{i_j} \le y_{i\,j} - t_{i\,j}\left(\bar{\tau}, y_{i\,j}, \Delta_{i_j}\right). \tag{6}$$

Suppose $\left[\tau, \left(Z_1, \dots Z_J\right), \left(\bar{B}_1, \dots \bar{B}_J\right)\right]$ and an interior solution exists. Further, suppose state planners "act as benevolent maximiser of their citizens' welfare" (Edwards and Keen, 1995, p. 113). Finally suppose the welfare of the residents of a state is described by a Bentham social welfare function, $W_j = \sum_{i_j=1}^{I_1} u_{i_j}$.

The optimization problem of the benevolent planner of a state j is,

$$L_j\left(g_j, \Delta_{1_j}, \dots, \Delta_{I_j}\right) = \tag{7}$$

[15] Mookherjee and Png (1990) address enforcement costs and optimal progressivity of income taxes. The present study takes the tax rate as given.
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$$\sum_{i_j=1}^{I_j}\left(f\left(y_{i_j}-t_{i_j}\left(\tau,y_{i_j},\Delta_{i_j}\right)\right)+h\left(g_j\right)\right)$$
$$+\lambda\left[g_j-\bar{r}\sum_{i_j=1}^{I_j}t_{i_j}\left(\tau,y_{i_j},\Delta_{i_j}\right)+\sum_{k\neq 1}Z_k(\cdot)-\bar{B}_j\right]$$

The solution is,

$$\frac{I_j\cdot\dfrac{\partial h}{\partial g_j}}{\dfrac{\partial f}{\partial c_{i_j}}\cdot\dfrac{\partial t_{i_j}(\cdot)}{\partial\Delta_{i_j}}}=\left[\bar{r}\frac{\partial t_{i_j}(\cdot)}{\partial\Delta_{i_j}}-\sum_{k\neq 1}\frac{\partial Z_k}{\partial T_j}\cdot\frac{\partial T_j}{\partial t_{i_j}(\cdot)}\cdot\frac{\partial t_{i_j}(\cdot)}{\partial\Delta_{i_j}}\right]^{-1}\qquad\forall i_j=1,\dots,I_j\tag{8}$$

$$\Leftrightarrow\ I_j\cdot\frac{\dfrac{\partial h}{\partial g_j^*}}{\dfrac{\partial f}{\partial c_{i_j}}}=\left[\bar{r}-\sum_{k\neq j}\frac{\partial Z_k}{\partial t_{i_j}\left(\cdot,\Delta_{i_j}^*\right)}\right]^{-1}\qquad\forall i_j=1,\dots,I_j$$

The benevolent planner of state j chooses $\left(\Delta_{i_j}^*,\dots,\Delta_{I_j}^*,g_j^*\right)$ so that the optimality condition (8) holds. The optimality condition is a modification of the standard Samuelson condition for the provision of public goods.

The left-hand side is the sum of rates of substitution between the public and the private good, known from the standard Samuelson condition. The expression in brackets on the right-hand side is the effect of a marginal variation of the tax base of resident i_j, Δ_{i_j}, on the public budget of state j: the internalized marginal tax revenue, IMR_{i_j}. The IMR_{i_j} comprises two terms. The first term gives the additional tax revenue resulting from a marginal tax base variation that is not vertically redistributed: the product of the marginal tax rate, $\partial t_{i_j}/\partial\Delta_{i_j}$, times the income tax share assigned to the state level, $\bar{r}\approx 0.575$. However, state 1 can internalize only part of this amount. The remainder, $\sum_{k\neq j}\frac{\partial Z_k}{\partial T_j}\cdot\frac{\partial T_j}{\partial t_{i_j}(\cdot)}\cdot\frac{\partial t_{i_j}(\cdot)}{\partial\Delta_{i_j}}>0$, constitutes a positive fiscal externality for the other 15 states.

Notice that the concept of $IMR_{i_j}=TBR_j\cdot\frac{\partial t_{i_j}(\cdot)}{\partial\Delta_{i_j}}$ is related to the concept of the tax back rate, $TBR_j=\bar{r}-\sum_{k\neq j}\frac{\partial Z_k}{\partial T_j}$. However, this reflects that the internalized marginal return from a marginal expansion of the tax base (by granting fewer tax deductions to a tax unit, i_j) depends on both a state-level and a micro-level component: the state's tax-back rate and the marginal tax rate of the taxpayer whose tax base is expanded. Hence, in the empirical analysis it is important to scrutinize the effect of TBR_j on the level of granted deductions after conditioning for the tax payer-specific marginal tax rates.

Equation (8) has immediate implications for the optimal level of deductions, $\Delta_j^* = \sum_{i_j=1}^{I_j} \Delta_{i_j}^*$, from the viewpoint of the benevolent planner in state j. Suppose there are two taxpayers with identical tax-relevant characteristics, i.e., identical marginal tax rates, living in two states 1 and 2, taxpayers 1_1 and 1_2. Further suppose the states' tax-back rates differ, $TBR_1 > TBR_2$. Under ceteris paribus conditions, condition (8) implies that then the level of tax deductions granted to taxpayer 1_1 should be lower than for taxpayer 1_2. This is because the internalized returns from tax enforcement are higher in state 1 than in state 2. For example, the states can control the effective tax burdens by deciding how many tax returns are audited, or through the 'generosity' of tax agents in granting of tax deductions. The argumentation requires that the substitution effect dominates the income effect.[16] In any case, it is unlikely that substitution and income effects cancel each other out.

Equation (8) also indicates that the state planner does not consider the effect of tax enforcement on the budgets of the other states: Every variation in granted tax deductions alters the state's tax revenue ex ante to fiscal equalization, and thus alters the revenues of all other states. This fiscal externality implies an inefficient level of tax enforcement in terms of overall costs and benefits to society.

The following empirical sections challenge equation (8) with empirical evidence. Except for a flat tax schedule, a rigorous empirical assessment requires tax-unit micro data. This is because individual marginal tax rates enter the optimality condition.

4 Data and key figures

4.1 Micro-level data

Germany's Income Tax Statistic (*Lohn- und Einkommensteuerstatistik*) provides income-tax returns from about 30 million tax units per assessment year. It conveys information on taxable income, family situation, income sources, granted deductions and exemptions, revenues and sources of revenues, income tax burden, etc. From all the tax units, a 10 percent stratified

[16] It must also be ensured that variations in discretionary deductions and corresponding changes in income tax revenues have at most a small effect on TBR. As Figures 1a-c indicated, this is not a too strong an assumption. As pointed out in Section 2.1, in the empirical examination, TBR are indeed exogenous.

random sample is made available for scientific purposes, the so-called Factually Anonymous Income Tax Statistic (*Faktisch anonymisierte Lohn- und Einkommensteuerstatistik*, FAST). As the amount of observations is rather high, at roughly 3 million tax units annually, we assume that the data are representative both for the national and for the state level.

FAST is provided in form of three cross-sectional scientific use files covering data for the assessment years 1998, 2001, and 2004. These three cross-sections form our database. Unfortunately, more recent data are not available. This is for two reasons. First, tax units have an extensive period to file their income tax statements before the statements are audited and processed by the tax authority. For complex income tax statements the whole process can easily take up to five years. Second, once the tax collection process is completed, the data must be assembled by the state statistical offices and forwarded to the federal statistical office, where the scientific use files are prepared.

FAST allows the identification of gross taxable income before any type of deductions (y_i) and taxable income. The difference between the two income concepts is the sum of all granted deductions (Δ_i) and serves as the indicator of enforcement: the higher the granted deductions (Δ_i), controlling for all tax relevant characteristics of the tax unit, the lower the level of enforcement.

According to equation (8) from the theoretical model, the core variable for understanding the states' incentives to tax is the internalized marginal return. Table 3 (columns 1-3) provides the respective state-wide averages, $av_j\left(IMR_{i_j}\right)$.[17] The higher $av_j\left(IMR_{i_j}\right)$, the higher the internalized revenue and the higher the incentive to ensure effective tax enforcement. As can be seen from Table 3, $av_j\left(IMR_{i_j}\right)$ differ substantially across states, ranging from 1.85 percent in 2004 in Mecklenburg-Western Pomerania to 17.65 percent in Schleswig-Holstein in 1998. They also change over time. These differences arise for two main reasons. The first reason is state-specific tax-back rates. The second reason is differences in the state-specific distributions of tax-relevant characteristics (especially taxable income) and thus in the marginal tax rates. Table 3 (columns 4-6) provides the state-wide averages of marginal tax rates.[18] Two patterns stand out. The first pattern is a decline in the averages of marginal tax rates over time. Most importantly, this decline is due to a lowering of the marginal tax rate of the top income bracket from 53 in 1998 to 45 percent in 2004. The second pattern is a difference in the period-specific

[17] The state- and period specific distributions of effective internalized marginal revenues (IMR_{i_j}) are provided in Figure A3a-c in the Appendix.

[18] Standard deviations of state-specific marginal tax rates can be found in Table A2 in the Appendix.

state-wide averages of the marginal tax rates: For example, in 1998 it ranges between 31.7 percent in Hamburg and 25.6 percent in Saxony-Anhalt.

Table 3 about here

Further descriptive statistics of FAST variables used in the following regression analyses are summarized in Table A2 in the Appendix. By year and state, the table provides means and standard deviations of the gross taxable income before any deductions, y_{i_j}, and total deductions defined as the difference between gross taxable income and the actual fixed tax base, Δ_{i_j}. All monetary amounts are expressed in 2004 prices. The table also gives the mean marginal tax rates and the number of weighted and non-weighted observations. Due to the factual anonymisation, information on the process of taxation and state of residency is incomplete for several tax units, particularly for very rich ones. These units had to be discarded from the database, leaving us with a pooled sample of roughly six million observations (two million per cross-section).

Gross taxable income before any deductions is the central micro-level conditioning variable in the empirical analysis. It has a profound impact on the level of deductions, and it is exogenous from the viewpoint of states' tax agents. Across the states, average gross taxable income is the highest for Baden-Wurttemberg and Hesse, and the lowest in Thuringia. Over time, average price adjusted gross taxable incomes varies little.

The central endogenous variable in the empirical analysis is granted tax deductions. Average granted deductions for tax units in 1998, for example, range between €5,466 (Brandenburg) and €7,186 (Baden-Wurttemberg). It is not necessarily true, however, that deductions are higher in richer than in poorer states. As an example, in 2004, average gross taxable income in Bavaria was about €1,500 lower than in Hesse, but average deductions in Bavaria were about €140 higher.

The process of granting an income tax deduction usually has non-discretionary and a discretionary elements. Non-discretionary in the sense that some amount of deduction is granted lump sum and based on automatisms following well-defined legal terms: Once a specific requirement is met (e.g., having a tax-relevant child or paying church taxes), the deduction is granted. This leaves little room for the taxmen to "steer" income tax burdens. The discretionary element is due to vague legal terms. This leaves the taxmen some discretion concerning the interpretation of the case-relevant facts and thus the level of granted deductions. For example, the level of expenses exceeding blanket allowances and qualified as deductible, despite some guidelines, is a decision ex aequo et bono of the auditing taxman.[19]

4.2 Aggregated state-level data

The basic idea of the state-level analysis is to explain the state-wide level of tax enforcement with state-specific tax incentives after controlling for a set of state characteristics. Tax enforcement is measured by an input variable: the staffing of tax administrations. This is defined as the number of income tax returns in a state divided by the number of full-time equivalent employees in the financial administration of the same state. The staffing of tax administrations is our proxy for the overall financial and human resources endowments of tax offices.

The incentive to tax is captured by two variables. The first variable is the state-specific tax-back rates, the $TBRs$. The second variable it the average rate of internalized marginal revenues, $av(IMR)$, as defined in Section 4.1. The set of state characteristics include real GDP per capita, the population density, and type of state (city-state [Hamburg, Bremen, and Berlin] vs. non-city-state).

Summary statistics on the staffing of tax administrations and the state characteristics are summarized in Table A1 in the Appendix. The staffing of tax administrations differs across states and varies over time. For example, in 1998 the ratio between the number of tax returns and full-time equivalent employees in the financial administration was about 226 in Lower Saxony compared with 110 and Bremen. Over time, the ratio increased: in 2004, it was 231 in Lower Saxony and 152 in Bremen. This is a common trend in all federal states. Real GDP per capita is much lower in Germany's new (former East Germany) federal states than in the old (West German) states. It is highest in Hamburg (about € 50,000 in 2004), and lowest in Thuringia (about € 19,000 in 1998). Over time, real GDP changes little. The population density is highest in Berlin (>3,800 inhabitants per square kilometer) and lowest in Mecklenburg-Western Pomerania (< 70 inhabitants per square kilometer), and exhibits some inter-temporal variation.

5 Econometric results

5.1 Analysis with state-level aggregates

[19] See Bönke et al. (2011) and references therein for details.

We start our analysis with a model using state-level aggregates in the spirit of studies such as Baretti et al (2002). The basic idea of these studies is to econometrically explain the state-wide level of tax enforcement by TBR, after controlling for other state-level variables. In particular, we measure tax enforcement by an input variable, the staffing of tax administrations: the state-wide number of income tax returns divided by the number of full-time equivalent employees in the financial administration. The smaller the ratio, so the argument, the better the endowment of the tax administrations, and the higher the enforcement level.

The state-level approach has two central weaknesses. First, economies of scale in tax administration are not well understood. In the presence of increasing returns to scale, highly populated states might enforce the tax law more effectively with the same staffing of tax administrations compared to less-populated states. Second, the approach does not control for differences in the distributions of individual IMRs across states (but uses a state-wide indicator). However, equation (8) indicates that the distribution of IMRs across a state's tax-payers matters for tax enforcement. For these two reasons, results from a state-level regression approach should be viewed only as a preliminary naïve attempt to study the incentives of Germany's federal system on the tax policies of the states.

We implement two state-level panel regressions. In both regressions, the dependent variable is the inter-temporal change in the staffing of tax administrations. As staffing will respond to changes in tax enforcement incentives with some delay, the inter-temporal change in staffing in state j is: $\Delta staffing_j = staffing_{j,2004} - staffing_{j,1998}$.[20] The definition of all the explanatory variables follows the same logic. Hence, the state-level regression is,

$$\Delta staffing_j = \beta_0 + \beta_1 \Delta INCENT_j + \beta_2 \Delta GDP_j + \beta_3 \Delta POP_j + \beta_4 CITY_j + \varepsilon_j. \qquad (9)$$

The change in tax enforcement incentives, $\Delta INCENT_j$, is measured alternatively as (a) change in tax-back rates, $\Delta TBR_j = TBR_{j,2004} - TBR_{j,1998}$ (specification S1.1); (b) change in average rate of internalized marginal revenues, $\Delta av_j\,(IMR) = av_{j,2004}\left(IMR_{i_j}\right) - av_{j,1998}\left(IMR_{i_j}\right)$ (specification S1.2). Our expectation is that β_1 is positive.

Control variables include the change in gross domestic product per capita, ΔGDP_j, the change in population density per square kilometer, ΔPOP_j, and a city-state dummy, $CITY$. We have included ΔGDP_j, because states whose gross domestic product increases relative to other states, in relative terms, increase their tax bases and the budget of their public sector. This should translate into a better staffing of the tax administrations. We have included ΔPOP_j for the reason

[20] The results for three-year differences support our findings from the six-year differences regarding the sign and magnitude of effects but are not significant at the 10 percent level.

that in states with a higher population density it is easier to achieve economies of scale and scope in tax administration. If $\Delta POP_j > 0$, the ratio of the number of income tax returns and full-time equivalent employees should increase. Last, with the distinction between city-states and no-city-states, we seek to control for the peculiar characteristics of these cities: high population densities, short commuting distances, and particular population characteristics (e.g., age structure, dependence on social welfare and unemployment, migration background).

The results of the two specifications are summarized in Table 4. In the first specification, the regression coefficient of ΔTBR carries the expected sign (a higher incentive for enforcing the tax law means that fewer taxpayers are audited per full-time employee in a state's financial administration). However, the coefficient is insignificant. One possible explanation provides the optimality condition (8): tax enforcement depends on the tax back rate together with the distribution of individual marginal tax rates. Accordingly, tax-back rates alone are not an ideal indicator of a state's incentive to enforce the tax law.[21] Specification S1.2 considers the interaction of tax back rates and individual marginal tax rates by averaging the IMRs of all taxpayers in a state. Here, the regression coefficient pertaining $\Delta av(IMR)$ carries the expected negative sign and is significant at a 10 percent level.

In sum, the results of the state-level approach do not reject our research hypothesis that higher internalized returns of taxation lead to higher tax enforcement activities at the state level. However, a state-level analysis misses the complexity of the condition (8): it is the distribution of IMRs over all the taxpayers in a state and not an average statistic that determines tax enforcement activities. Not controlling for differences in the distributions of the tax-relevant characteristics of the tax units in regression analysis could easily lead to spurious correlations. Considering the distributions of tax-relevant characteristics at the micro-level of tax units is thus crucial for estimating how fiscal equalization impacts tax enforcement activities of the states.[22] This can be best achieved by conducting a micro-level analysis at the tax unit level.

Table 4 about here

5.2 Micro-level analysis

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[21] This would to some extent explain the results in Baretti et al. (2002), who fail to find a robust link between the marginal rate of loss and the level of tax enforcement.

[22] Studies building on macro data instead proxy these and other issues with auxiliary variables such as an inequality index (e. g., Goodspeed, 2002).

On the micro level of the taxpayers, we perform two types of analysis. The first type rests on the observation that the state authorities' incentives to tax differ between states and vary over time. In a nutshell, in line with the equation (8) from the theoretical model, we set up a cross-sectional regression model with the level of tax enforcement, captured by the level of granted income tax deductions, as dependent variable, and incentives to tax, captured by the internalized marginal return, IMR, as the central explanatory variable. The second type is a treatment analysis. It rests on the observation that the incentives to tax, captured by TBR, exhibit little inter-temporal variation for most states but vary substantially in one state, namely Schleswig-Holstein. Since TBR is an exogenous variable from the viewpoint of the states, the setting can be interpreted as a natural experiment and the residents of Schleswig-Holstein form the treatment group.

5.2.1 Cross-sectional regressions

The micro-level regression analysis is conducted with OLS. The dependent variable is the natural logarithm of the amount of tax deductions granted to an individual tax unit, i. Suppressing period, and state-level subscripts, the OLS regression is:

$$\begin{aligned}\ln(\Delta_i) = {} & \alpha_0 + \boldsymbol{\beta}'\boldsymbol{Incentives_i} + \boldsymbol{\gamma}'\boldsymbol{Year} + \boldsymbol{\delta}'\boldsymbol{Char_i} + \boldsymbol{\theta}'\boldsymbol{Source_i} \\ & + \boldsymbol{\vartheta}'(\boldsymbol{Source_i} \cdot \boldsymbol{Year}') + \boldsymbol{\mu}'\boldsymbol{State} + \varepsilon_i\end{aligned} \tag{10}$$

The bold expressions denote vectors. Error terms are clustered at the state level to correct for spatial correlation of error terms across countries. $\boldsymbol{Incentives}$ includes a changing set of variables that mirror the tax enforcement incentives. Altogether four specifications are tested. In specification S2.1, $\boldsymbol{Incentives}$ comprises a single variable: the taxpayer-specific internalized marginal tax revenue, IMR. The specification thus complies with the optimality condition (8) from the theoretical model. According to the model, we should expect a negative regression coefficient: The higher the incentive to enforce the tax law, the lower the granted tax deductions should be. Of course, to isolate the effect of $\boldsymbol{Incentives}$ on granted tax deductions it is important to control for other potential determinants of granted tax deductions. To control for period effects, the vector $\boldsymbol{Year}$ includes two period dummies for 2001 and 2004. $\boldsymbol{Char}$ comprises the characteristics of the tax unit: the number of tax-relevant children, age, marital status and church membership. $\boldsymbol{Source}$ is a vector of seven dummies. Each dummy indicates whether the tax unit earned income from a particular income source. This is because the German income tax law distinguishes among seven different income sources, and for each, there are particular regulations. A dummy is one if the taxpayer has some positive income from the particular income source; otherwise it is zero. To capture changes in the tax law, we interact the income source dummies with the two period dummies for 2001 and 2004. Finally, the vector $\boldsymbol{State}$ comprises fifteen state dummies (base category is Baden-Wuerttemberg).[23]

We perform three tests for the specification of the incentive variable, $\boldsymbol{Incentives}$. First, in specification, S2.2, $\boldsymbol{Incentives}$ is comprised of two variables: IMR and the marginal tax rates of each taxpayer. This specification tests for the role of IMR after controlling for individual marginal tax rates. Second, in specifications S2.3, $\boldsymbol{Incentives}$ solely includes the state-specific TBRs. Hence, S2.3 can be seen as the complement to the state-level approach in Section 5.1 (Table 4, S.1.1). Third, in specification S2.4 $\boldsymbol{Incentives}$ decomposes the IMR into the TBR and the individual marginal tax rate. Specification 2.4 is thus the most flexible specification, allowing TBR and marginal tax rates to having distinct effects on the level of granted tax deductions.

