

Hack, Lukas

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Progressive Income Taxation and Inflation: The Macroeconomic Effects of Bracket Creep*

Lukas Hack

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Abstract

Under nominal progressive taxation, inflation drives up tax rates if the schedule is not adjusted, leading to bracket creep. To isolate bracket creep from other sources of tax rate changes, I propose a non-parametric decomposition of changes in tax rates. Applying the decomposition to German administrative tax records, I find sizeable bracket creep episodes. While the overall importance of bracket creep has decreased over time due to institutional changes, the post-Covid inflation surge led to a resurgence. I characterize how bracket creep affects labor supply decisions in a partial equilibrium framework. Further, I estimate a theory-consistent measure of bracket creep, the indexation gap, which is used to discipline a New Keynesian model with incomplete markets. The model predicts that a given reduction in inflation via a monetary contraction leads to less output costs in an economy with bracket creep.

Keywords: Progressive taxation, inflation, bracket creep.

JEL Codes: E31, E62, H24.

*Department of Economics, University of Mannheim, lukas.hack@uni-mannheim.de. I am grateful to Eckhard Janeba and Matthias Meier for their invaluable guidance and comments throughout this project. I thank Klaus Adam, Antoine Camous, Andreas Gulyas, Jon Hoddenbagh (discussant), and Arthur Seibold, as well as participants at various seminars and conferences, for their helpful comments. I thank Freya Cook and Elisabeth Klages, who provided excellent research assistance. I acknowledge financial support from the German Research Foundation (DFG) through CRC TR 224 (Project C05) as well as the data-handling support of the Research Data Centres of the Federal Statistical Office and the Statistical Offices of the Federal States.

1 Introduction

Most theoretical models of progressive income taxation consider a tax function that is a mapping from real taxable income to average and marginal tax rates (e.g. [Heathcote et al., 2017](#)). In practice, however, tax rates are a function of nominal taxable income. The distinction matters when the tax code is not indexed to inflation, that is, when the tax parameters are not adjusted to account for changes in prices.¹ In this paper, I refer to bracket creep as any wedge in tax rates between real and nominal taxation. Such wedges may exist when tax rates are not merely a function of real taxable income.²

Bracket creep implies that tax rates are differently affected by macroeconomic shocks. Demand shocks move real income and prices in the same direction, implying that nominal income responds stronger than real income. The stronger response in the nominal tax base translates into a greater tax rate change. Conversely, tax rates become less responsive to supply shocks as real income and prices move in opposite directions, implying a weaker nominal income response.³ This may matter for the macroeconomy since income tax changes have large aggregate effects (e.g. [Mertens and Ravn, 2013](#)). Moreover, in the context of monetary policy, it implies a new dimension of fiscal-monetary interaction because monetary policy shocks partly propagate through fiscal instruments, i.e., tax rates via inflation.

This paper investigates the quantitative consequences of bracket creep on the macroeconomy. Empirically, I isolate bracket creep from other sources of tax rate changes based on a non-parametric decomposition of changes in tax rates. Applying the decomposition to German administrative tax records yields sizable bracket creep episodes. While the overall impor-

¹Many developed countries still lack annual indexation schemes that automatically adjust the tax code. For example, ten out of twenty Euro Area member states that account for 63% of Euro Area GDP had no automatic annual indexation implemented by the end of 2022 (see, e.g., <https://taxfoundation.org/data/all/global/income-tax-inflation-adjustments-europe/>).

²Bracket creep in the literal sense refers to taxpayers who get pushed into the next tax bracket with a higher tax rate, even when only nominal income but not real income grows. The notion of bracket creep entertained in this paper encompasses this effect.

³For example, consider a contractionary supply shock such that real income falls, but prices rise. When real income was the tax base, tax rates would decline. However, the rise in prices implies that nominal income declines by less, leading to less reduction in tax rates. In the knife-edge case of constant nominal income, there would be no tax rate decline at all because both forces perfectly cancel each other.

tance of bracket creep has decreased over time due to institutional changes, the post-Covid inflation surge led to a resurgence. I characterize how bracket creep affects labor supply decisions in a partial equilibrium framework. Further, I estimate a theory-consistent measure of bracket creep, the indexation gap, which is used to discipline a New Keynesian model with incomplete markets. The model predicts that a given reduction in inflation via a contractionary monetary policy shock leads to substantially smaller short-run output costs in an economy with bracket creep. Put differently, the output costs are aggravated when the tax code is indexed to inflation, revealing a potential caveat of such indexation schemes.

To obtain a tax rate decomposition that separates bracket creep from other sources of tax rate changes, I propose to measure the adjustments that compensate for inflation as the actual change in tax rates that a taxpayer with constant real income faces relative to the change in tax rates she would face if the nominal tax code was not adjusted at all – the latter being a benchmark of “full” bracket creep. When this ratio is zero, then the taxpayer is fully compensated since tax rates remain unchanged, implying full indexation, i.e., there is no bracket creep. Conversely, when this ratio is one, then there is full bracket creep, implying no indexation because the taxpayer is not compensated at all. I use this measure to decompose year-over-year changes in average and marginal tax rates into three distinct components: (i) bracket creep, (ii) real income growth, and (iii) discretionary tax changes. Importantly, the decomposition imposes no restrictions on the tax schedule beyond progressivity.

Empirically, I implement the decomposition based on German administrative tax records from 2002 until 2018. The administrative tax data is desirable because I need to know the entire distribution of gross incomes and claimed deductions to compute tax rates accurately, which is a prerequisite for reliable decomposition results. Further, the German setting is suitable because there are multiple years in which the tax system was not adjusted, inevitably leading to bracket creep. Moreover, I can evaluate a 2012 tax reform that aimed at reducing bracket creep. The reform requires the government to publish a mandatory bracket creep report, along with suggestions to undo bracket creep. While not mandated by law, since

then, the government has aimed to adjust the tax code based on inflation forecasts, which may only address bracket creep due to anticipated inflation. Imputing the tax data until 2023 allows me to evaluate this policy regime in the presence of a large inflation surprise.

Focusing on the long-run average effects in my sample, I find that bracket creep accounts for an annual increase in average and marginal tax rates between 0.10 and 0.12 percentage points. For comparison, the average annual inflation rate in this sample was 1.43, which implies that a percentage point increase in inflation corresponds to a 7-9 basis point increase in tax rates per year. These bracket creep effects are relatively uniform across the income distribution. In contrast, tax changes due to real income growth are negligible, accounting for less than 0.05 percentage points. Finally, discretionary tax changes account for an annual decrease in tax rates between 0.14 and 0.17 percentage points. Importantly, discretionary tax changes do not compensate for bracket creep because they occur infrequently.

The above results characterize the trend in changes in tax rates. For macroeconomic stabilization, however, the fluctuations around the trend matter. The most pronounced fluctuations arise when the government does not adjust the tax schedule for multiple consecutive periods. There are two such bracket creep episodes before 2012. During these episodes, bracket creep accounts for a total increase in average and marginal tax rates between 0.64 and 0.86 percentage points, cumulated over each three-year bracket creep episode. In contrast, from 2013 until 2018, I find very little bracket creep, suggesting that the 2012 tax reform successfully eliminated bracket creep during a period of low and stable inflation. However, the post-Covid inflation surge, a large inflation surprise, led to a resurgence of bracket creep with sizable effects on average and marginal tax rates, which increased by 0.51 and 0.66 percentage points, respectively. Overall, this shows that bracket creep accounts for sizable changes in tax rates paid by households.

To understand how household choices respond to bracket creep, I propose an analytical model with a tax schedule that nests the one from [Heathcote et al. \(2017\)](#) but allows for bracket creep (HSV-type tax schedule, henceforth). I study the labor-leisure choice of a household

facing this tax schedule and a government that may return a fraction of the tax revenues to the household via a transfer. I show that the labor supply response to bracket creep is theoretically ambiguous and crucially depends on how the government uses tax revenues. Intuitively, when all tax revenues (from bracket creep) are returned to the households, then income effects are eliminated, and only a substitution effect prevails, reducing labor supply. Conversely, labor supply may increase when the government is not giving back tax revenues via transfers. Incidentally, the previous literature on bracket creep neglects the important role of transfers and assumes that all tax revenues are given back without (convincing) justification.⁴

An appealing feature of the proposed HSV-type tax schedule is that bracket creep can be conveniently summarized by a scalar statistic, the indexation gap. The time series of indexation gaps can be estimated based on restrictions derived from the HSV-type tax schedule, delivering a theory-consistent measurement of bracket creep that captures the government's adjustment or indexation choices as well as the prevailing inflation rate. Finally, I use the indexation gap series to provide reduced-form evidence that supports my tax schedule formulation and to discipline the quantitative analysis.

The quantitative analysis of bracket creep is based on a standard New Keynesian model with incomplete markets (e.g. [Auclert et al., 2021](#)), which also nests my analytical model. Households consume, supply labor, and may save in a liquid asset. The production side features nominal price rigidities. A fiscal authority uses the tax revenues to finance spending and transfers, and a monetary policy authority controls the nominal interest rate. I calibrate the model to the German economy before the 2012 tax reform, using the empirically observed indexation gaps to discipline how the fiscal authority adjusts the tax schedule.

In this setup, I study the responses to a monetary policy shock and compare it with the counterfactual responses under full indexation. The results suggest that indexation amplifies the effects of monetary policy on output, whereas the impact on inflation dynamics is negligible.

⁴It applies to the few papers that use New Keynesian models with complete markets ([Edge and Rudd, 2007](#); [Keinsley, 2016](#)), or a money growth model with incomplete markets ([Heer and Süßmuth, 2013](#)).

Quantitatively, the impact response under full indexation is roughly thirty percent larger than with bracket creep, but the difference vanishes roughly within a year. The intuition for the differential output effects is that tax rates are more responsive to demand shocks in an economy with bracket creep. The resulting substitution effects of taxation dominate income effects under the calibration to the German economy. This discourages labor supply, which depresses the production response. Finally, one interpretation of the result is that the output costs of reducing inflation via monetary policy are aggravated when the tax code is indexed to inflation, revealing a potential caveat of such indexation schemes.

Related literature. This research relates to the surprisingly scant literature on bracket creep. Empirically, most papers study bracket creep based on micro-simulations focusing on particular historical episodes in the European (e.g., [Immervoll, 2005, 2006](#); [Paulus et al., 2020](#)), or specifically in the German context (e.g., [Zhu, 2014](#); [Blömer et al., 2023](#)).⁵ My contribution lies in a comprehensive and transparent documentation of bracket creep effects over twenty years for Germany and a comparison with other sources of tax rate changes through my decomposition approach. Theoretically, bracket creep has been studied in New Keynesian models with complete markets ([Edge and Rudd, 2007](#); [Keinsley, 2016](#)) and in a money growth model with incomplete markets ([Heer and Süßmuth, 2013](#)). Relative to these papers, I analytically show that transfers crucially shape the labor supply response to bracket creep, and I offer a quantitative analysis of bracket creep using a workhorse New Keynesian model that accounts for household heterogeneity along the income distribution. More broadly, I relate to studies that focus on inflation and its interaction with taxation in general, (e.g., [Süßmuth and Wieschemeyer, 2022](#); [Cloyne et al., 2023](#); [Altig et al., 2024](#)), with capital taxation specifically (e.g., [Feldstein, 1983](#); [Gavin et al., 2007, 2015](#)), or on inflation and its impact on households (e.g., [Erosa and Ventura, 2002](#); [Doepke and Schneider, 2006](#); [Adam and Zhu, 2016](#); [Pallotti, 2022](#); [Pallotti et al., 2023](#)). Further, I relate to the broad literature on progressive taxation (e.g., [Benabou, 2002](#); [Conesa and Krueger, 2006](#); [Mattesini](#)

⁵For a current discussion of bracket creep during the recent inflation surge, see [Bundesbank \(2022\)](#).

and Rossi, 2012; Heathcote et al., 2017, 2020; McKay and Reis, 2021), as well as to the literature on New Keynesian models with incomplete markets (e.g., Kaplan et al., 2018; Auclert et al., 2021, 2023).

2 Empirical analysis

In this section, I propose a new approach to measure bracket creep based on tax data. My approach rests on measuring the degree of indexation of the tax schedule in reduced-form to compute a decomposition of the changes in tax rates into three distinct components: (i) real income growth, (ii) discretionary tax changes, and (iii) bracket creep. I apply this approach to German administrative tax records and show that bracket creep effects are of similar quantitative importance as discretionary tax changes. I further identify two sizable bracket creep episodes before 2012 and a decline in the quantitative importance of bracket creep thereafter. However, the 2022 inflation surge led to a sizable resurgence of bracket creep because of imperfect inflation adjustments.