Results from the four OLS regressions are summarized in Table 5. All four regression specifications tell the same consistent story: the higher the incentive to enforce the tax law, the lower the level of granted tax deductions is (controlling for all other aforementioned covariates). According to specification S2.1 the regression coefficient for IMR equals -1.227. Assuming that average granted deduction amount to €6,000 (see Table A2), the coefficient indicates that raising the internalized tax revenue (IMR) by five percentage points lowers granted tax deduction by €360. According to specification S2.2, this inverse relationship between IMR and tax deductions is confirmed even after additionally controlling for individual marginal tax rates. Specifications S2.3 and S2.4 show that both components of the IMR, TBR and marginal tax rates, matter for granted tax deductions, and that for both components the inverse relationship is again confirmed.

Table 5 about here

5.2.2 Treatment analysis

The treatment analysis exploits the fact that incentives to tax change very little in most states but markedly in one state, Schleswig-Holstein. In this state, TBR was atypically high in 1998 (of about 57 percent). Later it dropped to a usual level of about 12 percent in 2001 and 2004. Since TBR is exogenous for the state authorities, this can be used as a natural experiment in which the residents in Schleswig-Holstein form the treatment group and residents of other states with a similar TBR to Schleswig-Holstein in 1998/2001 form the control group.

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[23] Most importantly, the state dummies control for unobserved state effects on dependent variable. For example the level of deductions may vary across states simply because of the composition of the state.

The econometric device to isolate the effect of the treatment is a difference-in-differences estimator (DiD). The DiD estimator is the difference between two differences: the difference in tax deductions before and after treatment among the treated, and the same difference among the controls. The control group should be composed of tax units resident in states with an inter-temporally stable TBR with tax-relevant characteristics similar to the treated. The treatment in Schleswig-Holstein should lower the state's incentive to tax because it lowers the share of a marginal tax euro that can be internalized. Accordingly, the DiD estimator should carry a positive sign.

To establish experimental conditions, it is important to find adequate control states. By adequate, we mean that the TBR in the control states is constant over time and similar to that experienced by the treated state after treatment. Further, it is important that the tax units of the treatment and control states are comparable in terms of marginal tax returns. Otherwise, a uniform TBR does not guarantee an identical incentive to tax (see equation (8) in the model).

As can be seen from Table 2, adequate control states are Lower Saxony and Rhineland Palatinate. To achieve comparability of tax units and to isolate the effect of TBR, we restrict our control and treatment groups to tax units in the top income bracket ($y_i > 60.000$ respectively $y_i > 120.000$ for joint filers). This restriction further ensures that a fundamental change in the income tax tariff between 1998 and 2004 does not artificially alter the distributions of marginal tax rates within each state and prohibits us from constructing the appropriate treatment and control samples.[24]

Suppressing individual, period, and state-level subscripts, we estimate the DiD for 1998/2001 using OLS,

$$\ln(\Delta) = \alpha_0 + \boldsymbol{\beta}'\boldsymbol{Treat} + \boldsymbol{\gamma}'\boldsymbol{Year} + \boldsymbol{\delta}'\boldsymbol{Char} + \boldsymbol{\theta}'\boldsymbol{Source} + \boldsymbol{\mu}'\boldsymbol{State} + \varepsilon \qquad (11)$$

The notation is the same as in equation (8). The variable $\boldsymbol{Treat}$ is a dummy. The dummy is zero for all observations in 1998. For 2001, it is zero for residents of the control states and one for the residents of Schleswig Holstein.

We performed three types of robustness checks. First, to test whether the DiD is not just picking up a time effect, we ran the DiD again for Schleswig-Holstein for the period 2001/4 when its TBR was constant. Presumably we should find no effect. Second, we performed pseudo-treatments as a quasi-falsification test. Pseudo-treated states are states with a constant TBR. For these states we ran the DiD against other states with a constant and similar TBR. The main goal of the two tests is to rule out other state specific confounding policies that occur at the same

[24] Between 1998 and 2004, the top marginal tax rate was lowered from 53 to 45 percent. This, however, should be captured by a common time trend and poses no problem.

time as the TBR change. Finally, we ran all the DiD models after having reproduced the tax characteristics of the treated in the control groups with statistical matching. Because our analysis relies on repeated cross-sections, we implemented the statistical matching across three groups: the treated and the non-treated in the initial period before treatment, and the non-treated after treatment (Blundell and Costa-Dias, 2008, p. 58). Further information on the statistical matching and additional robustness checks can be found in Appendix, Section 2.

Table 6 about here

All the difference-in-differences estimators are summarized in Table 6. Altogether, the Table comprises six panels. In each panel, we report, from left to right, four estimators: the first two estimators relate to the period 1998/2001 from OLS and OLS after matching. The last two estimators relate to the period 2001/4.

Results for Schleswig-Holstein appear in the first panel. For the period 1998/2001, we find a positive and significant treatment effect both for OLS and OLS after matching that meets the prediction of our theoretical model: The drop in Schleswig Holstein's TBR from 57.05 to 12.15 percent lowered the incentives to tax, and this implies a higher level of granted tax deductions. The average treatment effect of the treated (att) amounts to € 205 for the simple OLS and to €410 for OLS after matching. Alone for the rich tax payers in Schleswig Holstein, the results from OLS/match indicate forgone tax revenues of 10.2 million Euro. The difference in the estimates is due to the higher average gross income of residents in the control states before matching (see Table A3a). For the period 2001/4 when Schleswig-Holstein's TBR remained stable, we find no significant effect. This can be viewed as supporting evidence that the DiD is not just picking up a time effect.

Results for the marginal treatment (Bavaria) and the pseudo-treatments are assembled in panels 2-6. In panel 2, we provide the treatment effects for the constellation Bavaria against the control states Baden-Wurttemberg and Hesse. Bavaria's TBR drops slightly by about four percentage points between 1998 and 2001 and hardly differs between 2001 and 2004. Like Bavaria, both controls are net-contributor non-city-states. Their TBR is constant over time, and comparable with Bavaria's TBR in 2001/4. Hence, we should expect a mild positive treatment effect between 1998/2001 and no effect between 2001/4. The results for 1998/2001 meet the expectation: the average treatment effect of the treated is €140 / €222 for the simple OLS / OLS after matching, amounting to 35.7 million Euro at the state level. In quantitative terms, the per capita effect is about half the size of the 1998/2001 effect for Schleswig Holstein. The results for 2001/2004, contrary to our expectations, indicate a negative treatment effect. However, it is small in quantitative terms and insignificant at the one percent level.

In panels 3-6, we provide results for four further pseudo treatments. In all the constellations both the pseudo-treated state and the control states have a similar TBR. Further, it is guaranteed that the TBRs exhibit very little inter-temporal variation. The first constellation is Brandenburg, one of Germany's "new" states, against the "new" states of Mecklenburg-Western Pomerania, Saxony-Anhalt, and Thuringia. In the three subsequent constellations we assigned Brandenburg to the control states and always changed the status of one control state from control to treated. For all constellations, TBR remained stable, we expect to find no significant effect. Indeed, 10 out of the 16 treatment effects are insignificant. If Mecklenburg-Western Pomerania or Thuringia has the status of being treated, none of the effects is significant at the five percent level. Only for the constellation with Brandenburg as pseudo-treated state, are the results at odds with our expectations: Here we find sizeable and significant positive treatment effects. Only possible explanation is Brandenburg's proximity to Berlin: in contrast to the other considered "new" states that experienced a substantial inter-temporal decline in their populations, Brandenburg's population remained stable overall (see Table A1). In the same time, the staffing of Brandenburg's tax administrations deteriorated, also in comparison with the other "new" states under consideration: As can be seen from Table A1 in the Appendix, the ratio full-time employees in the tax administration to the total number of income tax returns rose from 172 in 1998 to 247 in 2004. It is not unlikely that this decline in staffing is driving the positive treatment effect for Brandenburg.

In sum, our empirical analysis suggests that a uniform income tax law de jure does not necessarily guarantee uniform enforcement of the law de facto. In Germany, it is the federal states that are responsible for the enforcement of the law. Our analysis reveals that the enforcement of the law, as measured by the level of income tax deductions granted, differs across states. The design of Germany's federal system offers a reasonable explanation. The system implies substantial differences in the state-specific marginal tax-back rates. As a result, some states can internalize a larger share of an additional tax euro than others, i.e., incentive to tax differ between states. The pooled cross-sectional regressions revealed that the level of granted tax deductions hinges on the share of tax revenue a state can internalize. The treatment analysis reveals that the states adjust the administration of the income tax to changes in TBR. Our prototype case, Schleswig-Holstein, experienced a substantial decrease in its TBR.

Compared with the control states, this decrease translated into a significant increase in the level of granted income tax deductions.[25]

6 Conclusion

In many federations, fiscal equalization schemes have been created to mitigate fiscal imbalances across the member states. Various theoretical works have investigated the incentives of such cooperative systems. However, so far only a few studies have addressed the research question of the present paper: whether fiscal equalization affect the enforcement of a uniform tax by state governments.

By means of a stylized model, we show that state authorities have incentives to align the effective tax rates of their residents to the internalized marginal returns from taxation. We empirically test the model using two approaches: regression analysis and a natural experimental design, and our estimates support the model's prediction: states with a higher internalized share of marginal tax revenues exploit the tax bases to a higher extent via the instrument of granting lower tax deductions.

From the viewpoint of a single state it is rational to align tax enforcement activities with the fraction of additional tax revenue that the state internalizes. However, the alignment causes fiscal externalities, and these imply that state-specific tax enforcement activities are inefficient (too low) from the viewpoint of the overall economy. Further, differences in enforcement activity across the states violate the principle of equal treatment of equals, undermining the tax morality of taxpayers.

In principle, such problems can be rectified by shifting the tax enforcement responsibility to a central tax agency. Indeed, several initiatives in this direction have been made in Germany in recent years. For example, in 2007 a commission of German experts on federalism ("*Föderalismuskommission II*") discussed the installation of such an agency. In the past, however, such initiatives have always been abandoned, or failed due to the resistance of German states.

[25] It would be interesting to complement our micro econometric analysis with alternative measures of enforcement, i.e., the probability of audits, the level fines applied to taxpayers, or the difference between declared and granted tax deductions. However, the data do not offer the requested information.

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Table 1. Germany's fiscal equalization system

	Stage 1	**Stage 2**	**Stage 3**	**Stage 4**
Type	Revenue sharing	VAT distribution	Horizontal equalization payments	Supplementary federal grants
Instrument	Revenue sharing of joint taxes (income, corporation, VAT) according to fixed division rules	Distribution of VAT revenue amongst the states	Transfers from financially strong states (above average joint-tax-revenues) to financially weak ones (below average)	Transfers from the federal government to states whose fiscal revenue is still below average
Fiscal effect	Fixed rate of loss for provinces, e.g. 42.5% for income tax revenue, i.e. they keep 57.5% of income tax revenue.	All states receive at least 92% of average (per capita) tax revenue	All states receive at least 95% of average (per capita) fiscal revenue	All states receive at least 99.5% of average (per capita) fiscal revenue

Note. In addition to stage 1 to 4 some provinces receive special need grants that are paid lump-sum.

Table 2. Tax back rates

		TBR (in %)		
State	**Acronym**	**1998**	**2001**	**2004**
Baden-Wurttemberg	BW	21.12	21.98	22.45
Bavaria	BV	26.59	22.34	23.37
Berlin	BE	10.19	10.16	10.16
Brandenburg	BB	9.02	9.03	9.01
Bremen	HB	8.39	8.38	8.38
Hamburg	HH	8.80	8.50	17.08
Hesse	HE	19.20	20.08	19.41
Lower Saxony	NI	14.97	12.19	12.83
Mecklenburg-Western Pomerania	MV	8.56	8.54	8.51
North Rhine-Westphalia	NW	29.07	29.63	29.46
Rhineland-Palatine	RP	12.84	12.83	12.84
Saarland	SL	8.14	8.13	8.12
Saxony	SN	10.17	10.1	10.04
Saxony-Anhalt	ST	9.09	9.03	8.97
Schleswig-Holstein	SH	57.05	12.15	12.16
Thuringia	TH	8.96	8.92	8.89

Note. Own calculations.

Table 3. Average state level internalized marginal tax revenues

State	Acronym	$av_j(IMR_{i_j})$ (in %) 1998	2001	2004	$av\left(\frac{\partial t_{i_j}(\cdot)}{\partial \Delta_{i_j}}\right)$ (in %) 1998	2001	2004
Baden-Wurttemberg	BW	6.66	6.18	6.09	31.5	28.1	27.1
Bavaria	BV	8.21	6.16	6.19	30.9	27.5	26.4
Berlin	BE	3.13	2.74	2.54	30.8	26.8	24.9
Brandenburg	BB	2.44	2.12	2.06	26.9	23.4	22.9
Bremen	HB	2.57	2.25	2.13	30.5	26.8	24.5
Hamburg	HH	2.81	2.40	4.57	31.7	28.0	26.6
Hesse	HE	6.03	5.63	5.20	31.3	28.0	26.7
Mecklenburg-Western Pomerania	MV	2.24	1.92	1.85	26.0	22.5	21.5
Lower Saxony	NI	4.49	3.26	3.33	30.1	26.7	25.8
North Rhine-Westphalia	NW	9.03	8.17	7.81	31.0	27.5	26.5
Rhineland-Palatine	RP	3.93	3.49	3.37	30.7	27.0	26.1
Saarland	SL	2.46	2.20	2.12	30.3	26.9	25.6
Saxony	SN	2.66	2.26	2.17	26.2	22.2	21.7
Saxony-Anhalt	ST	2.35	2.01	1.95	25.6	22.1	21.6
Schleswig-Holstein	SH	17.65	3.32	3.18	31.0	27.3	26.1
Thuringia	TH	2.32	2.00	1.95	25.8	22.4	21.8

Note. The average marginal tax revenue is calculated as the state specific average marginal tax rate multiplied with one minus the state's tax back rate. Standard deviations for average marginal tax rates are provided in Table A2. Own calculations.

Table 4. State level regression

Specification	S1.1		S1.2	
Dependent variable: $\Delta staffing$				
ΔTBR	-71.323	(42.290)		
$\Delta av(IMR)$			-244.987*	(136.323)
ΔGDP	0.012**	(0.004)	0.012**	(0.004)
ΔPop	0.071	(0.324)	0.047	(0.320)
$City$	33.265**	(11.857)	33.975**	(11.766)
$Constant$	46.673***	(7.142)	44.614***	(7.571)
R^2	0.382		0.399	
F statistic	3.318		3.487	
Observations	16		16	

Note. Ordinary least squares regression, standard errors in parentheses. Levels of significance: * 10%, ** 5%, *** 1%. All variables denoted with Δ are calculated as difference between 1998 and 2004. Underlying values for the variables are provided in Table 2 (ΔTBR), Table 3 ($\Delta av(IMR)$) and Table A1 ($\Delta staffing$: difference in relative staffing; ΔGDP: difference in per capita GDP; ΔPop: difference in population density) in the Appendix. *Data.* Federal Statistical Office, Income Tax Statistics, Own Calculation.

Table 5. Regression results

Specification	**S2.1**		**S2.2**		**S2.3**		**S2.4**	
Dependent variable: $ln(\Delta_i)$								
Incentives								
IMR	-1.227***	(0.015)	-0.167***	(0.017)				
TBR					-0.036***	(0.007)	-0.033***	(0.007)
$\partial t_i/\partial\Delta_i$			-0.798***	(0.006)			-0.827***	(0.006)
Year								
$year_{2001}$	-0.100***	(0.003)	-0.113***	(0.003)	-0.089***	(0.003)	-0.113***	(0.003)
$year_{2004}$	-0.293***	(0.003)	-0.312***	(0.003)	-0.283***	(0.003)	-0.312***	(0.003)
Char								
$ln(y_i)$	0.624***	(0.001)	0.709***	(0.001)	0.593***	(0.000)	0.709***	(0.001)
$children$	0.255***	(0.000)	0.256***	(0.000)	0.256***	(0.000)	0.256***	(0.000)
age	0.103***	(0.000)	0.103***	(0.000)	0.103***	(0.000)	0.103***	(0.000)
$married$	0.131***	(0.001)	0.074***	(0.001)	0.073***	(0.001)	0.073***	(0.001)
$church$	0.138***	(0.001)	0.140***	(0.001)	0.139***	(0.001)	0.139***	(0.001)
Source								
$agriculture/forestry$	0.549***	(0.003)	0.544***	(0.003)	0.547***	(0.003)	0.544***	(0.003)
$business$	0.181***	(0.002)	0.184***	(0.002)	0.178***	(0.002)	0.183***	(0.002)
$self\ employment$	0.250***	(0.002)	0.256***	(0.002)	0.245***	(0.002)	0.256***	(0.002)
$employment$	0.134***	(0.002)	0.139***	(0.002)	0.131***	(0.002)	0.139***	(0.002)
$investment$	0.161***	(0.002)	0.165***	(0.002)	0.155***	(0.002)	0.165***	(0.002)
$rent/lease$	0.089***	(0.002)	0.091***	(0.002)	0.085***	(0.002)	0.090***	(0.002)
$other$	0.208***	(0.002)	0.198***	(0.002)	0.214***	(0.002)	0.198***	(0.002)
$\boldsymbol{Source} \cdot year_{2001}$								
$agriculture/forestry$	-0.061***	(0.004)	-0.055***	(0.004)	-0.051***	(0.004)	-0.054***	(0.004)
$business$	0.016***	(0.002)	0.013***	(0.002)	0.020***	(0.002)	0.013***	(0.002)
$self\ employment$	-0.020***	(0.003)	-0.022***	(0.003)	-0.014***	(0.003)	-0.022***	(0.003)
$employment$	-0.072***	(0.002)	-0.076***	(0.002)	-0.067***	(0.002)	-0.075***	(0.002)
$investment$	-0.089***	(0.002)	-0.089***	(0.002)	-0.084***	(0.002)	-0.089***	(0.002)
$rent/lease$	-0.021***	(0.002)	-0.018***	(0.002)	-0.017***	(0.002)	-0.018***	(0.002)
$other$	0.077***	(0.002)	0.074***	(0.002)	0.075***	(0.002)	0.074***	(0.002)
$\boldsymbol{Source} \cdot year_{2004}$								
$agriculture/forestry$	0.005	(0.004)	0.010**	(0.004)	0.015***	(0.004)	0.011**	(0.004)
$business$	-0.041***	(0.002)	-0.047***	(0.002)	-0.036***	(0.003)	-0.046***	(0.002)
$self\ employment$	0.006**	(0.003)	-0.002	(0.003)	0.013***	(0.003)	-0.001	(0.003)
$employment$	0.043***	(0.003)	0.036***	(0.003)	0.048***	(0.003)	0.037***	(0.003)
$investment$	-0.049***	(0.003)	-0.053***	(0.003)	-0.042***	(0.003)	-0.052***	(0.003)
$rent/lease$	0.037***	(0.002)	0.038***	(0.002)	0.041***	(0.002)	0.039***	(0.002)
$other$	0.170***	(0.002)	0.167***	(0.002)	0.169***	(0.002)	0.167***	(0.002)
State								
SH	-0.024***	(0.002)	-0.047***	(0.002)	-0.047***	(0.002)	-0.049***	(0.002)
HH	-0.127***	(0.002)	-0.095***	(0.002)	-0.092***	(0.002)	-0.093***	(0.002)
NI	-0.123***	(0.002)	-0.100***	(0.002)	-0.095***	(0.002)	-0.098***	(0.002)
HB	-0.138***	(0.003)	-0.103***	(0.003)	-0.100***	(0.003)	-0.102***	(0.003)
NW	-0.069***	(0.001)	-0.094***	(0.001)	-0.095***	(0.001)	-0.096***	(0.001)
HE	-0.064***	(0.002)	-0.057***	(0.002)	-0.056***	(0.002)	-0.057***	(0.002)
RP	-0.075***	(0.002)	-0.050***	(0.002)	-0.047***	(0.002)	-0.048***	(0.002)
BY	0.023***	(0.001)	0.014***	(0.001)	0.015***	(0.001)	0.014***	(0.001)
SL	-0.100***	(0.002)	-0.066***	(0.003)	-0.061***	(0.003)	-0.064***	(0.003)
BE	-0.150***	(0.002)	-0.120***	(0.002)	-0.116***	(0.002)	-0.118***	(0.002)
BB	-0.061***	(0.002)	-0.033***	(0.002)	-0.027***	(0.002)	-0.032***	(0.002)
MV	-0.034***	(0.002)	-0.005**	(0.002)	0.001	(0.002)	-0.005**	(0.002)
SN	0.012***	(0.002)	0.038***	(0.002)	0.044***	(0.002)	0.038***	(0.002)
ST	-0.056***	(0.002)	-0.029***	(0.002)	-0.023***	(0.002)	-0.029***	(0.002)
TH	0.023***	(0.002)	0.050***	(0.002)	0.057***	(0.002)	0.051***	(0.002)
$Constant$	1.324***	(0.005)	0.670***	(0.007)	1.555***	(0.005)	0.643***	(0.009)
R^2	0.559		0.561		0.559		0.561	
F statistic	186,735.8		185,765.7		185,068.3		185,713.8	
Observations	5,990,667		5,990,667		5,990,667		5,990,667	