2.1 Measuring bracket creep

I derive a decomposition of the year-over-year changes in average and marginal tax rates of a single taxpayer. Let $Y_t > 0$ be nominal pre-tax income in year t . Taxable income is $Z_t = Y_t - D_t$ with $D_t \geq 0$ being the amount of deductions. The average or marginal tax rate can be represented as a mapping $\tau_t : \mathbb{R}^+ \rightarrow \mathbb{R}^+$ from nominal taxable income to the respective tax rate. This mapping to tax rates incorporates tax exemptions.⁶ I assume that the tax schedule is progressive, which implies that $\tau_t(Z_t)$ is strictly increasing in income when it refers to the average tax rate. When $\tau_t(Z_t)$ refers to the marginal tax rate, then progressivity only demands that it exceeds the average tax rate for any Z_t , but it need not

⁶The tax exemption implies that $\tau_t(Z_t) = 0$ for all $Z_t \leq \underline{Z}$, where \underline{Z} is the exemption amount. This exemption amount is a parameter of the tax function that the government may adjust. Indeed, anticipating the empirical application, the exemption amount is adjusted on an annual basis in Germany.

be strictly increasing for any Z_t . I further assume that taxable income Z_t is sufficiently large to ensure $\tau_t(Z_t) > 0$, focusing on individuals who actually pay taxes. Put differently, this rules out incomes below the tax exemption threshold. Let $Z_t^\Pi = Y_{t-1} \Pi_t - D_t^\Pi$ be taxable income of a taxpayer who has the same real pre-tax income as in the previous year, i.e., $Y_t = Y_{t-1} \Pi_t$, and $\Pi_t = P_t/P_{t-1}$ is the gross inflation rate. Deductions $D_t^\Pi \in [D_{t-1}, D_{t-1} \Pi_t]$ may or may not be adjusted to inflation, as I explain below. I define a tax function that gives the tax rate in year t as a function of nominal taxable income in years t and $t - 1$ for the taxpayer with constant real pre-tax income.

Definition 1.

$$\tau_t^{\mathcal{I}}(Z_t^\Pi, Z_{t-1}) = \alpha_t \tau_{t-1}(Z_{t-1}) + (1 - \alpha_t) \tau_{t-1}(Z_t^\Pi). \quad (2.1)$$

The tax function is a (point-wise) convex combination of two cases where $\alpha_t \in [0, 1]$ measures the degree of indexation of the tax function. With $\alpha_t = 1$, the tax function is perfectly indexed to inflation since the tax rate in period t coincides with the tax rate in the previous period. In other words, tax rates are unaffected by nominal income growth that compensates for inflation. Conversely, when $\alpha_t = 0$, the tax function is not indexed at all because nominal income in t is evaluated at the schedule from the previous year. Thus, there is no inflation adjustment in the tax schedule, and the tax rate may change whenever $Z_t^\Pi \neq Z_{t-1}$.⁷

Decomposition. Given the tax function from Definition 1, I decompose the year-over-year changes in tax rates paid by the taxpayer as follows.

⁷Marginal tax rates may also stay constant when both Z_t^Π and Z_{t-1} fall in a tax bracket with the same constant marginal tax rate. The average tax rate necessarily adjusts under a progressive schedule when $Z_t^\Pi \neq Z_{t-1}$ because the average tax rate is strictly increasing in nominal income.

$$\tau_t(Z_t) - \tau_{t-1}(Z_{t-1}) = \Psi_t^{bc} + \Psi_t^{rg} + \Psi_t^{tc}, \quad (2.2)$$

and

$$\begin{aligned} \Psi_t^{bc} &= \underbrace{\tau_t^{\mathcal{I}}(Z_t^{\Pi}, Z_{t-1}) - \tau_{t-1}(Z_{t-1})}_{\text{bracket creep}}, \\ \Psi_t^{rg} &= \underbrace{\tau_t(Z_t) - \tau_t(Z_t^{\Pi})}_{\text{real income growth}}, \\ \Psi_t^{tc} &= \underbrace{\tau_t(Z_t^{\Pi}) - \tau_t^{\mathcal{I}}(Z_t^{\Pi}, Z_{t-1})}_{\text{discretionary tax change}}, \end{aligned}$$

The first term measures bracket creep, that is, changes in tax rates due to a lack of indexation of the tax schedule. The second term captures the changes in tax rates due to real income growth. Taken together, both terms show increases in tax rates due to nominal income growth. The third term captures discretionary changes to the tax schedule that are not captured by indexation through $\tau_t^{\mathcal{I}}(\cdot)$. Next, I can characterize the bracket creep term.

Proposition 1. *Given Definition 1, the bracket creep term from (2.2) is given by*

$$\Psi_t^{bc} = (1 - \alpha_t) \left[\tau_{t-1}(Z_t^{\Pi}) - \tau_{t-1}(Z_{t-1}) \right].$$

If $\Pi_t > 1$, and $\alpha_t < 1$ and $\frac{\partial \tau_{t-1}(Z)}{\partial Z} > 0$ for all $Z \in [Z_{t-1}, Z_t^{\Pi}]$, then it holds that $\Psi_t^{bc} > 0$.

The proof is in Appendix A. Note that under a progressive tax system, the third condition, $\frac{\partial \tau_{t-1}(Z)}{\partial Z} > 0$, is always satisfied for the average tax rate but not necessarily for the marginal tax rate.⁸ Suppose $\tau_t(\cdot)$ is indeed the average tax rate to illustrate the proposition. Then, the proposition states that the bracket creep term in the decomposition is strictly positive when three conditions apply: (i) there is positive inflation, (ii) the tax code is not perfectly

⁸When marginal tax rates are constant within a given tax bracket and, under constant real income, inflation does not push a taxpayer into the next bracket, then there is no bracket creep in terms of the marginal tax rate

indexed to the actual rate of inflation, and (iii) the tax code is progressive. In contrast, the bracket creep term is zero under full indexation or absent inflation or under a linear tax schedule. This suggests that the bracket creep term captures only bracket creep effects when expected.

Degree of indexation. To operationalize the decomposition, I need to measure α_t . I propose a measurement of α_t that leverages observed changes in the tax schedule, irrespective of whether these adjustments are discretionary or implemented via an automatic indexation scheme. This corresponds to a notion of *effective* indexation measured as

$$\alpha_t = \begin{cases} 1 - \max \left\{ \min \left\{ \frac{\tau_t(Z_t^\Pi) - \tau_{t-1}(Z_{t-1})}{\tau_{t-1}(Z_t^\Pi) - \tau_{t-1}(Z_{t-1})}, 1 \right\}, 0 \right\} & \text{if } \tau_{t-1}(Z_t^\Pi) > \tau_{t-1}(Z_{t-1}), \\ 1 & \text{otherwise.} \end{cases} \quad (2.3)$$

Focusing on the first case in (2.3), the denominator captures the amount of bracket creep under constant real income that prevails when the tax code is not adjusted at all, i.e., $\tau_t(Z) = \tau_{t-1}(Z)$, $\forall Z$. This is the benchmark of “full” bracket creep, or equivalently, no indexation. The numerator measures the change in the tax rate, accounting for actual adjustments in the tax function. The ratio can be interpreted as a measure of the “distance” between the actual change in the tax rate and the full bracket creep benchmark. Therefore, I refer to this ratio as the degree of bracket creep and, conversely, to α_t as the degree of indexation. Consider the empirically relevant case of positive inflation, where $Z_t^\Pi > Z_{t-1}$. In this case, when the numerator is larger than the denominator, then the degree of indexation is zero. Any increase in the tax rate larger than the full bracket creep benchmark must be a discretionary tax hike. Conversely, when the numerator is negative, the degree of indexation is unity because the taxpayer is fully compensated for bracket creep. Any (additional) reduction in the tax rate must be a discretionary tax cut. Further, the degree of indexation is also unity when the denominator is zero. It may only happen when considering marginal

tax rates that are constant within a tax bracket, and both Z_t^Π and Z_t fall in the same bracket with a constant marginal tax rate. Finally, note that this approach works equally well in the case of deflation, although this never occurs in my sample.⁹

This approach to quantifying the degree of indexation is appealing because it imposes no parametric restriction on the tax schedule. It can be implemented with relatively mild information requirements. One only needs to measure taxable income, deductions, inflation, and the exact tax schedule as specified in the tax law, including tax exemptions.

Aggregation. The presented decomposition applies to a single taxpayer. It may be a single person who files taxes on her behalf or married spouses who file their taxes jointly. The decomposition does not require to distinguish between these two cases. Aggregation to sample averages is straightforward since the decomposition is additive. Thus, I can readily compute arithmetic averages $\bar{\Psi}_A^k = \sum_{(i,t) \in A} \Psi_{i,t}^k$ for any decomposition term k , where A denotes the set of individuals and time periods over which the average is computed.

Alternative mechanical decomposition. An alternative decomposition may measure bracket creep as changes in tax rates under constant real income, keeping the tax schedule constant. From Proposition 1, it becomes clear that this naive mechanical decomposition is nested when imposing $\alpha_t = 0 \forall t$. Based on this, one could still compute the bracket creep term and subtract the discretionary tax change term after aggregation to check whether there is bracket creep that is not compensated with tax function changes. However, even when both terms net out, one cannot conclude that all taxpayers got compensated for bracket creep every year because it does not take into account how the compensation via discretionary tax changes is distributed across taxpayers and time. For example, it could be that a fraction of taxpayers is benefiting from large tax cuts (that over-compensate bracket creep), whereas others receive no compensation and, therefore, see tax rates changing due to bracket creep.

⁹In this case, the “full” bracket creep benchmark is negative. There is full indexation when actual tax rates do not change (or even increase). When tax rates fall, there is incomplete indexation or, equivalently, bracket creep. Naturally, in this case, bracket creep lowers the tax rates relative to full indexation.

Whether these composition effects matter is an empirical question. Thus, I also report the results of the mechanical decomposition.

Deductions. It may be important to account for deductions because many fixed-amount deductions are specified in the tax law and only infrequently adjusted. For example, this applies to work-related deductions that are lump-sum or calculated based on commuting distance in Germany.¹⁰ Accounting for deductions is particularly important for the constant real income scenario, where I aim to measure how taxable income would have evolved when the taxpayer’s behavior is kept constant. In this case, deduction amounts may only increase when the deductions reflect actual nominal payments that increase with inflation (itemized deductions) or when the government raises the deduction amounts specified in the tax law. Unfortunately, discriminating these two cases is infeasible in the data.¹¹ Thus, I will present two versions of the decomposition. As a conservative baseline, I assume that all deductions grow with inflation, i.e., $D_t^{\Pi} = D_{t-1}\Pi_t$. Alternatively, I present results where the deductions are kept constant, i.e., $D_t^{\Pi} = D_{t-1}$. The former may be a lower bound on the quantitative importance of bracket creep, while the latter delivers an upper bound. In practice, the appropriate value of D_t^{Π} should be in between these two extreme cases. Reporting both reveals to what extent my results depend on deductions. Finally, note that tax exemptions are part of the tax rate function $\tau_t(\cdot)$. Thus, I account for the empirically observed changes in exemption amounts, irrespective of the treatment of deductions.

¹⁰In practice, the available deduction possibilities may affect economic choices, e.g., the work location and commuting distance. While the decomposition does not take a stand on these incentive effects, I abstract from this in the theoretical models presented in Sections 3-4. This is a common assumption when one studies the (macroeconomic) consequences of taxation (see, e.g., [Heathcote et al., 2017](#)).

¹¹This is because the actual computation of deductions in the tax data is extremely complex since the tax declarations involve more than 2000 variables, of which most matter for this computation. While it is ex-ante unclear, it turns out that deductions are not crucial for the empirical results.

2.2 Administrative tax records

Institutional setting. I analyze administrative tax records from Germany, where income from most sources is subject to the progressive income tax schedule.¹² A fixed amount of around 10,000 euros (varying over time) is exempt. Any taxable income beyond the exemption is taxed. Figure B.1 in Appendix B illustrates the schedule for different years in my sample. An important feature of the schedule is that marginal tax rates increase linearly within each tax bracket, except for taxable income above around 60,000 euros. It implies that bracket creep can increase marginal tax rates for any taxpayer below the top brackets, even if she stays within her tax bracket. Moreover, all taxpayers may experience bracket creep effects in terms of the average tax rate as this rate is always increasing in income, regardless of whether the marginal tax rate is constant. This matters because an increase in the average tax rate reduces the real disposable income of taxpayers.