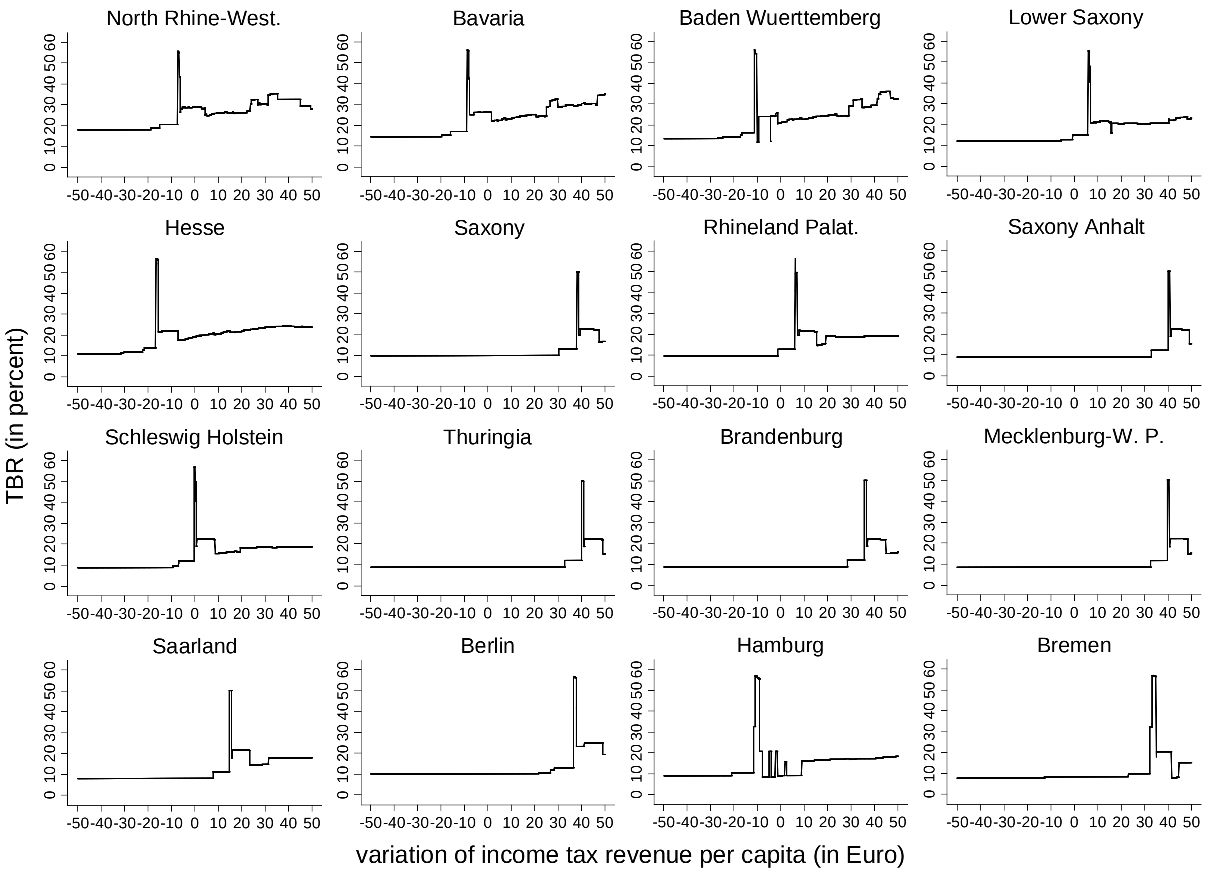
Note. Robust standard errors in parentheses. Levels of significance: * 10%, ** 5%, *** 1%. *Data.* FAST 1998-2004.

Table 6. Average treatment effects of the treated (att)

State (treatment group)	Control group	Treatment period 1998/2001 OLS	1998/2001 OLS/ matching	2001/2004 OLS	2001/2004 OLS/ matching
Schleswig-Holstein	Lower Saxony, Rhineland-Palat.	209.459**	409.685***	-82.389	-15.384
		(85.020)	(79.945)	(79.045)	(76.472)
Bavaria	Baden-Württemberg, Hesse	139.813***	222.343***	-86.632**	-96.922**
		(49.252)	(49.048)	(42.955)	(43.940)
Brandenburg	Mecklenburg-W. P., Saxony-Anhalt, Thuringia	210.793	451.118***	406.548***	419.492***
		(132.827)	(130.216)	(112.565)	(115.004)
Mecklenburg-W-.P.	Brandenburg, Saxony-Anhalt, Thuringia	84.538	95.965	20.965	-129.173
		(161.644)	(143.197)	(137.476)	(127.823)
Saxony-Anhalt	Brandenburg, Mecklenburg-W. P., Thuringia	-91.039	-92.951	-468.984***	-225.731*
		(145.368)	(134.628)	(122.358)	(116.847)
Thuringia	Brandenburg, Mecklenburg-W. P., Saxony-Anhalt	-292.879*	-72.719	-16.913	-46.843
		(152.654)	(137.851)	(127.367)	(122.790)

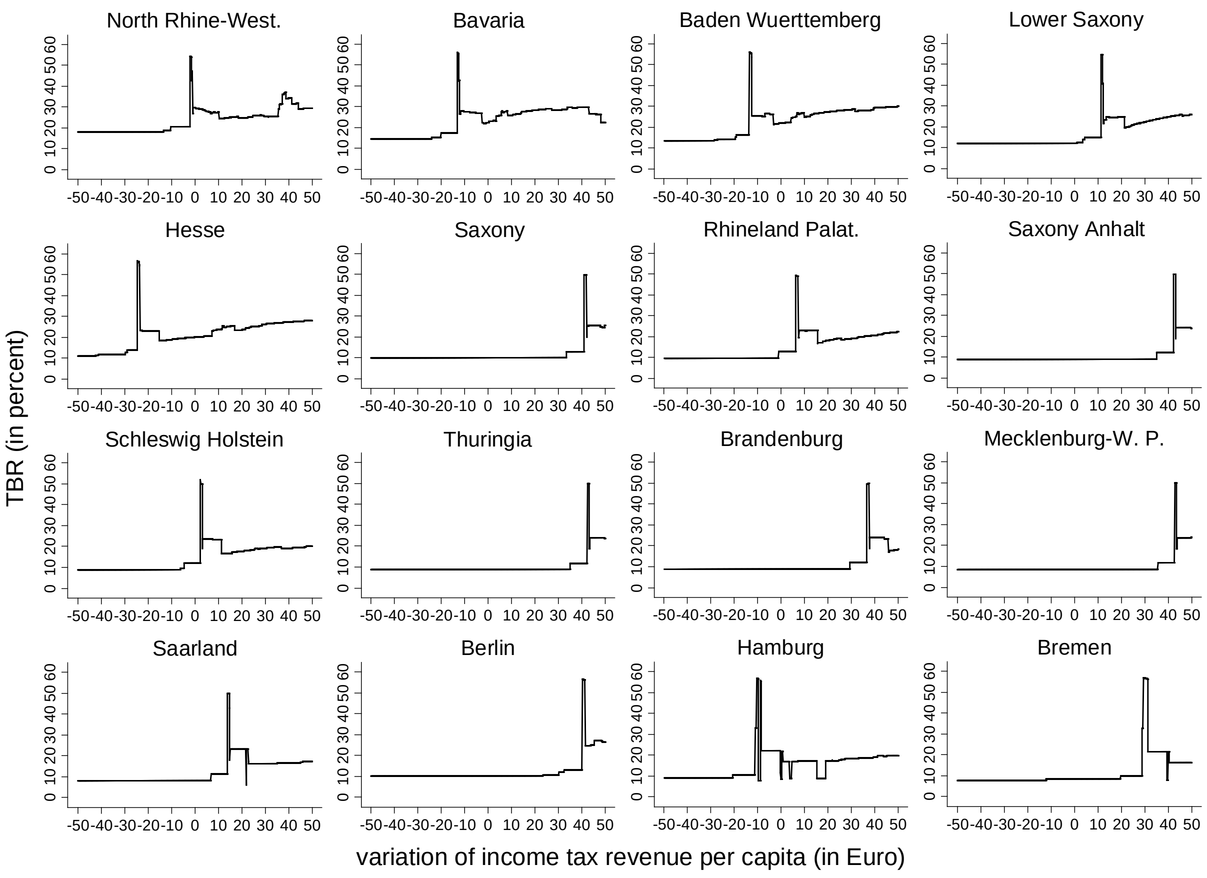
Note. Levels of significance: * 10%, ** 5%, *** 1%, robust standard errors in parentheses. Control groups are subject to similar a TBR experienced by the treatment group after treatment. Sample consists of "rich" tax units with gross taxable income in the top income bracket ($y_i > 60.000$ respectively $y_i > 120.000$ for joint filers) only. Full regression results provided in Tables A4a-f in Appendix Section 3. *Data*. FAST 1998-2004.

Figure 1a. Tax-back rate and income tax revenue, 1998



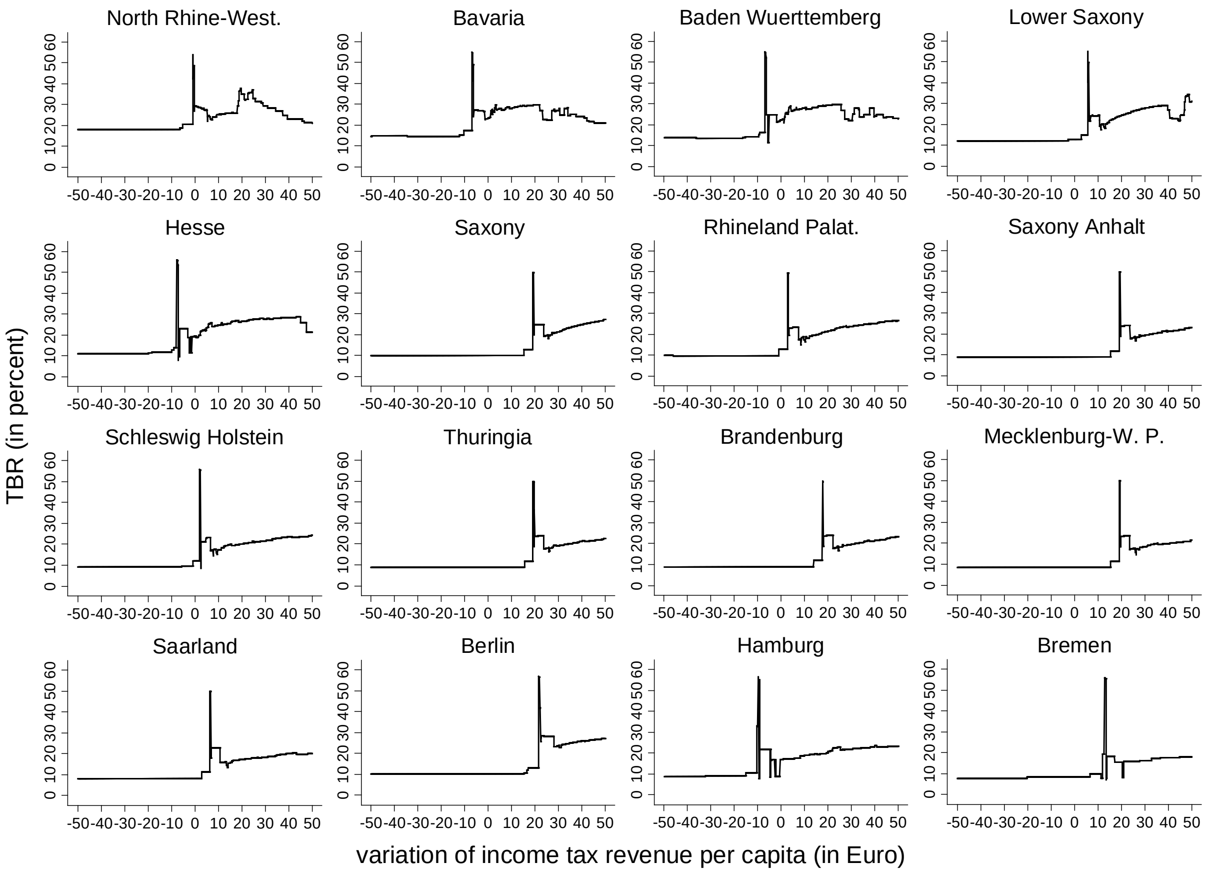
Note: authors' calculations.

Figure 1b. Tax-back rate and income tax revenue, 2001



Note: authors' calculations.

Figure 1c. Tax-back rate and income tax revenue, 2004



Note: authors' calculations.

Fiscal federalism and tax enforcement

Appendix/ Supplementary Materials

The Appendix is subdivided into four sections. The first section provides information on the data: The second section provides information on the statistical matching procedure and the quality of the matching. The third section provides details on the DID regressions provided in Section 5 of the main body of the paper. The fourth section provides details on the accounting model of the German fiscal-equalization system used for the derivation of the marginal tax-back rates.

Section 1: Information on the data

Our empirical analysis relies on two types of data: aggregated state-level data and micro data on income tax units. Our state-level data comes from the Federal Statistical Office. Table A1 provides the state-level indicators entering into the state-level regressions (Section 5.1): the number of income tax returns divided by the number of full-time equivalent employees in a state's financial administration (staffing of financial administration); per capita GDP in 2004 prices; the population density per square kilometer.

Table A1. State-level indicators

State	Staffing of financial administration			Per capita GDP			Population density (per km^2)		
	1998	2001	2004	1998	2001	2004	1998	2001	2004
BW	208.76	232.11	284.07	32,023	33,406	32,805	291.62	296.51	299.77
BY	222.51	243.83	285.19	32,767	34,290	34,631	171.32	174.76	176.38
BE	110.51	120.63	152.22	27,171	26,569	25,178	3828.80	3817.09	3816.41
BB	172.05	188.95	246.748	19,288	20,273	20,667	87.86	87.95	87.09
HB	109.86	174.47	240.40	37,908	39,421	40,197	1593.28	1573.44	1581.94
HH	105.92	143.14	187.02	48,985	50,646	50,171	2251.30	2286.09	2297.30
HE	210.79	245.35	287.79	34,006	35,672	35,873	285.82	287.84	288.79
MV	164.04	179.73	230.15	19,189	19,931	20,344	77.56	75.89	74.15
NI	226.13	230.89	280.30	26,009	26,151	25,707	165.20	167.11	168.04
NW	213.12	227.86	275.25	29,212	29,274	29,364	527.26	529.51	530.19
RP	210.64	226.17	258.88	25,653	25,729	26,174	202.73	203.94	204.55
SR	188.18	170.46	237.93	26,275	26,983	27,743	418.19	415.17	411.26
SN	156.55	184.92	230.43	19,561	20,381	21,896	243.73	238.02	233.25
ST	182.47	191.38	222.32	18,726	19,511	20,775	130.78	126.19	121.98
SH	221.51	227.03	292.33	26,832	27,121	26,229	175.07	177.49	179.04
TH	157.60	177.55	222.87	18,610	19,771	20,830	152.28	149.10	145.63

Note. Data from German's *Federal Statistical Office*. See Table 3 for the definition of the state acronyms.

Our micro data base is the German Factually Anonymous Income Tax Statistic (*Faktisch anonymisierte Lohn- und Einkommensteuerstatistik*, FAST), a stratified 10 percent random sample of the Income Tax Statistic (*Lohn- und Einkommensteuerstatistik*). It is an administrative database provided by the Federal Statistical Office, available for the assessment years 1998, 2001, and 2004.

Table A2 provides non-weighted sample statistics of the FAST tax units entering the cross-sectional analysis in Section 5.2.1. For every federal state and period, the table provides the number of observations and descriptive statistics (mean, standard deviations) of three central variables of our empirical analysis: gross taxable income, granted tax deductions, and marginal tax rate.

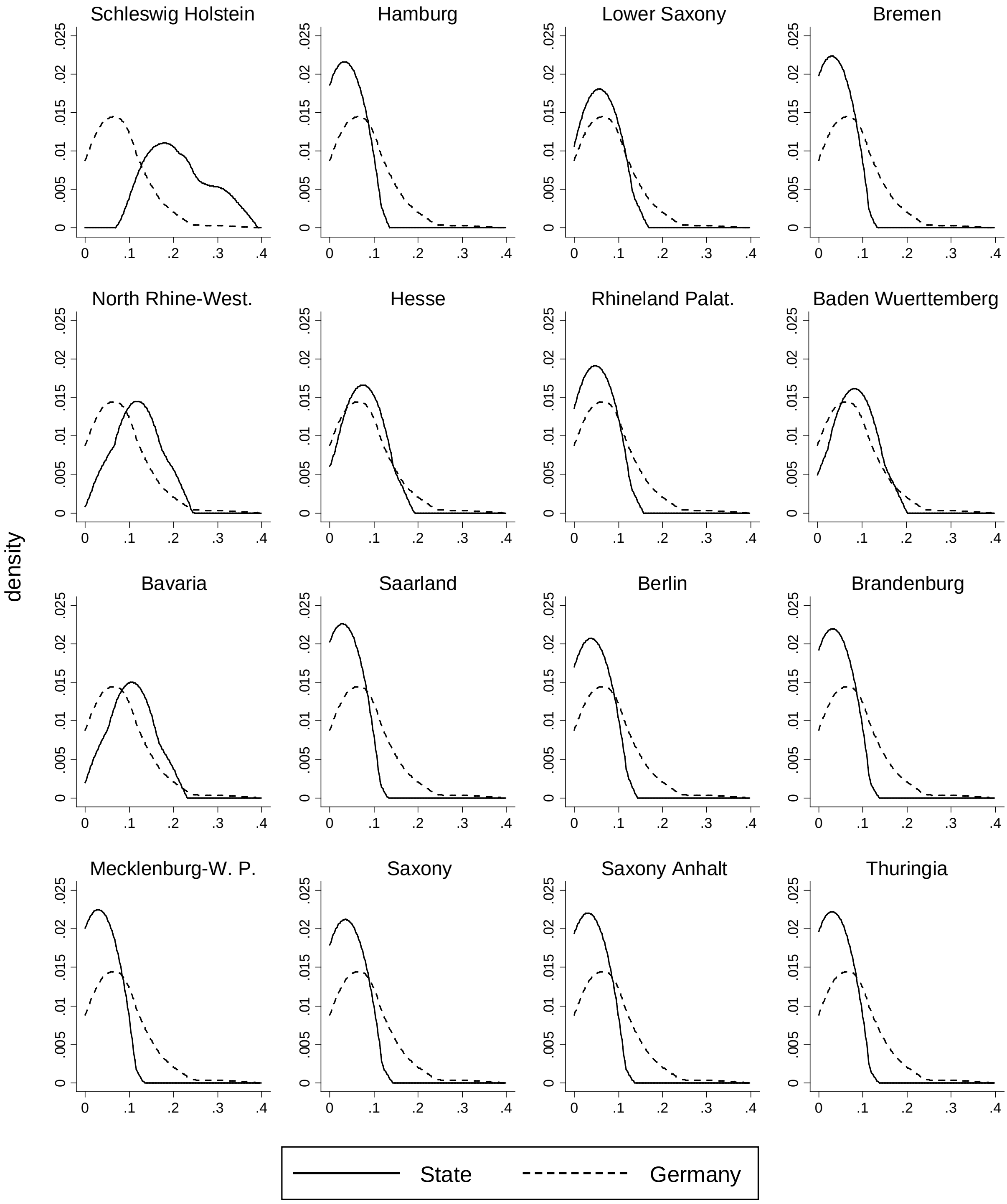
Table A2. Sample statistics

State j	Gross taxable income $av_j\left(y_{i_j}\right)$			Tax deductions $av_j\left(\Delta_{i_j}\right)$			Marginal tax rate $av_j\left(\partial t_{i_j}/\partial\Delta_{i_j}\right)$			Number of observations I_j		
	1998	**2001**	**2004**	**1998**	**2001**	**2004**	**1998**	**2001**	**2004**	**1998**	**2001**	**2004**
SH	34,344	34,606	34,367	6,163	5,440	5,472	0.310	0.273	0.261	878,828	903,132	854,272
	(25,390)	(26,147)	(25,316)	(9,739)	(8,094)	(7,622)	(0.125)	(0.118)	(0.119)	(110,474)	(107,632)	(77,594)
HH	34,651	35,167	34,510	5,836	5,443	5,397	0.317	0.280	0.266	548,603	570,559	528,053
	(28,227)	(28,838)	(27,568)	(11,916)	(9,398)	(9,350)	(0.142)	(0.132)	(0.132)	(91,902)	(90,759)	(65,226)
NI	32,976	33,800	33,705	5,927	5,361	5,283	0.301	0.267	0.258	2,474,700	2,479,352	2,337,241
	(25,182)	(25,263)	(24,375)	(10,746)	(7,689)	(7,097)	(0.129)	(0.120)	(0.118)	(191,631)	(192,710)	(135,470)
HB	32,383	32,944	30,847	5,615	5,087	4,809	0.305	0.268	0.245	178,317	191,403	181,383
	(24,402)	(25,489)	(24,341)	(8,137)	(7,278)	(7,108)	(0.135)	(0.127)	(0.131)	(46,499)	(44,400)	(32,636)
NW	34,687	35,382	35,148	6,074	5,484	5,479	0.310	0.275	0.265	5,679,807	5,689,523	5,380,788
	(25,658)	(26,321)	(25,358)	(10,053)	(7,816)	(7,173)	(0.129)	(0.121)	(0.120)	(299,115)	(335,094)	(255,416)
HE	35,623	36,817	36,124	6,619	5,877	5,775	0.313	0.280	0.267	1,992,821	2,033,802	1,950,343
	(27,509)	(28,236)	(27,095)	(11,646)	(8,694)	(8,216)	(0.137)	(0.126)	(0.126)	(180,180)	(194,493)	(143,737)
RP	33,920	34,340	34,188	6,254	5,521	5,383	0.307	0.270	0.261	1,271,695	1,315,679	1,266,083
	(24,488)	(25,336)	(24,449)	(9,090)	(7,528)	(6,884)	(0.125)	(0.118)	(0.118)	(132,092)	(130,962)	(95,025)
BW	36,100	36,986	36,614	7,186	6,241	6,036	0.315	0.281	0.271	3,400,128	3,551,120	3,435,706
	(26,851)	(27,235)	(26,225)	(11,493)	(8,475)	(7,281)	(0.133)	(0.123)	(0.123)	(230,061)	(250,835)	(194,084)
BY	34,184	35,141	34,691	6,976	6,147	5,913	0.309	0.275	0.264	4,274,891	4,407,231	4,243,803
	(26,330)	(27,151)	(25,837)	(11,280)	(9,052)	(7,982)	(0.131)	(0.123)	(0.122)	(262,694)	(290,241)	(219,380)
SL	32,785	33,343	32,848	5,859	5,175	4,964	0.303	0.269	0.256	299,006	318,922	311,526
	(22,432)	(23,983)	(23,357)	(7,077)	(6,770)	(6,301)	(0.123)	(0.118)	(0.120)	(59,284)	(57,246)	(39,514)
BE	33,252	32,860	31,400	5,657	5,065	4,947	0.308	0.268	0.249	958,551	953,737	908,772
	(26,740)	(26,767)	(26,054)	(11,508)	(8,354)	(9,094)	(0.140)	(0.133)	(0.135)	(124,825)	(123,849)	(86,642)
BB	27,985	28,466	29,156	5,466	4,650	4,246	0.269	0.234	0.229	742,139	734,397	702,976
	(22,590)	(23,490)	(23,365)	(7,973)	(6,422)	(5,860)	(0.136)	(0.129)	(0.127)	(99,581)	(97,004)	(65,408)
MV	26,566	26,903	26,785	5,571	4,730	4,124	0.260	0.225	0.215	484,863	477,469	452,290
	(22,014)	(22,499)	(22,095)	(8,433)	(6,349)	(5,561)	(0.137)	(0.129)	(0.128)	(79,687)	(76,526)	(50,242)
SN	26,485	26,347	26,752	5,912	5,030	4,445	0.262	0.222	0.217	1,238,743	1,227,052	1,164,448
	(21,949)	(22,201)	(22,183)	(9,177)	(6,749)	(6,099)	(0.135)	(0.130)	(0.128)	(129,644)	(126,153)	(84,642)
ST	26,036	26,275	26,823	5,467	4,558	3,965	0.256	0.221	0.216	719,091	689,597	651,628
	(21,240)	(21,721)	(22,043)	(7,683)	(6,069)	(5,050)	(0.137)	(0.129)	(0.128)	(96,218)	(90,504)	(61,496)
TH	25,617	25,988	26,370	5,771	4,769	4,221	0.258	0.224	0.218	706,092	704,049	665,284
	(20,885)	(21,248)	(21,151)	(8,295)	(5,975)	(5,311)	(0.134)	(0.126)	(0.124)	(92,765)	(89,928)	(59,595)

Note. Standard deviation in parentheses. Weighted numbers of observations. Non-weighted numbers in parentheses. See Table 3 for the definition of the state acronyms. *Data.* FAST 1998-2004.

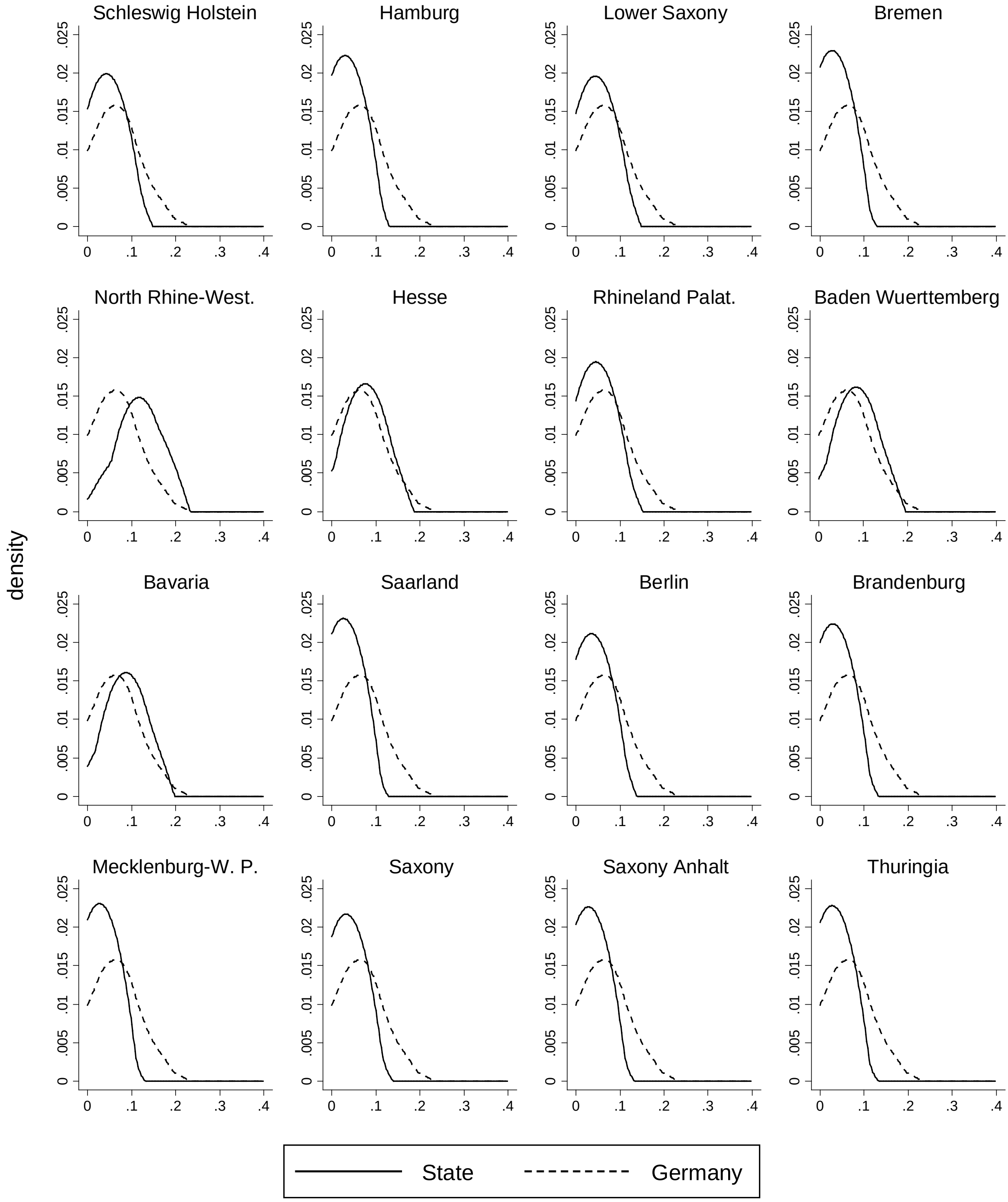
Figures A3a-c give the state- and period-specific distributions of effective internalized marginal revenues (IMR_{i_j}). Each figure comprises sixteen graphs. In each graph, a state specific distribution of IMR (solid line) is benchmarked against the German average (dashed line). The differences between the two distributions mirror differences in the state-specific income distributions and TBRs.

Figure A3a. Distributions of internalized marginal tax revenues (IMR) of an additional taxed Euro, 1998



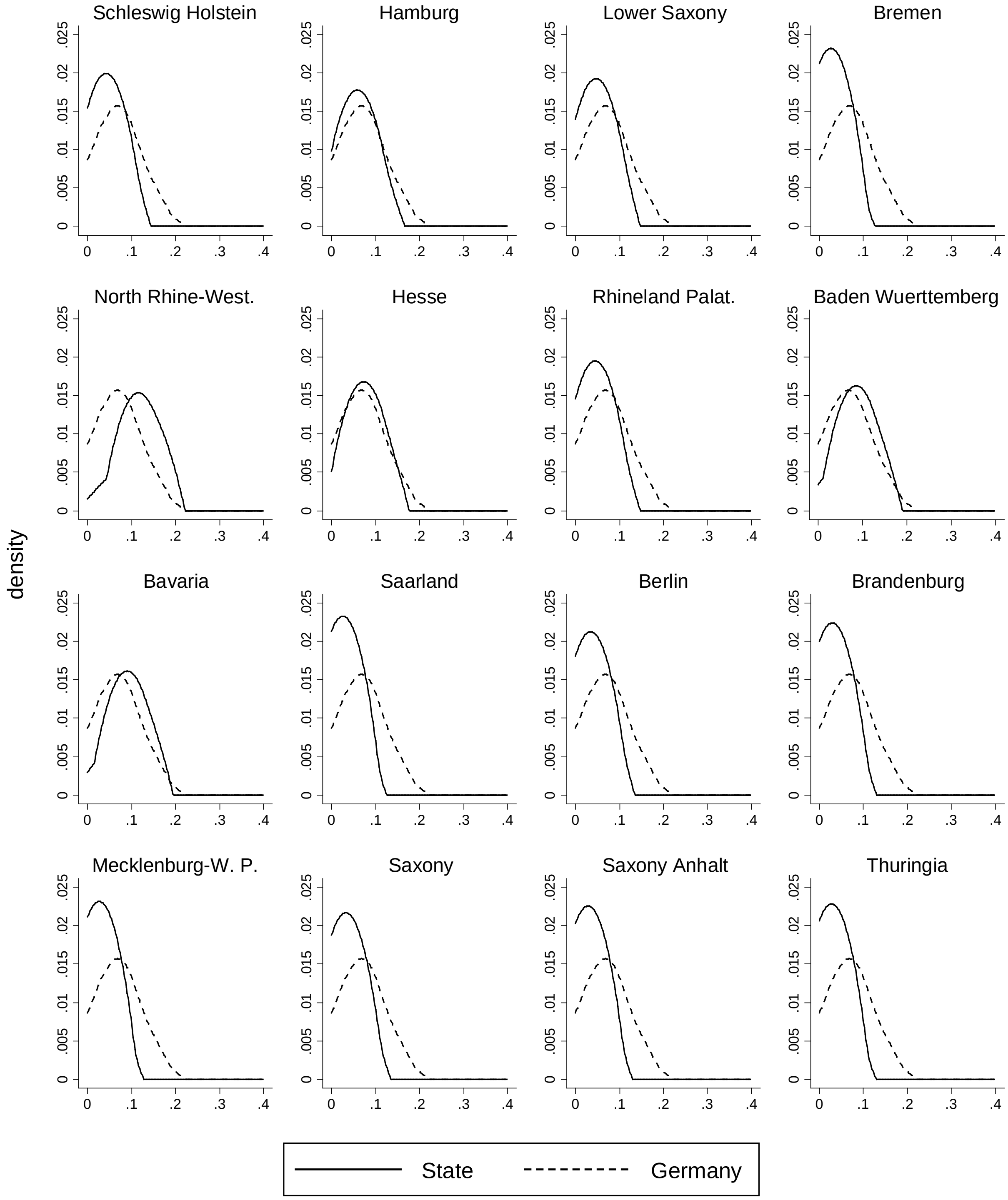
Note. Own computations. *Data*. FAST 1998.

Figure A3b. Distributions of internalized marginal tax revenues (IMR) of an additional taxed Euro, 2001



Note. Own computations. *Data*. FAST 2001.

Figure A3c. Distributions of internalized marginal tax revenues (IMR) of an additional taxed Euro, 2004



Note. Own computations. *Data.* FAST 2004.

Section 2: Information on the statistical matching

To establish experimental conditions in the treatment analysis (Section 5.2.2), it is important to ensure similar distributions of characteristics of tax units in the treatment and control group. The standard procedure for doing so is statistical matching. After the matching, the effect of the treatment on the treated is estimated over the common support, i.e. the part of the distribution of characteristics that is represented among both the treated and the controls. As our analysis relies on repeated cross-sections, we have implemented the statistical matching over three groups: the treated and the non-treated in the initial period before treatment and the non-treated after treatment.

Ex ante to the statistical matching we partitioned the treatment and control samples into four sub-groups by marital and parental status (having children or not). Partitioning means that matches between observations in different sub-groups are not allowed. Partitioning by marital and parental status is important for the reliability of the estimates of the treatment effects, because tax burdens of the partitioned groups differ systematically due to splitting and child-related tax allowances.

For each partitioned group, we implemented a propensity score based on nearest-neighbor matching with replacement and allowing for ties (identical propensity scores): an observation from the potential control group was chosen as a matching partner for a treated observation that is closest in terms of the propensity score. The matching considers the following characteristics of the tax units: taxable base before discretionary deductions; age by means of dummy (age older than 60); three dummies for the income composition (income from employment; self-employed and business income; capital income). Up to five neighbors were allowed. In case of ties, all neighbors with identical propensity scores were considered.

The following twelve Tables (A3a-l) provide sample statistics for each of the sets of (pseudo-) treatment and control groups in Table 6 in the main body of the manuscript. For example, A3a provides the sample statistics for 1998/2001 where the treated state is Schleswig-Holstein and the control states are Lower Saxony and Rhineland-Palatinate. More precisely, the tables provide means and standard deviations of the dependent variable, the amount of tax deductions, and core independent variables, with and without propensity-score weighting. These statistics indicate that the matching was effective: First, for the treatment group the mean and standard deviation of the dependent variable are basically the same with and without propensity-score weighting. Second, means and standard deviations of the independent variables with propensity-score weighting for the treatment group before treatment and also for the control group before and after treatment are close to the propensity-score weighted mean for the treatment group after treatment. Third, means and standard deviations of the dependent and independent variables in the treatment group after treatment with and without propensity-score weighting hardly differ, indicating that the exclusion of observations with lack of common[1] support did not lead to systematic changes in the distributions of the variables entering the propensity-score weighted regressions.

Table A3a. Sample statistics of treatment and control samples, Schleswig-Holstein 1998/2001

	Mean (standard deviation)							
	Treatment group				**Control group**			
	T_1 (2001)		T_0 (1998)		C_1 (2001)		C_0 (1998)	
PS weighting:	No	yes	no	yes	no	yes	no	yes
Δ_i	12,701	12,701	12,772	13,971	13,195	12,809	13,448	14,376
	(7,625)	(7,625)	(7,506)	(7,667)	(7,518)	(7,537)	(7,446)	(7,829)
y_i	126,221	126,222	117,678	125,300	129,592	126,251	120,886	125,453
	(30,485)	(30,487)	(29,297)	(29,418)	(28,566)	(30,441)	(27,747)	(29,545)
$married$	0.646	0.646	0.606	0.645	0.690	0.646	0.654	0.645
	(0.478)	(0.478)	(0.489)	(0.478)	(0.462)	(0.478)	(0.476)	(0.479)
$children$	0.884	0.884	0.819	0.860	0.925	0.884	0.873	0.851
	(1.035)	(1.034)	(1.025)	(1.025)	(1.033)	(1.027)	(1.033)	(1.004)
age	0.205	0.205	0.192	0.220	0.185	0.204	0.177	0.212
	(0.404)	(0.404)	(0.394)	(0.414)	(0.389)	(0.403)	(0.381)	(0.409)
$employment$	0.295	0.295	0.331	0.290	0.272	0.295	0.311	0.298
	(0.456)	(0.456)	(0.471)	(0.454)	(0.445)	(0.456)	(0.463)	(0.458)
$business$	0.516	0.516	0.504	0.500	0.515	0.516	0.511	0.506
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
$capital$	0.428	0.428	0.362	0.442	0.476	0.426	0.400	0.424
	(0.495)	(0.495)	(0.480)	(0.497)	(0.499)	(0.494)	(0.490)	(0.494)

Note. Treatment group in 2001 is the base sample, treatment group 1998 and control groups in 2001and 1998 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 1998 and 2001.

Table A3b. Sample statistics of treatment and control samples, Schleswig-Holstein 2001/2004

	Mean (standard deviation)							
	Treatment group				**Control group**			
	T_1 (2004)		T_0 (2001)		C_1 (2004)		C_0 (2001)	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	12,984	12,982	12,701	12,514	13,396	13,044	13,195	12,697
	(7,885)	(7,883)	(7,625)	(7,550)	(7,768)	(7,781)	(7,518)	(7,451)
y_i	125,101	125,105	126,221	125,346	127,240	125,115	129,592	125,397
	(24,239)	(24,224)	(30,485)	(24,985)	(22,103)	(24,046)	(28,566)	(25,533)
$married$	0.654	0.654	0.646	0.654	0.687	0.654	0.690	0.654
	(0.476)	(0.476)	(0.478)	(0.476)	(0.464)	(0.476)	(0.462)	(0.476)
$children$	0.870	0.870	0.884	0.869	0.902	0.848	0.925	0.869
	(1.020)	(1.020)	(1.035)	(1.036)	(1.011)	(0.996)	(1.033)	(1.030)
age	0.216	0.216	0.205	0.212	0.185	0.217	0.185	0.218
	(0.411)	(0.411)	(0.404)	(0.409)	(0.389)	(0.412)	(0.389)	(0.413)
$employment$	0.310	0.310	0.295	0.298	0.302	0.309	0.272	0.301
	(0.462)	(0.462)	(0.456)	(0.457)	(0.459)	(0.462)	(0.445)	(0.459)
$business$	0.521	0.520	0.516	0.520	0.517	0.519	0.515	0.525
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.499)
$capital$	0.399	0.399	0.428	0.417	0.432	0.400	0.476	0.408
	(0.490)	(0.490)	(0.495)	(0.493)	(0.495)	(0.490)	(0.499)	(0.491)

[1] The numbers of observations with lacking common support can be inferred from Tables A4a-A4f by comparing the sample sizes from OLS vs. OLS / matching.

Note. Treatment group in 2004 is the base sample, treatment group 2001 and control groups in 2004 and 2001 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 2001 and 2004.