Germany also offers a preferential tax scheme for married spouses. Under this joint taxation scheme, the tax function is evaluated only at the average taxable income of both spouses.¹³ This implies that married spouses are typically in a lower tax bracket than the higher income earner under individual taxation. Thus, under joint taxation, the tax function is evaluated at lower taxable income where average and marginal tax rates respond more strongly to income changes; see also Figure B.1 for an illustration. Thus, bracket creep may also be important for middle-class households. This is especially relevant when one spouse is the only breadwinner.

Turning to indexation, Germany has no automatic inflation adjustments to the tax code. However, a tax reform in 2012 mandated the government to prepare a bracket creep report

¹²A noteworthy exception is that capital income has been taxed at a flat rate of 25% since 2009. A further special case is that taxpayers may opt to pay regular income taxes on their capital income (as opposed to the flat rate) when the progressive tax schedule implies a lower tax rate. In practice, these cases are likely negligible. It only applies to taxpayers with sufficiently low taxable income (including capital income) so that the regular income tax rate (based on the progressive tax schedule) does not exceed 25%, but capital income still exceeds the exemption amount on capital income, the so-called “Sparerfreibetrag”.

¹³The final nominal tax payment is given by two times the tax payment that a single taxpayer with this average income would have to pay.

every other year (e.g. [Bundesbank, 2022](#)). Along with this obligation, the Federal Ministry of Finance regularly adjusts the tax schedule for inflation based on inflation forecasts for the subsequent two years. The tax parameters are adjusted for both years separately, given the inflation forecast. The adjustment procedure applies only to the statutory tax code but not to deductions.¹⁴ Below, I study to which extent this reform eliminated bracket creep.

Taxpayer panel. The data is an annual panel of income taxpayers in Germany from 2002 until 2018. It contains administrative tax records that are provided by the German Federal Statistical Office.¹⁵ An individual taxpayer may be an individual or married spouses who file their taxes jointly. Specifically, I define a taxpayer conditional on filing status. For example, a taxpayer filing taxes individually is considered a different cross-sectional unit than the same taxpayer when filing jointly later in life. The data is a five percent random sample taken from the universe of taxpayers. For my analysis, I focus on taxpayers who file their tax declarations, have positive tax liabilities, and do not apply specific widow tax schemes.¹⁶ The resulting sample contains around 14 million tax records. Restricting the attention to taxpayers with observations available for at least two consecutive years leaves me with around 10 million tax records as the baseline sample for the tax rate decomposition.

Variables. The Taxpayer panel contains all variables that can be filed in German income tax declarations. For my analysis, I mainly use gross income, taxable income, and the final tax liability. Gross income refers to all reported income before deductions are subtracted, whereas taxable income is gross income minus deductions. I use these two variables to compute the total amount of deductions. Finally, I use the tax liability to verify that my

¹⁴Note that I account for changes in tax exemptions, which are part of the statutory tax code. This is important because the exemption amount is frequently adjusted to not tax a subsistence level of income.

¹⁵To be precise, the data source is the Research Data Center of the Federal Statistical Office and Statistical Offices of the Laender, Taxpayer Panel, 2002-2018. All presented results are based on my own calculations.

¹⁶Not all taxpayers in Germany need to file their taxes. This applies when taxpayers have only one source of (labor) income such that the monthly withholding tax can be expected to be close to the tax liability when filing (these are the so-called “Lohnsteuerfälle”). I exclude these taxpayers to maintain a consistent sample because they are not in the tax data before 2012.

implementation of the tax schedule is accurate for all years.¹⁷ The descriptive statistics are presented in Table B.1 in Appendix B.

Additional data. I use the inflation rate of the German CPI to obtain nominal income that maintains constant real value. To study the post-Covid inflation surge, I use average household income growth from the German Federal Statistical Office to impute the income distribution for years beyond 2018. Specifically, I take the 2018 cross-sectional distribution of taxpayers as given and assume that all Euro-value variables grow at the rate at which average household income was growing; see Table B.2 for the data used for imputation.

2.3 Results

I report empirical results based on the decomposition developed in Section 2.1. First, I present averages over the entire sample, which reflect long-run trends in tax rate changes. Then, I show how the effects vary across years to understand the cyclical properties. I find two sizable bracket creep episodes before 2012 and a resurgence of bracket creep during the post-Covid inflation period. All reported results are significant at the 5% level, and standard errors are reported in Tables B.3-B.4 in Appendix B.

Average effects. Panels (a) and (b) of Figure 1 provide the decomposition averaged across all taxpayers between 2002 and 2018 for average and marginal tax rates, respectively. The baseline decomposition results are depicted as blue bars. The (smaller) red bars indicate how the decomposition would change when deductions are assumed to be constant in nominal terms.¹⁸ Finally, the cross-markers give the total effect under constant deductions. I find that bracket creep accounts for 0.10 percentage points when measured in average tax rates and 0.11 percentage points when measured in marginal tax rates. Keeping deductions constant

¹⁷The difference between the actual tax liability and my own calculations is less than 1 euro per average monthly income of each taxpayer for more than 99% of the tax declarations.

¹⁸Recall the baseline decomposition assumes that deductions grow at the rate of inflation. The exemption is directly included in $\tau_t(\cdot)$ and not kept constant, even when nominal deductions are fixed.