Table A3c. Sample statistics of treatment and control samples, Bavaria 1998/2001

	Mean (standard deviation)							
	Treatment group				Control group			
	T_1 (2001)		T_0 (1998)		C_1 (2001)		C_0 (1998)	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	13,429	13,428	13,780	14,880	13,056	13,122	13,493	14,800
	(7,687)	(7,686)	(7,548)	(7,852)	(7,624)	(7,634)	(7,564)	(7,886)
y_i	132,894	132,891	125,044	132,202	131,929	132,874	123,789	132,275
	(25,767)	(25,764)	(25,441)	(24,406)	(26,520)	(25,877)	(26,374)	(24,515)
$married$	0.700	0.700	0.692	0.700	0.699	0.700	0.683	0.701
	(0.458)	(0.458)	(0.462)	(0.458)	(0.459)	(0.458)	(0.465)	(0.458)
$children$	0.862	0.862	0.818	0.850	0.862	0.866	0.813	0.847
	(1.007)	(1.007)	(1.013)	(1.010)	(1.009)	(1.010)	(1.011)	(1.006)
age	0.161	0.161	0.166	0.157	0.167	0.160	0.171	0.155
	(0.367)	(0.367)	(0.372)	(0.364)	(0.373)	(0.367)	(0.377)	(0.362)
$employment$	0.323	0.323	0.352	0.312	0.338	0.322	0.368	0.315
	(0.467)	(0.467)	(0.478)	(0.463)	(0.473)	(0.467)	(0.482)	(0.465)
$business$	0.450	0.450	0.472	0.434	0.434	0.451	0.450	0.435
	(0.498)	(0.498)	(0.499)	(0.496)	(0.496)	(0.498)	(0.497)	(0.496)
$capital$	0.460	0.460	0.374	0.466	0.451	0.461	0.373	0.467
	(0.498)	(0.498)	(0.484)	(0.499)	(0.498)	(0.498)	(0.484)	(0.499)

Note. Treatment group in 2001 is the base sample, treatment group 1998 and control groups in 2001and 1998 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 1998 and 2001.

Table A3d. Sample statistics of treatment and control samples, Bavaria 2001/2004

	Mean (standard deviation)							
	Treatment group				Control group			
	T_1 (2004)		T_0 (2001)		C_1 (2004)		C_0 (2001)	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	13,368	13,368	13,429	12,940	13,160	13,178	13,056	12,650
	(7,889)	(7,889)	(7,687)	(7,665)	(7,853)	(7,860)	(7,624)	(7,600)
y_i	129,059	129,059	132,894	129,015	128,687	129,054	131,929	129,409
	(19,669)	(19,667)	(25,767)	(20,519)	(20,240)	(19,754)	(26,520)	(20,536)
$married$	0.677	0.677	0.700	0.677	0.687	0.677	0.699	0.677
	(0.468)	(0.468)	(0.458)	(0.468)	(0.464)	(0.468)	(0.459)	(0.468)
$children$	0.842	0.842	0.862	0.849	0.849	0.844	0.862	0.852
	(0.991)	(0.991)	(1.007)	(1.009)	(0.993)	(0.992)	(1.009)	(1.012)
age	0.163	0.162	0.161	0.161	0.167	0.164	0.167	0.159
	(0.369)	(0.369)	(0.367)	(0.367)	(0.373)	(0.370)	(0.373)	(0.366)
$employment$	0.346	0.346	0.323	0.341	0.362	0.345	0.338	0.345
	(0.476)	(0.476)	(0.467)	(0.474)	(0.481)	(0.475)	(0.473)	(0.475)
$business$	0.453	0.453	0.450	0.449	0.430	0.453	0.434	0.444
	(0.498)	(0.498)	(0.498)	(0.497)	(0.495)	(0.498)	(0.496)	(0.497)
$capital$	0.427	0.427	0.460	0.438	0.421	0.427	0.451	0.435
	(0.495)	(0.495)	(0.498)	(0.496)	(0.494)	(0.495)	(0.498)	(0.496)

Note. Treatment group in 2004 is the base sample, treatment group 2001 and control groups in 2004 and 2001 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 2004 and 2001.

Table A3e. Sample statistics of treatment and control samples, Brandenburg 1998/2001

	Mean (standard deviation)							
	Treatment group				**Control group**			
	2001		1998		2001		1998	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	12,012	12,011	12,595	13,447	12,729	12,418	13,530	14,334
	(7,225)	(7,224)	(7,535)	(7,527)	(7,216)	(7,236)	(7,656)	(7,636)
y_i	121,731	121,696	112,588	120,037	119,284	121,617	111,152	120,783
	(32,057)	(32,038)	(30,533)	(30,369)	(33,170)	(32,156)	(31,233)	(30,689)
$married$	0.597	0.597	0.554	0.591	0.560	0.597	0.527	0.594
	(0.491)	(0.491)	(0.497)	(0.492)	(0.496)	(0.491)	(0.499)	(0.491)
$children$	1.015	1.015	0.928	1.009	1.000	1.012	0.949	0.991
	(0.966)	(0.967)	(0.968)	(0.961)	(0.965)	(0.969)	(0.968)	(0.955)
age	0.113	0.113	0.091	0.111	0.123	0.115	0.087	0.114
	(0.317)	(0.317)	(0.288)	(0.314)	(0.329)	(0.319)	(0.282)	(0.318)
$employment$	0.326	0.326	0.356	0.324	0.235	0.325	0.295	0.326
	(0.469)	(0.469)	(0.479)	(0.468)	(0.424)	(0.468)	(0.456)	(0.469)
$business$	0.533	0.533	0.540	0.530	0.638	0.532	0.607	0.532
	(0.499)	(0.499)	(0.498)	(0.499)	(0.481)	(0.499)	(0.488)	(0.499)
$capital$	0.349	0.349	0.244	0.351	0.400	0.350	0.257	0.339
	(0.477)	(0.477)	(0.429)	(0.477)	(0.490)	(0.477)	(0.437)	(0.473)

Note. Treatment group in 2001 is the base sample, treatment group 1998 and control groups in 2001and 1998 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 1998 and 2001.

Table A3f. Sample statistics of treatment and control samples, Brandenburg 2001/2004

	Mean (standard deviation)							
	Treatment group				**Control group**			
	T_1 (2004)		T_0 (2001)		C_1 (2004)		C_0 (2001)	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	11,961	11,962	12,012	12,058	12,212	12,010	12,729	12,615
	(7,446)	(7,444)	(7,225)	(7,161)	(7,048)	(7,085)	(7,216)	(7,166)
y_i	122,523	122,516	121,731	122,822	120,227	122,539	119,284	122,537
	(25,442)	(25,428)	(32,057)	(26,053)	(27,165)	(25,652)	(33,171)	(27,010)
$married$	0.614	0.615	0.597	0.615	0.585	0.615	0.560	0.614
	(0.487)	(0.487)	(0.491)	(0.487)	(0.493)	(0.487)	(0.496)	(0.487)
$children$	1.032	1.032	1.015	1.026	0.991	0.998	1.000	1.022
	(0.972)	(0.973)	(0.966)	(0.965)	(0.950)	(0.942)	(0.965)	(0.968)
age	0.137	0.136	0.113	0.125	0.141	0.137	0.123	0.135
	(0.344)	(0.343)	(0.317)	(0.331)	(0.348)	(0.344)	(0.329)	(0.341)
$employment$	0.345	0.345	0.326	0.337	0.273	0.339	0.235	0.327
	(0.475)	(0.475)	(0.469)	(0.473)	(0.445)	(0.473)	(0.424)	(0.469)
$business$	0.531	0.531	0.533	0.536	0.622	0.534	0.638	0.545
	(0.499)	(0.499)	(0.499)	(0.499)	(0.485)	(0.499)	(0.481)	(0.498)
$capital$	0.323	0.323	0.349	0.331	0.363	0.324	0.400	0.327
	(0.468)	(0.468)	(0.477)	(0.471)	(0.481)	(0.468)	(0.490)	(0.469)

Note. Treatment group in 2004 is the base sample, treatment group 2001 and control groups in 2004 and 2001 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 2004 and 2001.

Table A3g. Sample statistics of treatment and control samples, Mecklenburg-W. P. 1998/2001

	Mean (standard deviation)							
	Treatment group				Control group			
	2001		1998		2001		1998	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	12,733	12,732	13,461	14,167	12,428	12,643	13,151	14,197
	(7,146)	(7,145)	(7,537)	(7,490)	(7,245)	(7,245)	(7,647)	(7,710)
y_i	119,233	119,230	111,060	117,656	120,322	119,156	111,780	118,052
	(33,240)	(33,219)	(31,347)	(31,808)	(32,713)	(33,342)	(30,921)	(32,011)
$married$	0.556	0.556	0.523	0.551	0.576	0.556	0.540	0.552
	(0.497)	(0.497)	(0.500)	(0.497)	(0.494)	(0.497)	(0.498)	(0.497)
$children$	1.045	1.045	1.026	1.040	0.995	1.026	0.923	0.992
	(0.983)	(0.983)	(1.009)	(0.990)	(0.961)	(0.964)	(0.958)	(0.944)
age	0.126	0.125	0.096	0.128	0.119	0.123	0.087	0.129
	(0.331)	(0.331)	(0.295)	(0.335)	(0.323)	(0.329)	(0.281)	(0.335)
$employment$	0.239	0.239	0.292	0.254	0.272	0.240	0.321	0.245
	(0.426)	(0.426)	(0.455)	(0.435)	(0.445)	(0.427)	(0.467)	(0.430)
$business$	0.642	0.642	0.611	0.624	0.593	0.643	0.578	0.639
	(0.479)	(0.479)	(0.488)	(0.485)	(0.491)	(0.479)	(0.494)	(0.480)
$capital$	0.371	0.371	0.246	0.367	0.385	0.371	0.254	0.380
	(0.483)	(0.483)	(0.431)	(0.482)	(0.487)	(0.483)	(0.435)	(0.485)

Note. Treatment group in 2001 is the base sample, treatment group 1998 and control groups in 2001and 1998 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 1998 and 2001.

Table A3h. Sample statistics of treatment and control samples, Mecklenburg-W. P. 2001/2004

	Mean (standard deviation)							
	Treatment group				Control group			
	T_1 (2004)		T_0 (2001)		C_1 (2004)		C_0 (2001)	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	12,279	12,279	12,733	12,705	12,095	12,218	12,428	12,518
	(7,039)	(7,039)	(7,146)	(7,073)	(7,215)	(7,170)	(7,245)	(7,085)
y_i	118,818	118,818	119,233	118,658	121,469	118,850	120,322	119,306
	(28,107)	(28,107)	(33,240)	(28,580)	(26,266)	(27,929)	(32,714)	(28,968)
$married$	0.537	0.537	0.556	0.537	0.608	0.537	0.576	0.537
	(0.499)	(0.499)	(0.497)	(0.499)	(0.488)	(0.499)	(0.494)	(0.499)
$children$	0.998	0.998	1.045	1.002	1.006	0.983	0.995	0.984
	(0.969)	(0.969)	(0.983)	(0.978)	(0.955)	(0.960)	(0.961)	(0.963)
age	0.152	0.152	0.126	0.148	0.137	0.153	0.119	0.154
	(0.359)	(0.359)	(0.331)	(0.355)	(0.343)	(0.360)	(0.323)	(0.361)
$employment$	0.231	0.231	0.239	0.225	0.311	0.233	0.272	0.229
	(0.421)	(0.421)	(0.426)	(0.417)	(0.463)	(0.423)	(0.445)	(0.420)
$business$	0.677	0.677	0.642	0.678	0.573	0.678	0.593	0.673
	(0.468)	(0.468)	(0.479)	(0.467)	(0.495)	(0.467)	(0.491)	(0.469)
$capital$	0.354	0.354	0.371	0.361	0.349	0.357	0.385	0.374
	(0.478)	(0.478)	(0.483)	(0.480)	(0.477)	(0.479)	(0.487)	(0.484)

Note. Treatment group in 2004 is the base sample, treatment group 2001 and control groups in 2004 and 2001 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 2004 and 2001.

Table A3i. Sample statistics of treatment and control samples, Saxony-Anhalt 1998/2001

	Mean (standard deviation)							
	Treatment group				**Control group**			
	2001		1998		2001		1998	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	12,530	12,530	13,241	14,050	12,471	12,538	13,197	13,983
	(7,207)	(7,208)	(7,689)	(7,695)	(7,233)	(7,209)	(7,606)	(7,586)
y_i	119,146	119,154	111,256	117,540	120,431	119,039	111,781	117,766
	(33,106)	(33,084)	(31,132)	(31,550)	(32,715)	(32,978)	(30,956)	(31,479)
$married$	0.556	0.557	0.525	0.554	0.578	0.557	0.540	0.551
	(0.497)	(0.497)	(0.499)	(0.497)	(0.494)	(0.497)	(0.498)	(0.497)
$children$	0.969	0.969	0.903	0.950	1.016	0.979	0.955	0.978
	(0.955)	(0.955)	(0.949)	(0.950)	(0.968)	(0.963)	(0.975)	(0.967)
age	0.130	0.130	0.087	0.135	0.117	0.129	0.089	0.132
	(0.337)	(0.336)	(0.282)	(0.342)	(0.321)	(0.335)	(0.285)	(0.339)
$employment$	0.231	0.231	0.303	0.230	0.277	0.232	0.320	0.243
	(0.422)	(0.422)	(0.459)	(0.421)	(0.448)	(0.422)	(0.467)	(0.429)
$business$	0.646	0.646	0.602	0.640	0.588	0.648	0.578	0.639
	(0.478)	(0.478)	(0.490)	(0.480)	(0.492)	(0.478)	(0.494)	(0.480)
$capital$	0.402	0.402	0.254	0.405	0.376	0.399	0.252	0.404
	(0.490)	(0.490)	(0.435)	(0.491)	(0.484)	(0.490)	(0.434)	(0.491)

Note. Treatment group in 2001 is the base sample, treatment group 1998 and control groups in 2001and 1998 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 1998 and 2001.

Table A3j. Sample statistics of treatment and control samples, Saxony-Anhalt 2001/2004

	Mean (standard deviation)							
	Treatment group				**Control group**			
	T_1 (2004)		T_0 (2001)		C_1 (2004)		C_0 (2001)	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	11,780	11,781	12,530	12,503	12,254	12,107	12,471	12,555
	(6,893)	(6,892)	(7,207)	(7,042)	(7,281)	(7,258)	(7,233)	(7,093)
y_i	120,902	120,913	119,146	120,897	121,025	120,709	120,431	120,826
	(26,557)	(26,547)	(33,106)	(27,051)	(26,650)	(26,422)	(32,716)	(27,389)
$married$	0.612	0.612	0.556	0.612	0.589	0.612	0.578	0.612
	(0.487)	(0.487)	(0.497)	(0.487)	(0.492)	(0.487)	(0.494)	(0.487)
$children$	0.991	0.991	0.969	1.022	1.009	1.032	1.016	1.035
	(0.927)	(0.927)	(0.955)	(0.962)	(0.968)	(0.972)	(0.968)	(0.973)
age	0.128	0.127	0.130	0.127	0.143	0.128	0.117	0.130
	(0.334)	(0.333)	(0.337)	(0.333)	(0.351)	(0.334)	(0.321)	(0.336)
$employment$	0.331	0.331	0.231	0.322	0.285	0.333	0.277	0.322
	(0.470)	(0.471)	(0.422)	(0.467)	(0.451)	(0.471)	(0.448)	(0.467)
$business$	0.567	0.567	0.646	0.574	0.600	0.567	0.588	0.571
	(0.496)	(0.495)	(0.478)	(0.495)	(0.490)	(0.495)	(0.492)	(0.495)
$capital$	0.339	0.339	0.402	0.348	0.354	0.335	0.376	0.348
	(0.474)	(0.474)	(0.490)	(0.477)	(0.478)	(0.472)	(0.484)	(0.476)

Note. Treatment group in 2004 is the base sample, treatment group 2001 and control groups in 2004 and 2001 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 2004 and 2001.

Table A3k. Sample statistics of treatment and control samples, Thuringia 1998/2001

	Mean (standard deviation)							
	Treatment group				**Control group**			
	2001		1998		2001		1998	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	12,941	12,941	13,940	14,555	12,352	12,448	13,011	14,008
	(7,279)	(7,279)	(7,703)	(7,562)	(7,206)	(7,204)	(7,595)	(7,594)
y_i	119,477	119,477	111,108	117,358	120,304	119,543	111,791	118,301
	(33,188)	(33,188)	(31,265)	(31,219)	(32,704)	(33,163)	(30,929)	(31,830)
$married$	0.567	0.567	0.533	0.556	0.574	0.567	0.537	0.565
	(0.496)	(0.496)	(0.499)	(0.497)	(0.495)	(0.496)	(0.499)	(0.496)
$children$	0.995	0.995	0.938	0.956	1.008	1.007	0.943	0.983
	(0.959)	(0.959)	(0.951)	(0.931)	(0.967)	(0.971)	(0.973)	(0.959)
age	0.114	0.114	0.079	0.119	0.122	0.114	0.091	0.115
	(0.318)	(0.318)	(0.270)	(0.324)	(0.327)	(0.318)	(0.288)	(0.319)
$employment$	0.235	0.235	0.289	0.237	0.275	0.232	0.323	0.238
	(0.424)	(0.424)	(0.453)	(0.425)	(0.446)	(0.422)	(0.468)	(0.426)
$business$	0.626	0.626	0.611	0.635	0.595	0.630	0.577	0.622
	(0.484)	(0.484)	(0.488)	(0.481)	(0.491)	(0.483)	(0.494)	(0.485)
$capital$	0.422	0.422	0.271	0.406	0.371	0.422	0.248	0.422
	(0.494)	(0.494)	(0.444)	(0.491)	(0.483)	(0.494)	(0.432)	(0.494)

Note. Treatment group in 2001 is the base sample, treatment group 1998 and control groups in 2001and 1998 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 1998 and 2001.

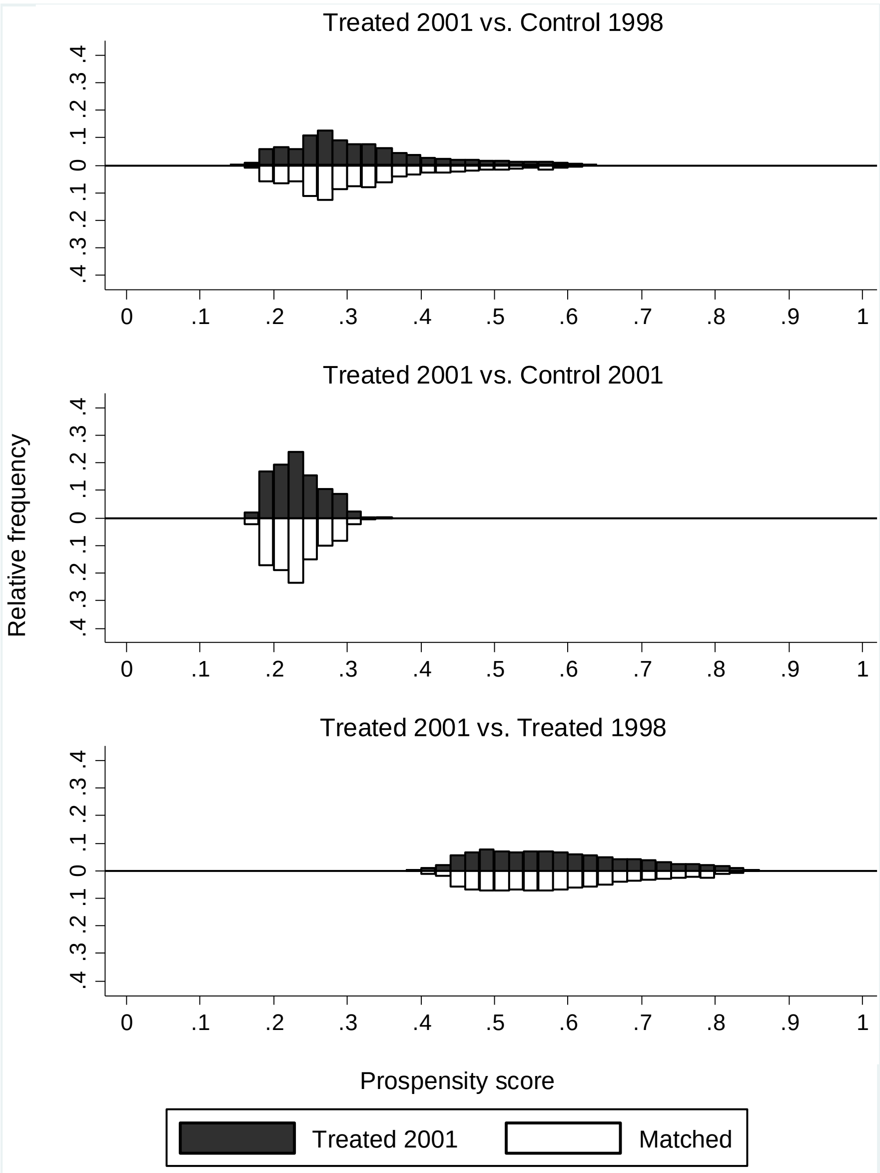
Table A3l. Sample statistics of treatment and control samples, Thuringia 2001/2004

	Mean (standard deviation)							
	Treatment group				**Control group**			
	T_1 (2004)		T_0 (2001)		C_1 (2004)		C_0 (2001)	
PS weighting:	no	yes	no	yes	no	Yes	no	yes
Δ_i	12,669	12,669	12,941	12,996	11,973	12,262	12,352	12,545
	(7,206)	(7,206)	(7,279)	(7,149)	(7,170)	(7,185)	(7,206)	(7,107)
y_i	120,565	120,565	119,477	120,694	121,115	120,666	120,304	120,677
	(27,072)	(27,072)	(33,188)	(27,747)	(26,495)	(27,171)	(32,704)	(27,763)
$married$	0.593	0.593	0.567	0.593	0.596	0.593	0.574	0.592
	(0.491)	(0.491)	(0.496)	(0.491)	(0.491)	(0.491)	(0.495)	(0.491)
$children$	0.984	0.984	0.995	0.977	1.010	0.993	1.008	0.997
	(0.961)	(0.961)	(0.959)	(0.955)	(0.956)	(0.961)	(0.967)	(0.973)
age	0.147	0.147	0.114	0.142	0.137	0.149	0.122	0.143
	(0.354)	(0.354)	(0.318)	(0.349)	(0.344)	(0.356)	(0.327)	(0.350)
$employment$	0.238	0.238	0.235	0.228	0.314	0.235	0.275	0.243
	(0.426)	(0.426)	(0.424)	(0.420)	(0.464)	(0.424)	(0.446)	(0.429)
$business$	0.643	0.643	0.626	0.644	0.577	0.649	0.595	0.635
	(0.479)	(0.479)	(0.484)	(0.479)	(0.494)	(0.477)	(0.491)	(0.481)
$capital$	0.398	0.398	0.422	0.407	0.336	0.393	0.371	0.396
	(0.490)	(0.490)	(0.494)	(0.491)	(0.472)	(0.488)	(0.483)	(0.489)

Note. Treatment group in 2004 is the base sample, treatment group 2001 and control groups in 2004 and 2001 are matched to the base sample to resemble base sample characteristics. Standard deviation in parentheses. PS denotes propensity-score matching, Δ_i denotes tax deductions, y_i denotes gross taxable income. *Data*. FAST 2004 and 2001.

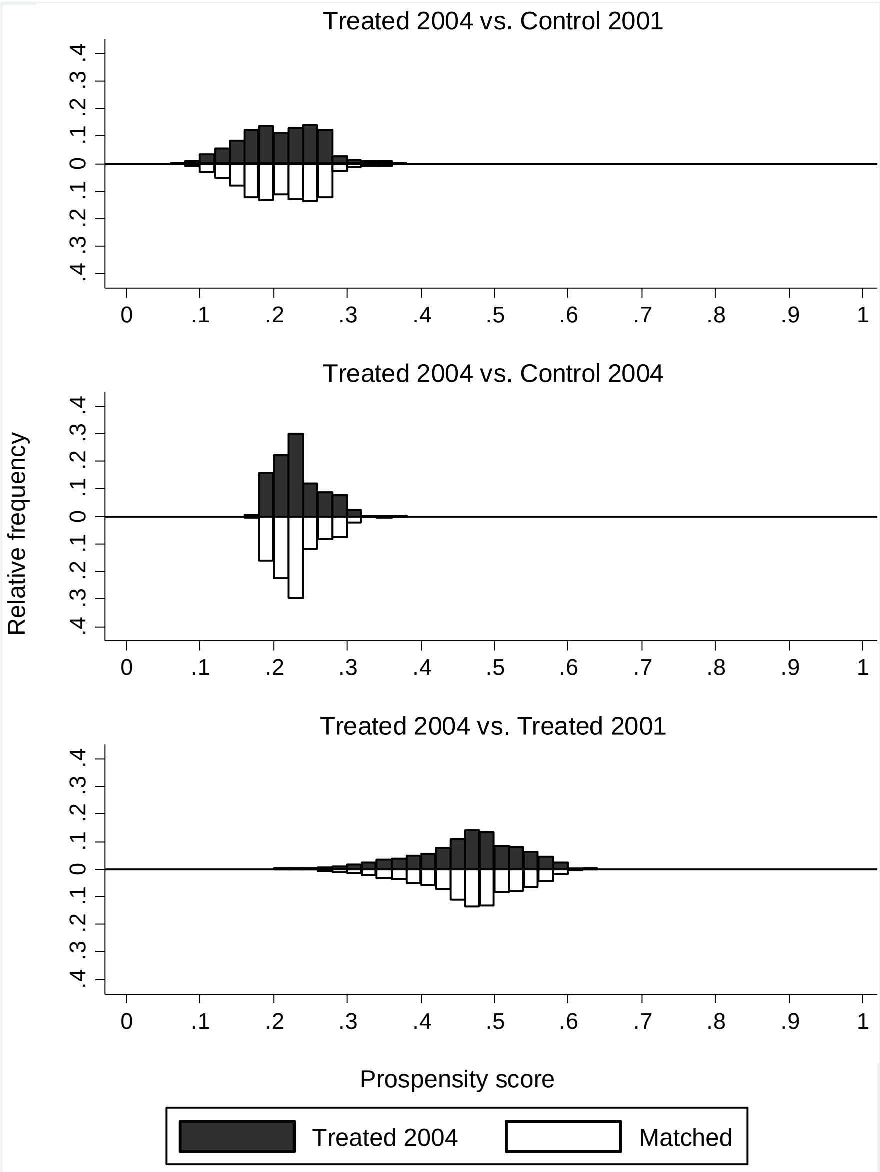
Figures A4a-A4l provide the corresponding propensity score distributions. Each figure contains three symmetry plots. Each symmetry plot depicts the propensity score distribution for the treated group after treatment (black shaded distribution above the horizontal axis), against one of the three other groups, treated before treatment and the control group before and after treatment (distribution below the horizontal axis). As can be seen from the graphs, the propensity scores are highly symmetric, indicating that the distributions of observational characteristics are similar across groups.

Figure A4a. Distribution of Prospensity score for Schleswig-Holstein, matching 1998/2001



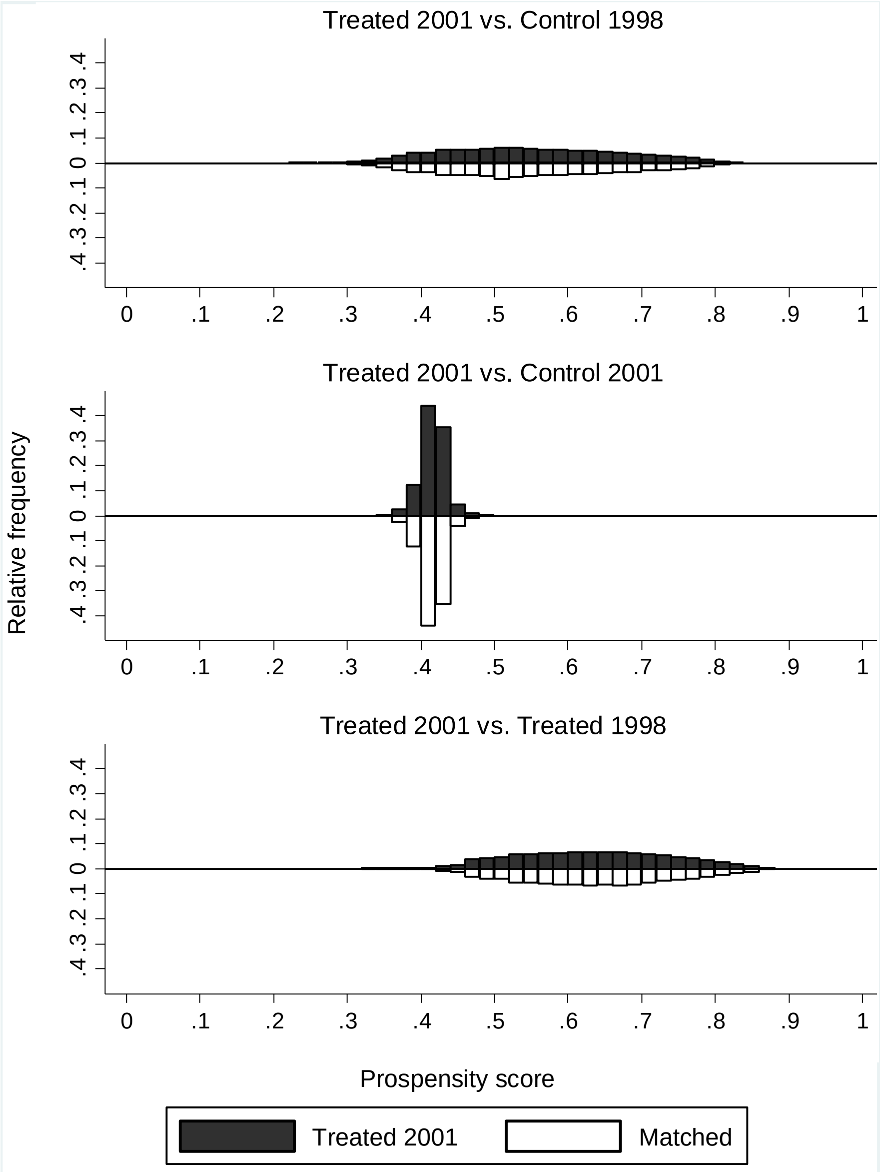
Note. Database is FAST 1998 and 2001.

Figure A4b. Distribution of Prospensity score for Schleswig-Holstein, matching 2001/2004



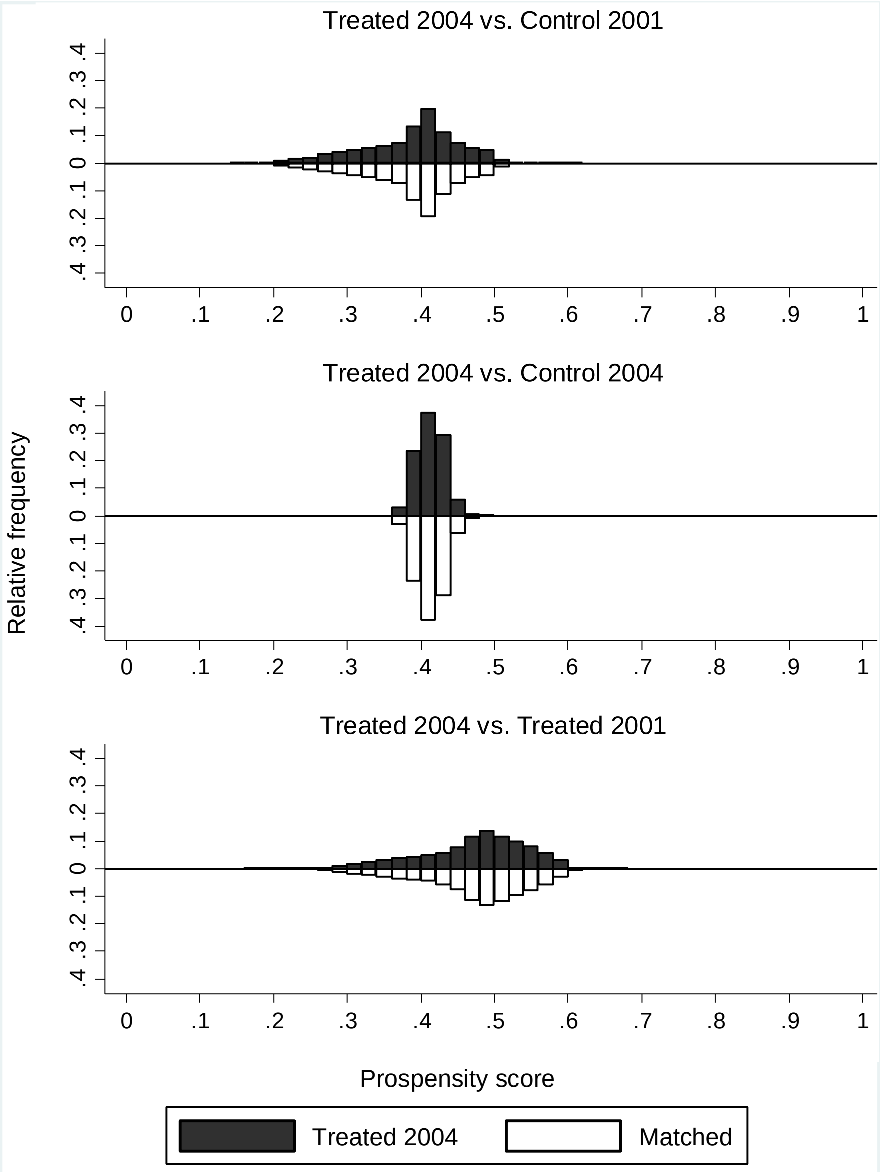
Note. Database is FAST 2001 and 2004.

Figure A4c. Distribution of Prospensity score for Bavaria, matching 1998/2001



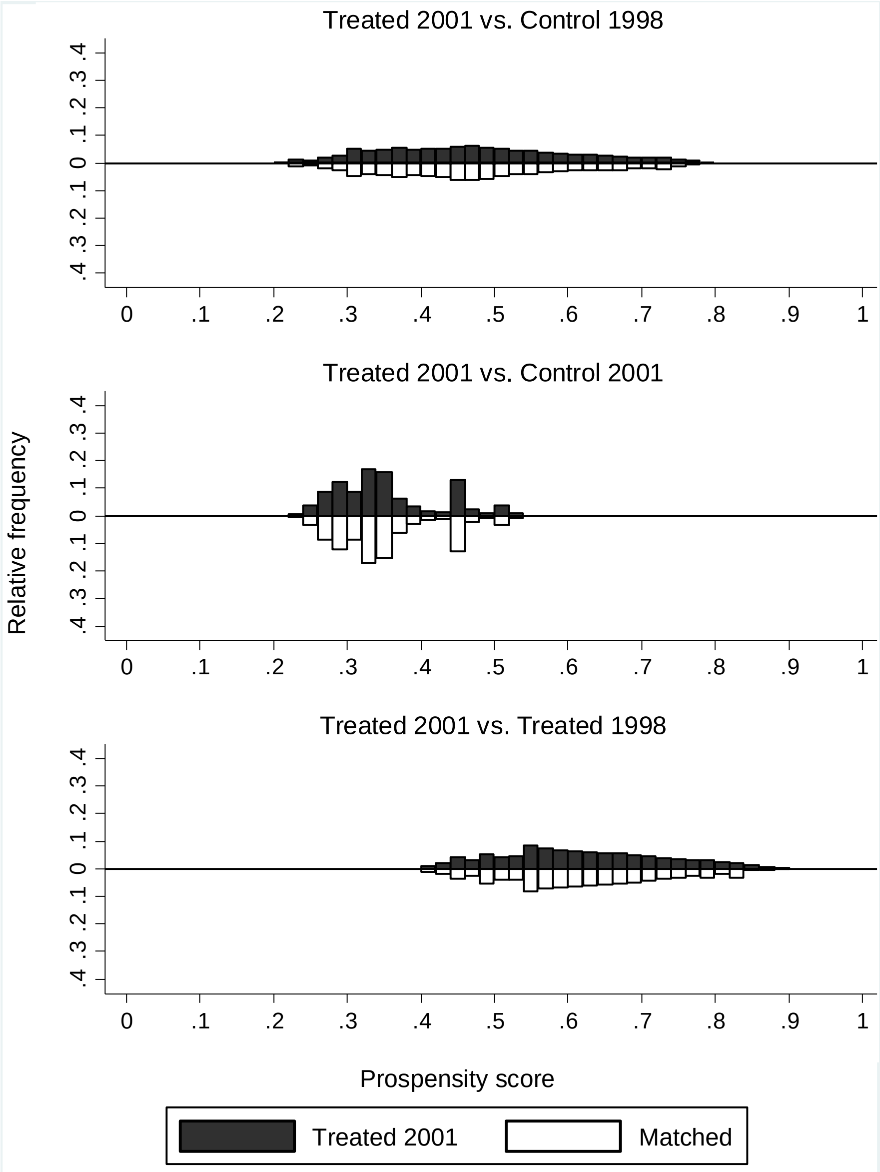
Note. Database is FAST 1998 and 2001.

Figure A4d. Distribution of Prospensity score for Bavaria, matching 2001/2004



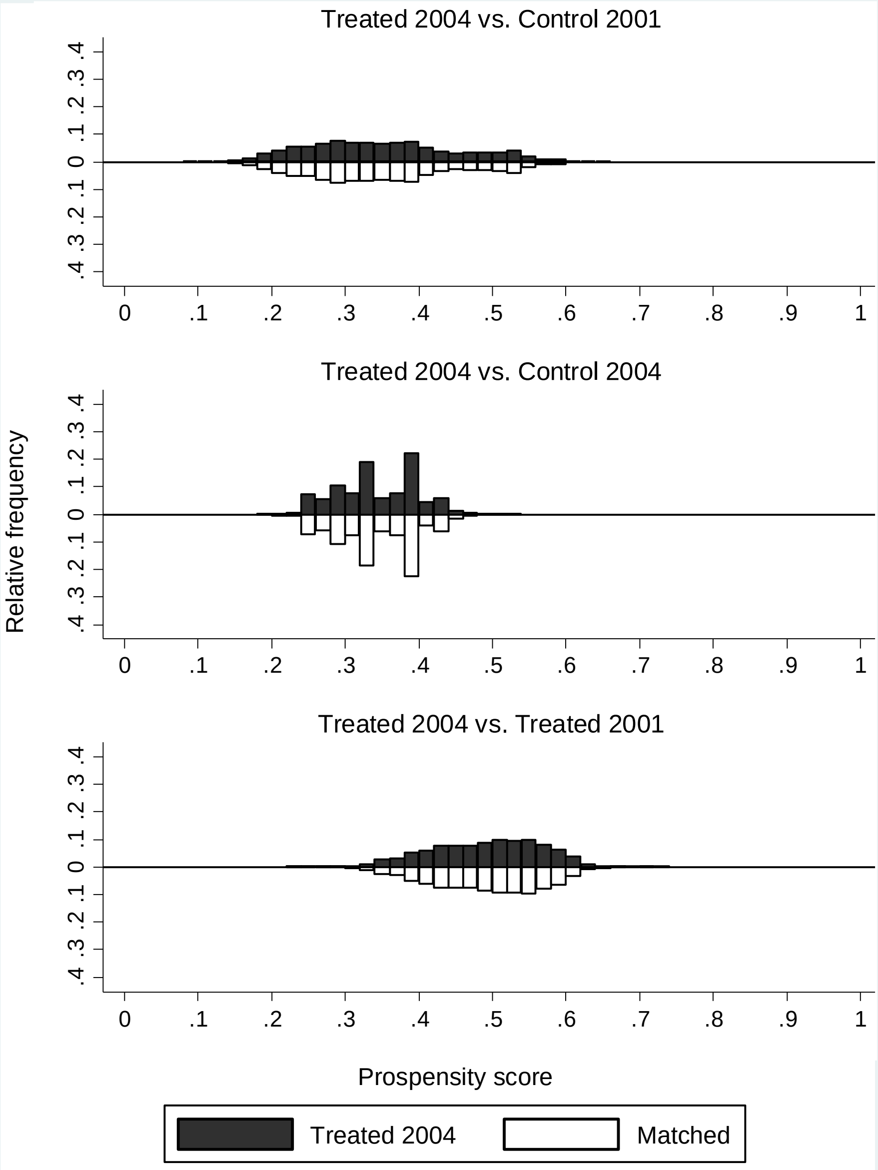
Note. Database is FAST 2001 and 2004.