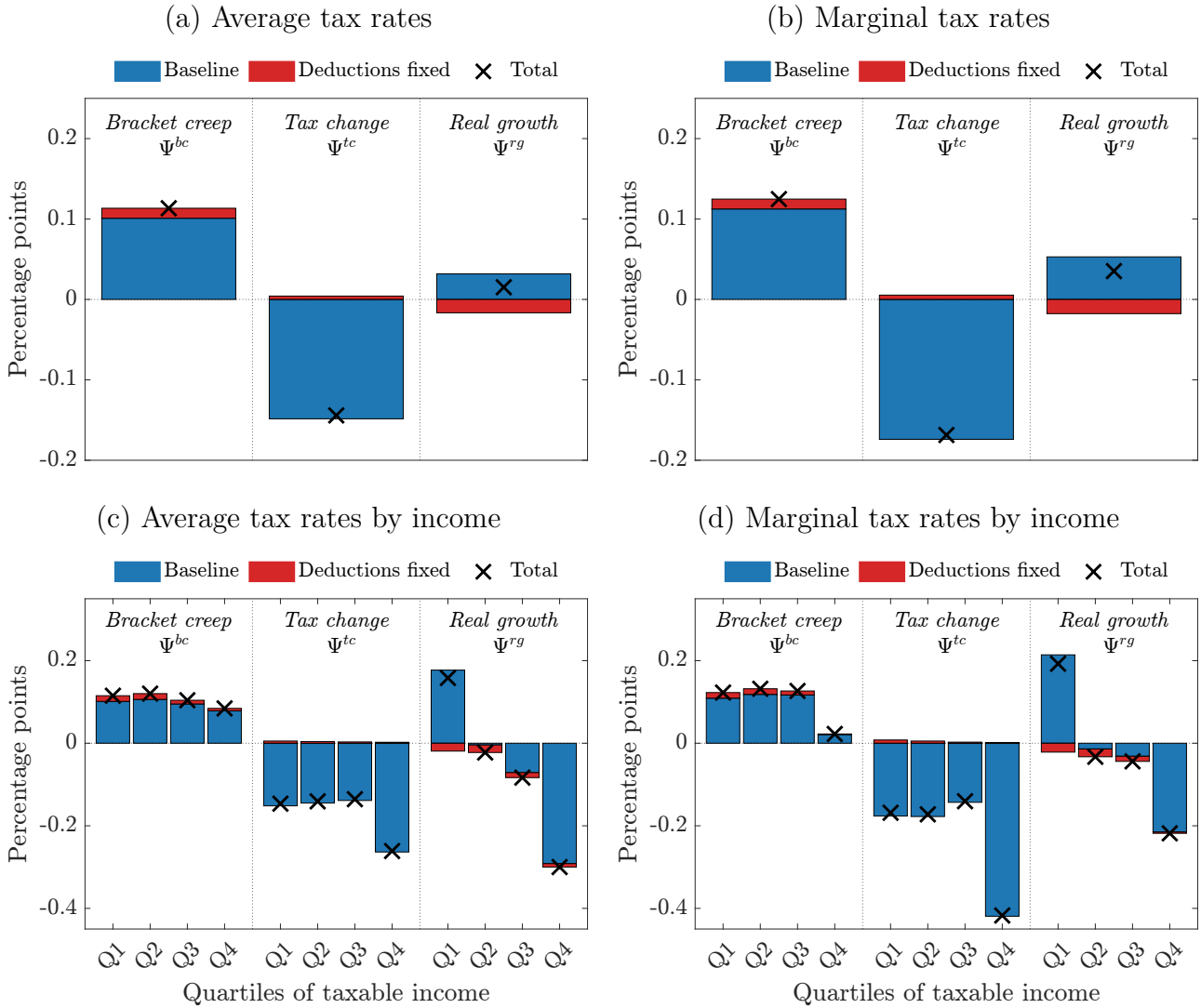
raises these numbers by one basis point only, suggesting that the treatment of deductions is quantitatively not relevant. The average annual inflation rate in this sample was 1.43, which implies that a percentage point inflation corresponds to a 7-9 basis point increase in tax rates per year. In comparison, real income growth leads to modest increases in tax rates of up to 0.05 percentage points and even less when keeping deductions fixed. Tax rate increases due to both bracket creep and real income growth fundamentally reflect growth in nominal incomes. The estimates suggest that the former is more important for the average changes in tax rates.¹⁹ Finally, discretionary tax changes contribute negatively with -0.14 and -0.17 percentage points, respectively. Below, I show that discretionary tax rate changes do not cancel out with tax rate changes due to bracket creep because they occur in different years.

Distributional effects. Panels (c) and (d) of Figure 1 unpack how the average decomposition results varies along the taxable income distribution. Specifically, I group households in quartiles of their taxable income from the previous year and divide the taxable income of jointly filing spouses by two to obtain a per-person measure of taxable income. Irrespective of the tax rate for which the decomposition is implemented, bracket creep appears to be relatively uniform across the income distribution. Only the top quartile is slightly less exposed to bracket creep.²⁰ While absent tax adjustments, one should expect that bracket creep continuously decreases along the income distribution; it is consistent with households in the second and third quartiles being less compensated by tax adjustments. A noteworthy heterogeneity is that bracket creep in terms of the marginal tax rate is very small at the top quartile. This is in line with the German tax schedule because the marginal tax rate is constant in the two top tax brackets. In comparison, tax rate changes due to real income growth are more pronounced in the tails of the income distribution, consistent with mean-reversion of

¹⁹Note that the results reflect aggregate effects that net out idiosyncratic shocks. Thus, tax rate changes due to real income growth may be more important when idiosyncratic shocks are considered.

²⁰Fixed exemption amounts for capital income are unlikely to affect the results for two reasons. First, capital income is typically not included in taxable income since 2009. Second, before 2009, capital income makes up a small fraction of total gross income for most households. For those with large capital income, in turn, the exemption amount may be negligible.

Figure 1: Decomposition of tax rates



Notes: The figure shows the decomposition of year-over-year changes in average and marginal tax rates, see equation (2.2). *Bracket creep* refers to the change in the tax rate that a taxpayer with constant real income experiences, absent discretionary tax reforms, whereas *Tax change* refers to changes due to discretionary tax reforms. *Real growth* refers to changes in tax rates due to real income growth under the contemporaneous tax schedule. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018; all estimates are significant at the 5% level, for standard errors, see Table B.3. The top row presents the results for the full sample and the bottom row distinguishes taxpayers by quartiles of per-person taxable income in the previous calendar year. For reference, the average annual inflation rate over this sample period was 1.43 percentage points.

idiosyncratic shocks. Finally, the tax rate changes from discretionary tax function changes suggest that high-income earners benefited most from discretionary tax reforms.

Time variation. The results presented so far are averages over all years, which mask potentially important time variation. In Figure 2, I present the baseline tax rate decom-

position for the average and marginal tax rate for each year separately. The shaded areas indicate the time sample before and after the reform that mandated the government to publish a bracket creep report, as well as the time sample that is imputed, as explained in Section 2.2.