Figure A4e. Distribution of Prospensity score for Brandenburg, matching 1998/2001



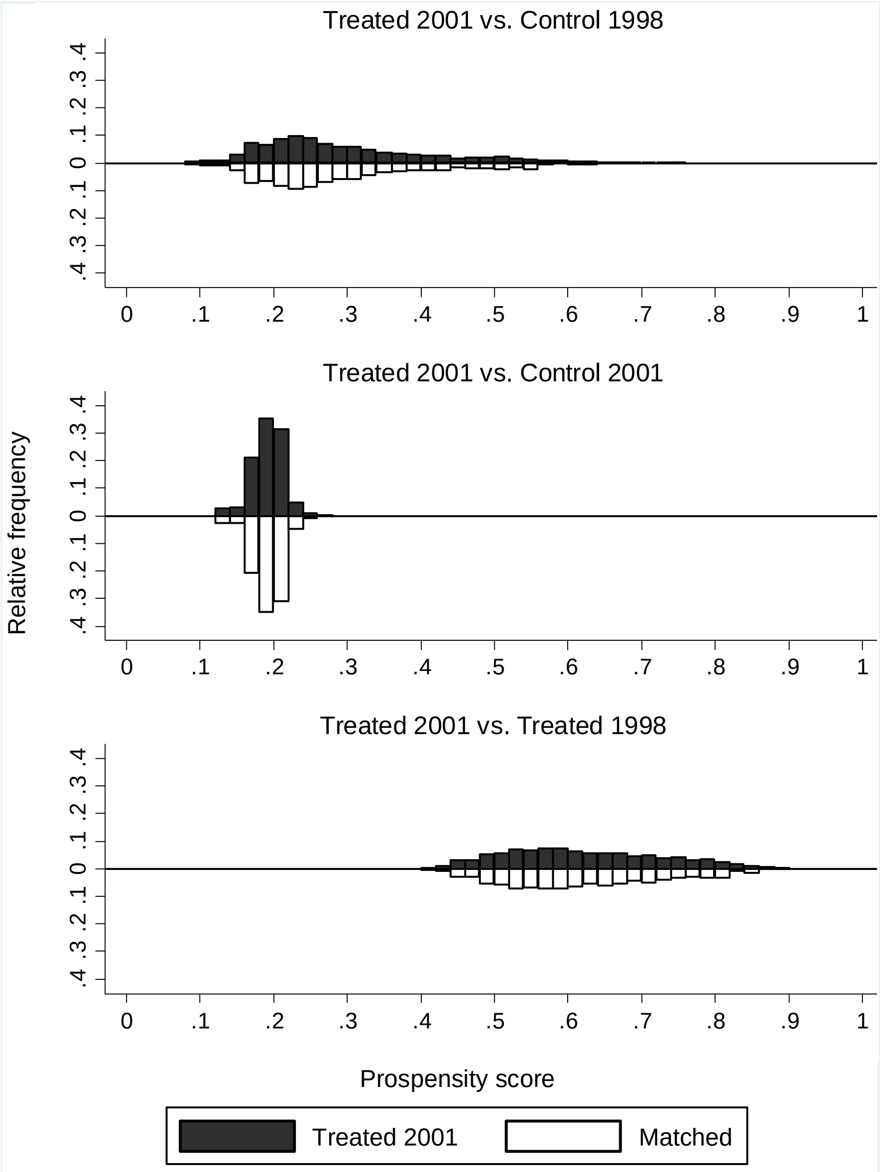
Note. Database is FAST 1998 and 2001.

Figure A4f. Distribution of Prospensity score for Brandenburg, matching 2001/2004



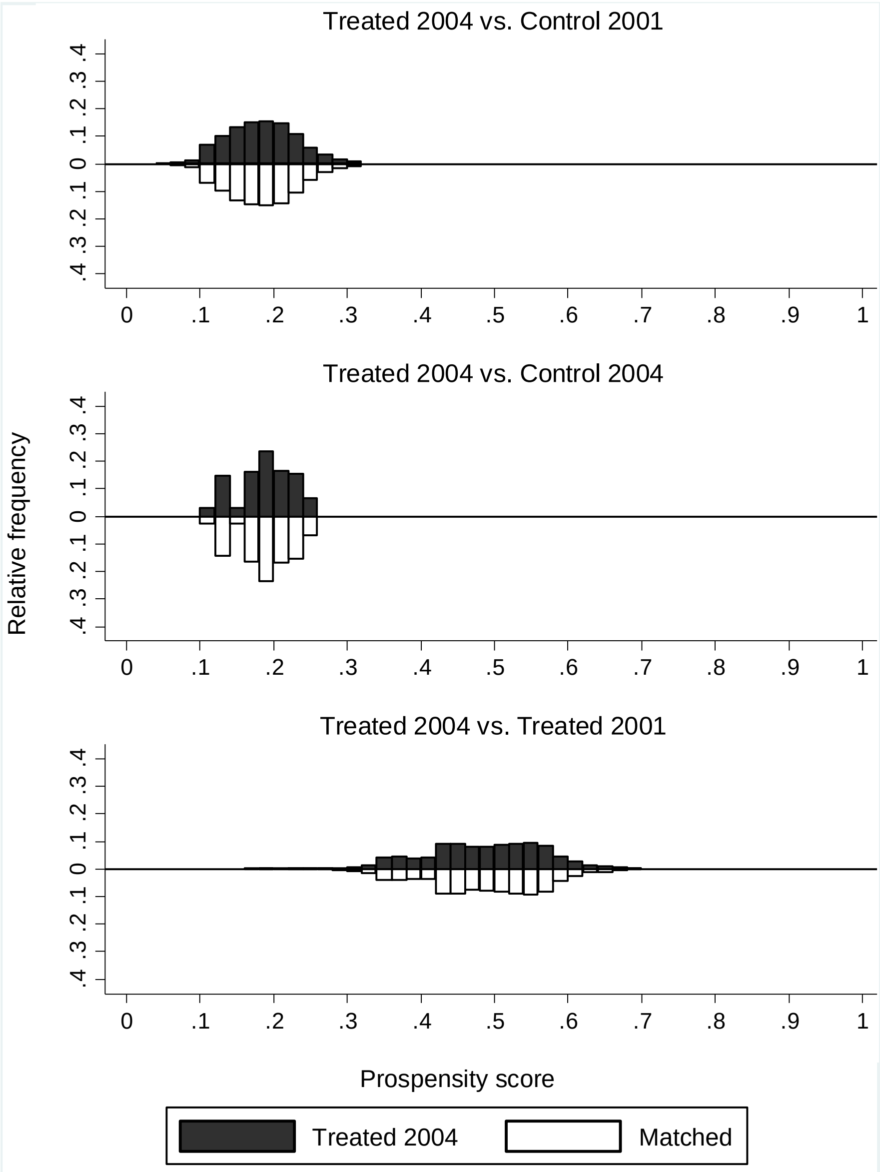
Note. Database is FAST 2001 and 2004.

Figure A4g. Distribution of Prospensity score for Mecklenburg-W. P., matching 1998/2001



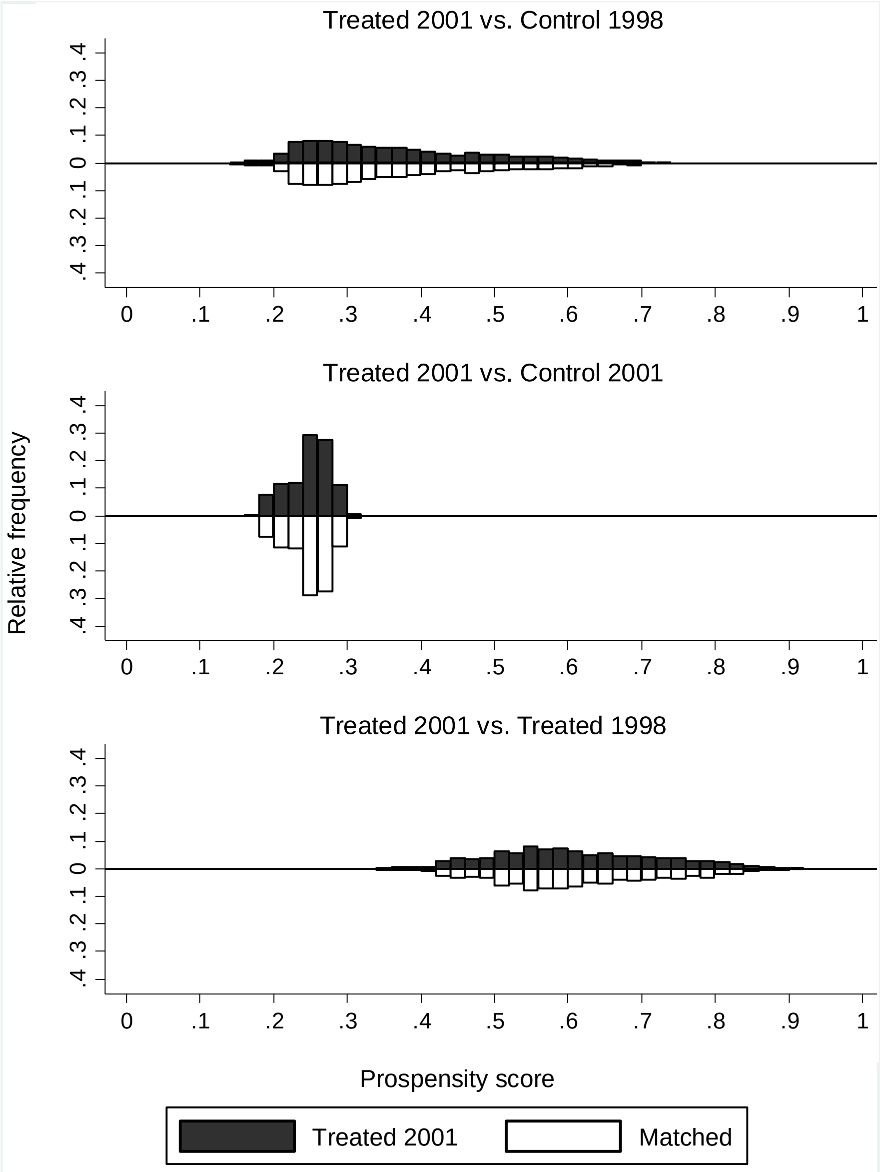
Note. Database is FAST 1998 and 2001.

Figure A4h. Distribution of Prospensity score for Mecklenburg-W. P., matching 2001/2004



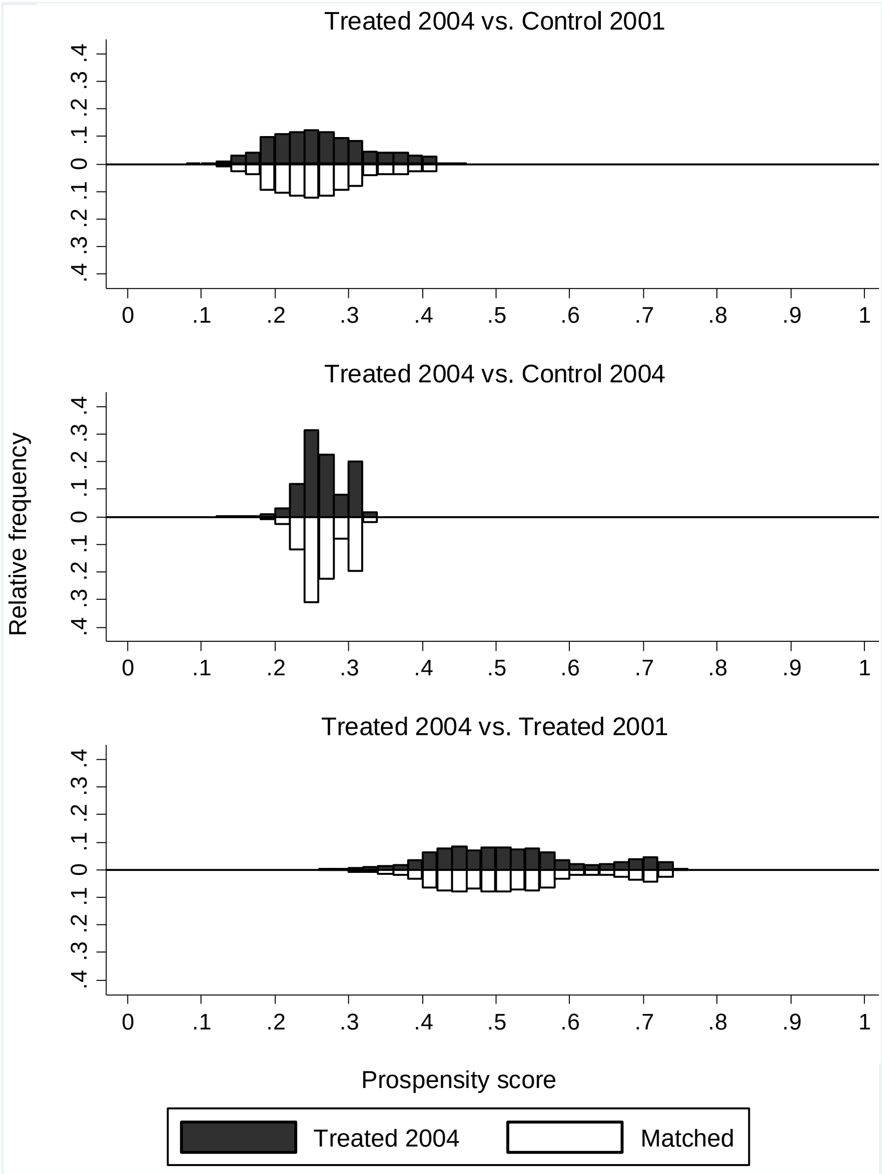
Note. Database is FAST 2001 and 2004.

Figure A4i. Distribution of Prospensity score for Saxony-Anhalt, matching 1998/2001



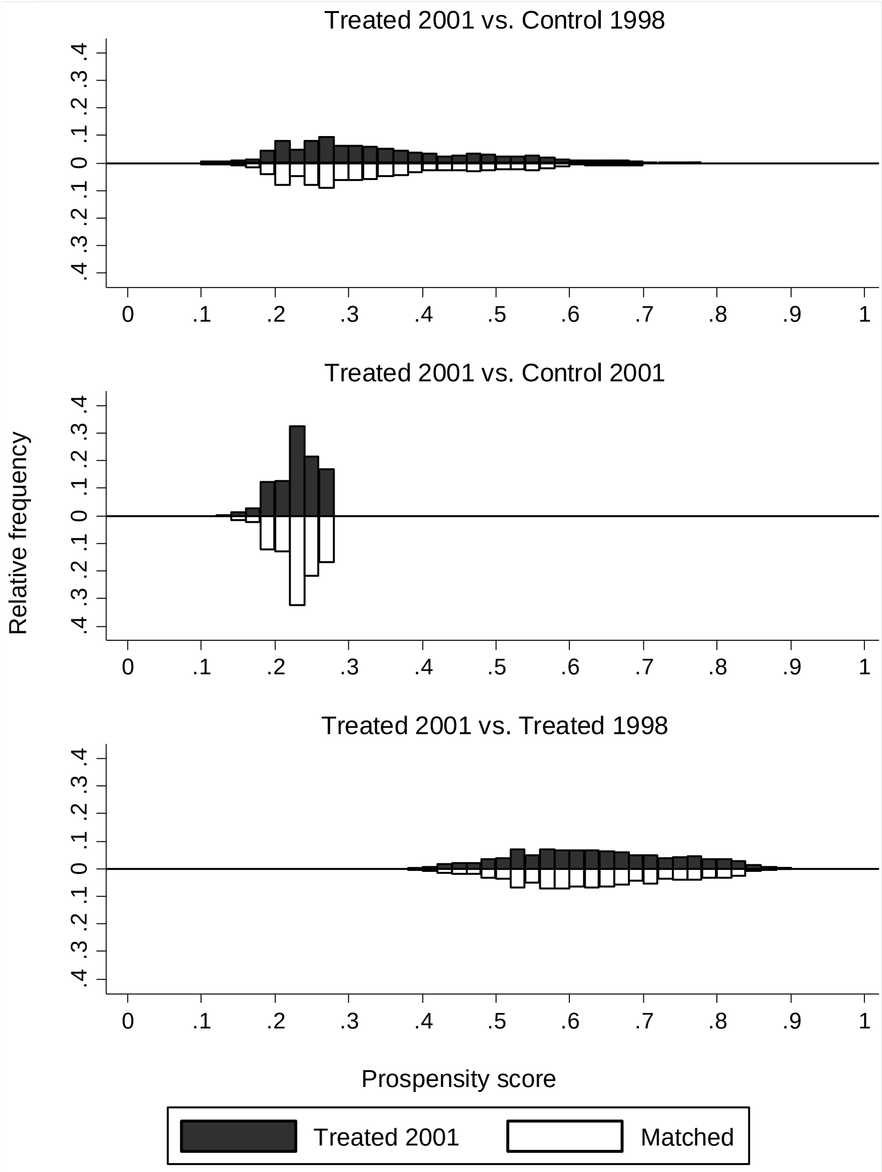
Note. Database is FAST 1998 and 2001.

Figure A4j. Distribution of Prospensity score for Saxony-Anhalt, matching 2001/2004



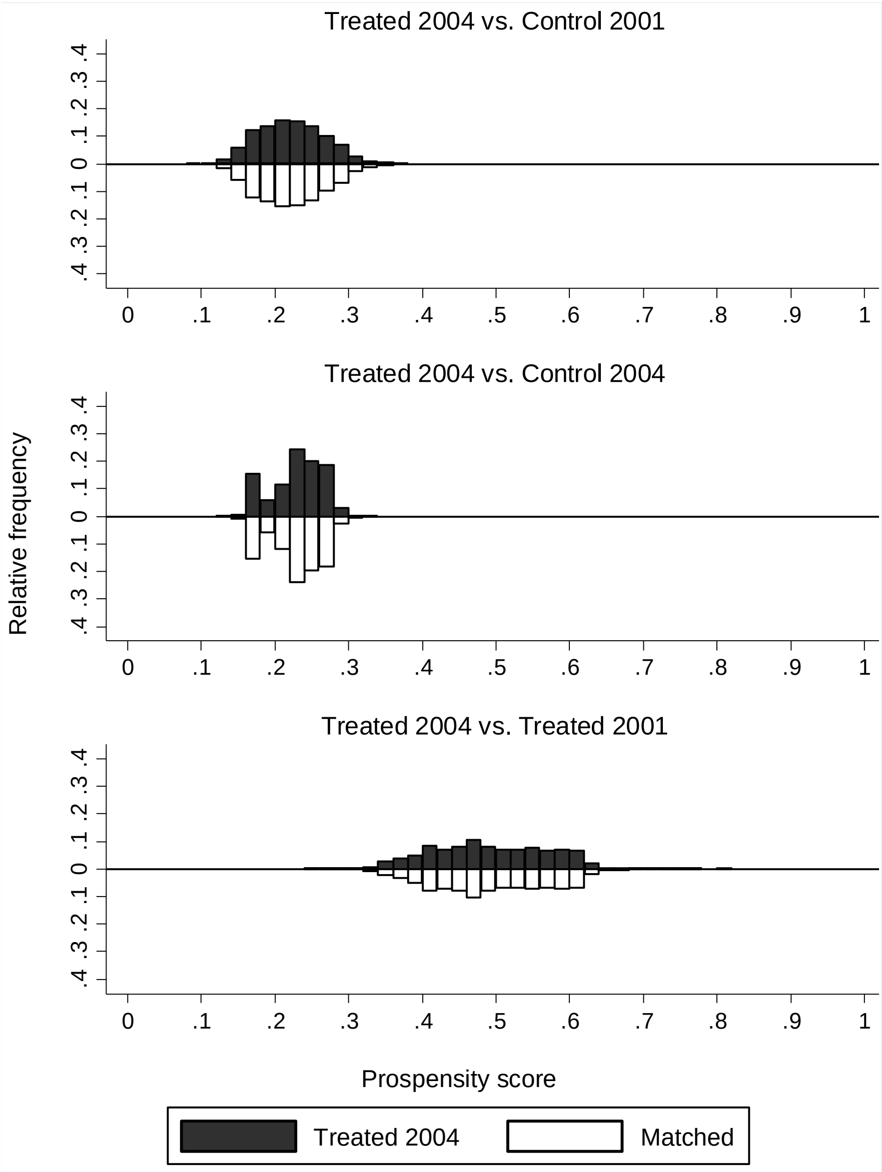
Note. Database is FAST 2001 and 2004.

Figure A4k. Distribution of Prospensity score for Thuringia, matching 1998/2001



Note. Database is FAST 1998 and 2001.

Figure A4l. Distribution of Prospensity score for Thuringia, matching 2001/2004



Note. Database is FAST 2001 and 2004.

Section 3: Details on the DID regressions

Table 6 in the main body of the paper provides the average treatment effects of the treated for six sets of treatment/control groups. Summaries of the regressions are assembled in Tables A4a-g. Further, Table A5 provides another robustness check: In the main body, residents from several states constitute the control group. However, it is not ruled out that the control states follow different time trends. For this reason, we re-ran the DID regressions considering using only the tax units of a single state as controls. The table focuses on Schleswig-Holstein and Bavaria, the two states with time-variant TBRs. As an example, for Schleswig-Holstein, the table provides the average treatment effects using either the residents of Lower-Saxony or of Rhineland-Palatinate as controls. Further, it provides another pseudo treatment and control constellation: Lower-Saxony and Rhineland-Palatinate.

For Schleswig-Holstein we do not see indications that the common trend assumption is violated. Further, if the control state is Lower Saxony, all the results are consistent with the results in the main body: a significant positive effect for 1998/2001 and no effect for 2001/2004. If the control state is Rhineland-Palatinate, the evidence is mixed: the treatment effect is positive but insignificant for 1998/2001 and insignificant in 2001/2004. For Bavaria, it seems that Baden-Württemberg and Hesse follow different trends. Accordingly, the results for Bavaria in the main body should be interpreted with adequate care.

Table A4a. DiD regression details for Schleswig-Holstein

	Treatment group 1998/2001				**Treatment group 2001/2004**			
	OLS		OLS/ matching		OLS		OLS/ matching	
treatment	209.459**	(85.020)	409.685***	(79.945)	-82.389	(79.045)	-15.384	(76.472)
state	-387.012***	(64.829)	-559.195***	(56.751)	-138.069***	(53.020)	-194.031***	(54.082)
year	-1113.256***	(41.928)	-1866.631***	(56.736)	416.353***	(37.878)	463.409***	(54.099)
y_i	0.049***	(0.001)	0.066***	(0.001)	0.049***	(0.001)	0.045***	(0.001)
children	3406.606***	(18.366)	3293.604***	(20.933)	4021.165***	(17.330)	4064.599***	(20.264)
age	393.531***	(18.945)	440.372***	(21.151)	459.891***	(18.330)	444.261***	(20.711)
married	1961.850***	(54.728)	1583.084***	(60.861)	2354.639***	(48.487)	2397.556***	(54.873)
agriculture	2252.546***	(103.470)	2085.540***	(118.548)	2865.387***	(98.660)	3301.004***	(115.912)
business	1782.804***	(43.335)	1562.375***	(48.838)	1868.580***	(39.927)	1869.042***	(46.305)
self empl.	1820.605***	(44.743)	1745.981***	(50.765)	1751.561***	(41.093)	1826.614***	(47.643)
employment	-2499.622***	(51.306)	-2365.135***	(57.209)	-2662.444***	(48.050)	-2644.004***	(54.596)
investment	898.851***	(42.306)	1099.673***	(47.633)	883.391***	(38.364)	944.796***	(45.939)
rent/ lease	-179.309***	(43.657)	-266.627***	(49.621)	-20.154	(40.807)	34.209	(49.238)
other	1512.103***	(69.682)	1126.610***	(75.318)	1813.459***	(62.047)	1857.092***	(70.696)
Constant	2136.309***	(125.390)	905.122***	(141.337)	-40.111	(122.852)	353.638**	(145.752)
R^2	0.363		0.364		0.434		0.439	
Observations	1.15e+05		94591.000		1.22e+05		90279.000	

Note. Robust standard errors in parentheses. Levels of significance: * 10%, ** 5%, *** 1%. *Data.* FAST 1998-2004.

Table A4b. DiD regression details for Bavaria

	Treatment group 1998/2001				**Treatment group 2001/2004**			
	OLS		OLS/ matching		OLS		OLS/ matching	
treatment	139.813***	(49.252)	222.343***	(49.048)	-86.632**	(42.955)	-96.922**	(43.940)
state	118.160***	(38.796)	74.101**	(34.758)	250.350***	(28.998)	271.296***	(31.078)
year	-1080.932***	(31.984)	-1837.295***	(34.723)	375.330***	(27.658)	524.355***	(31.097)
y_i	0.055***	(0.001)	0.077***	(0.001)	0.057***	(0.001)	0.055***	(0.001)
children	3447.202***	(12.377)	3288.829***	(12.952)	4086.767***	(11.240)	4127.441***	(11.795)
age	544.898***	(12.523)	520.695***	(13.111)	647.801***	(11.394)	646.894***	(11.831)
married	2048.125***	(34.071)	1917.503***	(34.469)	2289.071***	(29.177)	2437.166***	(29.616)
agriculture	809.134***	(99.449)	372.585***	(102.776)	2091.373***	(92.848)	2175.376***	(94.146)
business	1789.078***	(29.654)	1481.921***	(30.817)	1857.632***	(26.465)	1893.030***	(27.448)
self empl.	1560.758***	(30.142)	1324.170***	(31.535)	1401.306***	(27.020)	1391.581***	(28.087)
employment	-2384.635***	(36.922)	-2258.901***	(38.590)	-2513.288***	(33.397)	-2566.463***	(34.464)
investment	932.357***	(27.846)	1435.824***	(27.960)	802.156***	(24.299)	807.362***	(25.468)
rent/ lease	-681.692***	(30.059)	-891.761***	(30.202)	-490.204***	(26.823)	-434.582***	(28.133)
other	1533.326***	(46.281)	1192.267***	(48.105)	1956.150***	(41.581)	1961.547***	(43.632)
Constant	916.496***	(86.533)	-1022.281***	(94.175)	-1420.161***	(82.314)	-1491.352***	(92.994)
R^2	0.338		0.332		0.417		0.425	
Observations	2.78e+05		2.71e+05		3.16e+05		2.87e+05	

Note. Robust standard errors in parentheses. Levels of significance: * 10%, ** 5%, *** 1%. *Data.* FAST 1998-2004.

Table A4c. DiD regression details for Brandenburg

	Treatment group 1998/2001				**Treatment group 2001/2004**			
	OLS		OLS/ matching		OLS		OLS/ matching	
$treatment$	210.793	(132.827)	451.118***	(130.216)	406.548***	(112.565)	419.492***	(115.004)
$state$	-792.257***	(103.633)	-890.235***	(92.537)	-565.757***	(78.195)	-543.201***	(81.364)
$year$	-1594.715***	(78.897)	-2055.103***	(92.061)	-637.962***	(65.547)	-528.771***	(81.433)
y_i	0.033***	(0.001)	0.043***	(0.002)	0.033***	(0.001)	0.031***	(0.001)
$children$	2949.765***	(33.933)	2893.813***	(36.162)	3404.159***	(29.729)	3444.653***	(32.140)
age	125.512***	(35.795)	115.764***	(37.908)	118.219***	(31.718)	152.579***	(34.209)
$married$	3492.851***	(103.511)	2988.513***	(105.259)	3474.311***	(83.373)	3320.813***	(84.566)
$agriculture$	1652.673***	(216.143)	1450.594***	(256.229)	2304.266***	(185.980)	2372.503***	(223.398)
$business$	1705.710***	(80.429)	1629.765***	(86.230)	2022.121***	(67.409)	2223.886***	(74.719)
$self\ empl.$	2534.458***	(75.696)	2531.332***	(80.207)	2512.267***	(64.649)	2606.445***	(70.307)
$employment$	-2745.899***	(90.766)	-2533.630***	(100.555)	-2715.688***	(78.003)	-2584.296***	(88.003)
$investment$	655.577***	(77.465)	724.042***	(80.236)	656.543***	(64.073)	785.478***	(71.931)
$rent/\ lease$	-191.811**	(84.809)	-217.609**	(88.687)	-186.522***	(70.324)	-84.260	(80.625)
$other$	755.972***	(133.633)	866.844***	(137.166)	1316.591***	(111.922)	1445.981***	(122.476)
$Constant$	5271.026***	(214.841)	4607.988***	(238.113)	3110.749***	(192.650)	2895.798***	(222.635)
R^2	0.352		0.335		0.402		0.386	
Observations	37502.000		34975.000		44016.000		38760.000	

Note. Robust standard errors in parentheses. Levels of significance: * 10%, ** 5%, *** 1%. *Data.* FAST 1998-2004.

Table A4d. DiD regression details for Mecklenburg-W. P.

	Treatment group 1998/2001				**Treatment group 2001/2004**			
	OLS		OLS/ matching		OLS		OLS/ matching	
$treatment$	84.538	(161.644)	95.965	(143.197)	20.965	(137.476)	-129.173	(127.823)
$state$	-32.089	(126.419)	-95.710	(101.878)	6.485	(94.577)	98.300	(90.562)
$year$	-1536.771***	(71.320)	-1771.715***	(101.127)	-501.841***	(59.179)	-345.933***	(90.463)
y_i	0.032***	(0.001)	0.040***	(0.002)	0.033***	(0.001)	0.031***	(0.002)
$children$	2950.947***	(33.999)	2780.321***	(39.648)	3403.301***	(29.751)	3310.013***	(35.870)
age	125.463***	(35.850)	74.986*	(41.635)	118.435***	(31.739)	114.748***	(37.321)
$married$	3482.505***	(103.657)	3607.959***	(120.895)	3475.430***	(83.439)	3802.814***	(96.656)
$agriculture$	1779.784***	(216.574)	1215.780***	(219.676)	2369.101***	(186.204)	2120.179***	(192.364)
$business$	1743.534***	(80.436)	1395.001***	(93.412)	2046.130***	(67.373)	1907.735***	(80.388)
$self\ empl.$	2588.546***	(75.610)	2279.565***	(88.193)	2541.780***	(64.584)	2424.717***	(77.576)
$employment$	-2734.160***	(90.894)	-2801.324***	(102.818)	-2713.406***	(78.061)	-2750.878***	(89.245)
$investment$	669.840***	(77.560)	617.342***	(86.570)	665.225***	(64.109)	543.143***	(77.511)
$rent/\ lease$	-165.785*	(84.877)	-451.699***	(93.691)	-169.197**	(70.320)	-272.068***	(84.740)
$other$	757.056***	(133.832)	571.503***	(147.623)	1315.489***	(112.002)	1143.130***	(128.823)
$Constant$	5006.180***	(213.148)	5059.424***	(256.340)	2930.935***	(191.939)	3154.136***	(235.167)
R^2	0.350		0.348		0.401		0.395	
Observations	37502.000		28203.000		44016.000		29865.000	

Note. Robust standard errors in parentheses. Levels of significance: * 10%, ** 5%, *** 1%. *Data.* FAST 1998-2004.

Table A4e. DiD regression details for Saxony-Anhalt

	Treatment group 1998/2001				Treatment group 2001/2004			
	OLS		OLS/ matching		OLS		OLS/ matching	
treatment	-91.039	(145.368)	-92.951	(134.628)	-468.984***	(122.358)	-225.731*	(116.847)
state	151.693	(112.720)	104.697	(95.696)	72.482	(85.999)	-25.916	(82.633)
year	-1496.742***	(74.157)	-1621.756***	(95.186)	-376.275***	(61.840)	-437.002***	(82.689)
y_i	0.032***	(0.001)	0.036***	(0.002)	0.032***	(0.001)	0.032***	(0.001)
children	2951.946***	(33.985)	2868.677***	(37.832)	3402.617***	(29.743)	3426.903***	(32.976)
age	125.226***	(35.846)	82.193**	(38.876)	120.090***	(31.733)	36.398	(35.389)
married	3483.533***	(103.651)	3749.764***	(111.697)	3482.803***	(83.422)	3468.427***	(91.775)
agriculture	1771.042***	(216.243)	1670.587***	(218.830)	2388.055***	(185.856)	2704.079***	(199.128)
business	1742.293***	(80.461)	1525.858***	(86.730)	2039.685***	(67.366)	2144.357***	(74.930)
self empl.	2585.663***	(75.656)	2474.638***	(82.883)	2535.370***	(64.561)	2636.706***	(70.920)
employment	-2735.106***	(90.886)	-2843.617***	(95.991)	-2719.186***	(78.042)	-2652.343***	(88.270)
investment	669.662***	(77.556)	713.002***	(79.440)	660.542***	(64.095)	769.942***	(72.760)
rent/ lease	-167.280**	(84.886)	-305.946***	(85.824)	-168.307**	(70.308)	-118.048	(79.163)
other	757.694***	(133.822)	623.982***	(136.434)	1309.046***	(111.980)	1428.438***	(124.374)
Constant	4962.119***	(214.053)	4993.353***	(238.769)	2919.700***	(192.238)	3116.565***	(224.406)
R^2	0.350		0.352		0.402		0.390	
Observations	37502.000		31916.000		44016.000		35853.000	

Note. Robust standard errors in parentheses. Levels of significance: * 10%, ** 5%, *** 1%. *Data.* FAST 1998-2004.

Table A4f. DiD regression details for Thuringia

	Treatment group 1998/2001				Treatment group 2001/2004			
	OLS		OLS/ matching		OLS		OLS/ matching	
treatment	-292.879*	(152.654)	-72.719	(137.851)	-16.913	(127.367)	-46.843	(122.790)
state	920.603***	(120.286)	690.623***	(98.277)	639.290***	(88.214)	572.531***	(86.934)
year	-1466.257***	(72.460)	-1787.948***	(97.294)	-493.852***	(60.617)	-369.735***	(86.978)
y_i	0.033***	(0.001)	0.040***	(0.002)	0.033***	(0.001)	0.030***	(0.002)
children	2953.584***	(33.935)	2790.211***	(38.785)	3405.410***	(29.714)	3357.328***	(34.720)
age	133.054***	(35.805)	178.187***	(40.239)	123.681***	(31.707)	137.321***	(36.238)
married	3478.706***	(103.512)	3528.174***	(115.791)	3472.781***	(83.333)	3857.003***	(94.702)
agriculture	1866.491***	(215.925)	1742.321***	(257.952)	2424.963***	(185.690)	2343.100***	(227.168)
business	1722.791***	(80.350)	1467.155***	(89.284)	2021.842***	(67.336)	1978.319***	(76.540)
self empl.	2563.898***	(75.541)	2414.886***	(84.836)	2516.908***	(64.519)	2466.859***	(73.699)
employment	-2751.141***	(90.780)	-2843.773***	(99.862)	-2732.950***	(77.990)	-2877.882***	(88.531)
investment	647.359***	(77.486)	682.303***	(80.319)	641.994***	(64.075)	678.814***	(71.892)
rent/ lease	-183.960**	(84.787)	-355.991***	(86.443)	-188.699***	(70.269)	-226.046***	(78.283)
other	759.784***	(133.640)	533.870***	(144.397)	1311.591***	(111.876)	1251.693***	(125.691)
Constant	4777.421***	(213.657)	4459.481***	(245.680)	2773.909***	(192.085)	3018.865***	(230.177)
R^2	0.352		0.345		0.403		0.394	
Observations	37502.000		30680.000		44016.000		33044.000	

Note. Robust standard errors in parentheses. Levels of significance: * 10%, ** 5%, *** 1%. *Data.* FAST 1998-2004.

Table A5. Average treatment effects of the treated (att) for additional control groups

State (treatment group)	**Control group**	**Treatment period** 1998/2001 OLS	1998/2001 OLS/ matching	2001/2004 OLS	2001/2004 OLS/ matching
Schleswig-Holstein	Lower Saxony	278.798***	469.024***	-109.735	-82.735
Schleswig-Holstein	Rhineland-Palat.	90.338	33.777	-29.430	48.744
Rhineland-Palat.	Lower Saxony	198.276**	17.759	-85.664	-76.024
Bavaria	Hesse	130.060**	45.737	-142.481***	-196.271***
Bavaria	Baden-Wurttemberg	140.744**	258.019***	-32.578	6.027
Hesse	Baden-Wurttemberg	10.943	80.646	111.861**	131.429**

Note. Levels of significance: * 10%, ** 5%, *** 1%. Control groups are subject to similar a TBR experienced by the treatment group after treatment. . Sample consists of "rich" tax units with gross taxable income in the top income bracket ($y_i > 60.000$ respectively $y_i > 120.000$ for joint filers) only. *Data.* FAST 1998-2004.

Section 4: Modelling of the German Fiscal Equalization System

Germany's fiscal equalization scheme entails several interacting sub-systems that redistribute the taxes collected by the states' tax authorities in two directions: vertically to the federal level and horizontally across states. Total tax revenue of a state originates from two sources: the so-called "own-source" taxes and joint taxes. Own-source taxes are administered and collected by the states (or municipalities), and the generated tax revenue benefits the state (or municipality) exclusively. Inheritance, property acquisition, and lottery taxes are examples for own-source taxes. Revenues from own-source taxes contribute only a small fraction of total tax revenue, however. Joint taxes (income, corporation and value added tax) contribute the lion's share of tax revenue. In the year 2011, for example, joint taxes made up about 70 percent of total tax revenue.[2] The common characteristic of joint taxes is that the tax revenue is shared by the three levels of government: federal, state, and local. A four-stage equalization system assigns joint taxes to the three levels:[3]

1. Initial assignment of joint taxes by means of politically determined vertical distribution rules: Fixed proportions of states' tax revenues are assigned to the federal level and the states.
2. Horizontal redistribution of up to 25 percent of state-specific revenues from value added taxes (VAT). The aim of the VAT redistribution (*Umsatzsteuervorwegausgleich*) is to ensure that each state receives at least 92 percent of average per capita tax revenue of all states (mainly the states' shares of income and corporate taxes and some state taxes).
3. Horizontal redistribution of fiscal revenues from financially strong states to financially weak states. A state's payments/transfers depend on deviations of its fiscal revenue per (virtual)[4] capita and average fiscal revenue per capita over all states. Fiscal revenues of a state covers its share of income and value added tax, revenues from pure state taxes like inheritance or beer tax and 50 percent of the most important local taxes' (i.e. local business tax and property tax). The aim of the third stage ("*Finanzausgleich im engeren Sinne*") is to ensure that each state receives at least 95 percent of the average (per capita) fiscal revenue.
4. Vertical transfers from the federal to the state level. The aim of the vertical transfers ("*Fehlbetragsbundesergänzungszuweisungen*") is to improve the financial situation of

[2] Of the remaining 30 percent, 17 percent of the revenue is channeled to the federal level. Federal taxes include energy taxes, motor vehicle taxes, various consumer taxes (e.g., tobacco, alcohol and insurance taxes) and the solidarity surcharge. Roughly some two percent of total tax revenue is state taxes. The remaining nine percent is channeled to the local level in form of property, business and some local consumption taxes (Federal Ministry of Finance, 2012).
[3] Part of the equalization system changed in 2005. As our data are only available up to 2004 we describe the equalization system valid as existed. However, the main mechanisms have remained in place since then.
[4] For some states with specific financial burdens, population size is adjusted by particular weighting factors.

those states whose fiscal revenue still falls below the inter-state average after stages 1 to 3. The grants are uncommitted and cover at least 90 percent of the remaining gap between fiscal revenue and fiscal need. Accordingly, all states effectively end up with at least 99.5 percent of average per capita fiscal revenue.

In addition, special needs grants (*Sonderbedarfsbundesergänzungszuweisungen*) compensate for special fiscal burdens some states have to bear. These grants are given lump-sum, regardless of fiscal or economic performance.

Our accounting model is implemented in STATA and covers all the legal rules codified in the German fiscal equalization law (*Finanzausgleichsgesetz*, FAG) for the period 1998 to 2004. The necessary federal and state-level information on tax revenues, population sizes, indebtedness, etc. come from the German Federal Ministry of Finance. The model proceeds in two stages. In the first stage, the model determines every state's actual tax returns after fiscal equalization, R_j, using official data on tax revenues, population size, etc. from the Federal Ministry of Finance as input. In the second stage, the tax-back rates are derived. The tax-back rate of state j is derived by increasing the state's actual income tax revenue before equalization by a hypothetical marginal amount (€1,000,000) holding all other inputs constant. Based on this variation, the model determines the new tax returns after fiscal equalization, $\tilde{R}_s$. The state's marginal tax-back rate is the ratio of the change in tax returns after fiscal equalization and the marginal tax base variation, $TBR_j = (\tilde{R}_j - R_j)/1{,}000{,}000$. The second step is implemented for all 16 states and for all three periods of analysis.

The results from the first stage are consistent with available official statistics. Particularly, it reproduces the actual tax entitlements of the states after fiscal equalization from publications by the Federal Council (Bundesrat) and provided by the Federal Ministry of Finance detailed below. Further, if possible, we have cross-checked our $TBRs$ with simulations in earlier works (Baretti et al., 2002, and http://www.laenderfinanzausgleich.com): TBRs from our simulations and theirs coincide.

Relevant official publications by the German Federal Ministry of Finance:

Federal Council Journal (Bundesrats-Drucksache) No. 123/00; 577/03; 922/05 –available online at www.bundesfinanzministerium.de)

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