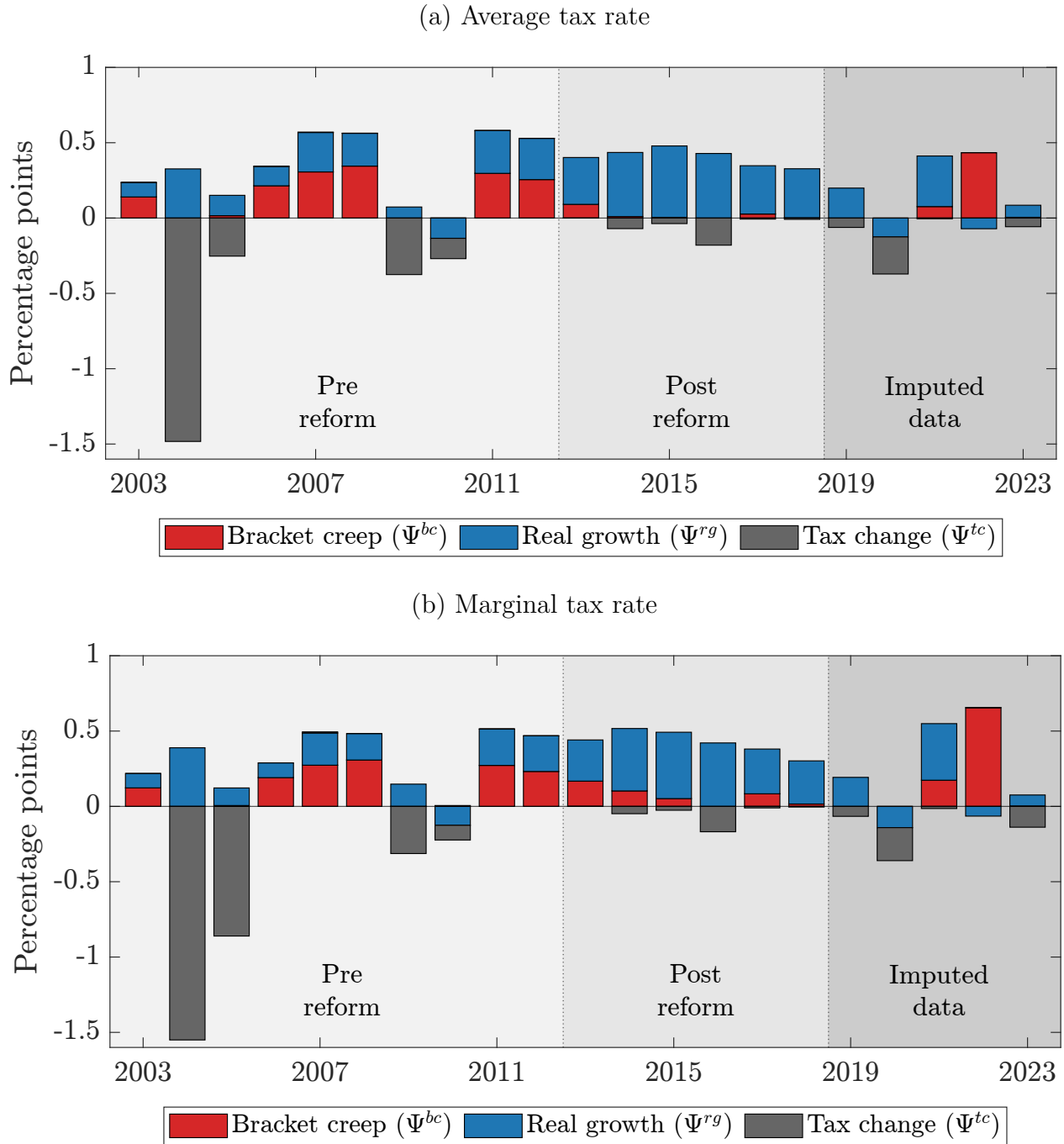
In 2004 and 2005, there were large tax cuts implemented, leading to a sizable decline in tax rates that fully compensated bracket creep and also over-compensated tax rate increases due to real income growth. In contrast, between 2006 and 2008, there were virtually no changes to the tax function, so nominal income growth led to higher tax rates. Decomposing these increases into real income growth and bracket creep suggests that bracket creep accounts for the larger fraction of tax rate increases during these years. Since there were no tax adjustments, the increases in bracket creep cumulate over multiple years: on average, in 2008, a taxpayer with the same real income as in 2005 faces an average tax rate that is 0.86 percentage points higher and a marginal tax rate that is 0.77 percentage points higher.²¹ To see the cross-sectional impact of this episode, I display how the 2005 distribution of tax rates would have shifted until 2008 when all taxpayers had the same real income as in 2005 in Panels (a) and (b) of Figure B.3 in Appendix B.

While bracket creep played no role in 2009 and 2010, there is a second bracket creep episode from 2011 until 2013. During these years, bracket creep accumulated to 0.64 and 0.67 percentage points in terms of the average and marginal tax rates, respectively. The distribution of tax rates, assuming constant real income, shifts similarly as for the first bracket creep episode; see Panels (c) and (d) of Figure B.3. Comparing tax rate changes due to real income growth and bracket creep, I find that real income growth turns out to be more important. Yet, bracket creep still implies a sizable amplification relative to tax rate changes under real income growth only.

From 2013 until 2018, I find only smaller bracket creep effects, suggesting that the 2012 tax reform successfully induced regular adjustments to the tax code. In Figure B.4 in the

²¹These numbers can be computed by summing up the red bars for 2006 until 2008 from Figure 2.

Figure 2: Time variation in the tax rate decomposition



Notes: The figure shows the decomposition of year-over-year changes in average and marginal tax rates, see equation (2.2). *Bracket creep* refers to the change in the tax rate that a taxpayer with constant real income experiences, absent discretionary tax reforms, whereas *Tax change* refers to changes due to discretionary tax reforms. *Real growth* refers to changes in tax rates due to real income growth under the contemporaneous tax schedule. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018; all non-zero estimates are significant at the 5% level, for standard errors, see Table B.4. The imputed data is based on average household income growth as explained in Section 2.3.. Panel (a) and (b) show the results for the average and marginal tax rate, respectively.

appendix, I present the average results before and after the reform, which support this conclusion.

The tax code adjustments that regularly occur since 2012 are based on inflation forecasts, as discussed in Section 2.2. It is not surprising that adjustments based on inflation forecasts successfully compensate for bracket creep during a period of low and stable inflation. Thus, I use the imputed data to evaluate to what extent there is bracket creep during the post-Covid inflation surprise episode. I find a sizable resurgence of bracket creep because inflation was underestimated for 2021 and especially for 2022. Cumulated over both years, this amounts to an increase of 0.51 and 0.83 percentage points in terms of average and marginal tax rates, respectively.

Finally, note that the results from Figure 2 use the baseline treatment of deductions, which are assumed to be perfectly indexed to inflation. The results when keeping deductions fixed are similar and shown in Figure B.2 in Appendix B.

Mechanical decomposition. The presented decomposition estimates α_t based on equation (2.3). Thus, the bracket creep term already accounts for inflation adjustments of the tax function, if they occur. An alternative is the naive mechanical decomposition, where I set $\alpha_t = 0$ directly. This decomposition computes the hypothetical bracket creep that may occur when the nominal tax code is kept constant, ignoring inflation adjustments. The resulting decomposition is presented in Figure B.5 in Appendix B. Two observations are noteworthy. First, during the above-highlighted bracket creep episodes, there is virtually no change in the tax function, which implies that the mechanical decomposition coincides with my baseline. Second, I can use the mechanical results and subtract the tax change term, Ψ^{tc} , from the mechanical bracket creep term, Ψ^{bc} , and set the difference to zero if negative because bracket creep is fully compensated in this case (circular markers in Figure B.5). Then, this difference mostly coincides with my baseline bracket creep term (plus markers in Figure B.5), suggesting that the mechanical decomposition leads to similar conclusions as

the baseline version. Finally, note that this is not true for the (long-run) effects, where I also average across time. There, the naive decomposition would mask important time variation because discretionary tax changes exceed bracket creep when averaged across all years.

Overall, my findings show that bracket creep accounts for a non-negligible fraction of the changes in tax rates, irrespective of whether it is measured via average or marginal tax rates. It suggests that analysis based on a tax function that only depends on real income misses important aspects of taxation that may matter empirically.

3 A tractable model with bracket creep

I develop an analytical partial equilibrium model that encompasses (i) a progressive income tax schedule allowing for bracket creep, (ii) a household choosing consumption and labor, and (iii) a government that uses tax revenues for government spending or transfers to the household. The model is useful to understand what we miss when abstracting from bracket creep by modeling the tax system only in real terms. I characterize the labor supply response to bracket creep and use the administrative data to estimate a theory-consistent measure of bracket creep, the indexation gap.

3.1 Model

Progressive tax schedule. I consider the following generalized version of the progressive income tax schedule in [Heathcote et al. \(2017\)](#) where

$$T(Y) = Y - \lambda \frac{Y^{1-\tilde{\tau}}}{1-\tilde{\tau}} (\mathcal{P}^g)^{\tilde{\tau}} \tag{3.1}$$

maps nominal income $Y \geq \underline{Y}$ into a nominal tax liability $T(Y)$. The parameter $\tilde{\tau} \in [0, 1)$ measures the degree of tax progressivity, and $\lambda \geq 0$ captures the average level of taxation. In the special case of no progressivity, i.e., $\tilde{\tau} = 0$, the system reduces to a linear tax on Y at rate $1 - \lambda$. The degree of indexation to inflation is captured by $\mathcal{P}^g > 0$, which denotes the price

level to which the tax code is anchored.²² Full indexation requires that \mathcal{P}^g coincides with the (market) price level $P > 0$, whereas there will be bracket creep effects when $\mathcal{P}^g \neq P$.²³ Throughout, I assume that $\underline{Y} > \left(\frac{\lambda}{1-\tilde{\tau}}\right)^{1/\tilde{\tau}} \mathcal{P}^g$ to ensure that income is sufficiently high to have only positive tax payments because I focus on progressive income taxation and bracket creep, and not on the entire tax and transfer system. The tax schedule implies that real net-of-tax income y^{net} is given by

$$y^{net} = \lambda \frac{y^{1-\tilde{\tau}}}{1-\tilde{\tau}} x^{-\tilde{\tau}}, \quad (3.2)$$

where $y = Y/P$ is real pre-tax income, and $x \equiv P/\mathcal{P}^g$ is the *indexation gap* that measures the “distance” between the market price level and the level to which the tax code is anchored. The tax schedule in real terms coincides with the version from [Heathcote et al. \(2017\)](#) when the indexation gap is closed, i.e., $x = 1$. The tax schedule further implies

$$ATR = 1 - \lambda \frac{(yx)^{-\tilde{\tau}}}{1-\tilde{\tau}} \quad \text{and} \quad MTR = 1 - \lambda (yx)^{-\tilde{\tau}}, \quad (3.3)$$

where $ATR \equiv T(Y)/Y$ and $MTR \equiv T'(Y)/P$ denote the average and (real) marginal tax rate, respectively. Both tax rates increase in the indexation gap, i.e., $\partial_x ATR > 0$ and $\partial_x MTR > 0$, where ∂_x denotes the partial derivative regarding the indexation gap x . The magnitude of the increase declines in income as $\partial_{x,y} ATR < 0$ and $\partial_{x,y} MTR < 0$, where $\partial_{x,y}$ denotes the second partial derivative regarding the indexation gap x and income y .²⁴ It implies that bracket creep effects are stronger at the bottom of the income distribution

²²The parameter \mathcal{P}^g could be subsumed in λ . However, I aim to distinguish between taxation under full indexation, as captured by λ , $\tilde{\tau}$, and additional bracket creep effects that will crucially depend on \mathcal{P}^g . In Section 2.3, I also show that German administrative tax data support my formulation of the tax schedule.

²³Bracket creep in the sense of higher tax rates because of higher nominal income despite no real income gains is captured by $\mathcal{P}^g < P$, i.e., the tax code is not adjusted to increases in the price level.

²⁴Both properties are consistent with the German tax schedule where the ATR and the MTR increase with decreasing magnitude in nominal taxable income within and across tax brackets. The MTR only jumps from 42 to 45 percent at an income level of around 250,000 euros since 2009, affecting only very few taxpayers. Further, [Heathcote et al. \(2017\)](#) argues that their schedule provides a good approximation for the U.S. despite marginal tax rates being constant within tax brackets.

because tax rates are more sensitive to changes in nominal income. Finally, it is worthwhile reiterating that I refer to bracket creep as the difference between real and nominal taxation. Such a difference exists whenever the indexation gap is not unity. For example, it encompasses the circumstances where the price level increases but nominal income stays constant, leading to a decline in $y = Y/P$. If the tax schedule is perfectly indexed ($x = 1$), then average and marginal tax rates would fall, partly compensating for the decline in real income. However, when the tax code is not adjusted, then the indexation gap exceeds unity providing a counteracting force leading to higher tax rates. In the knife-edge case of constant nominal incomes, both forces cancel, leaving tax rates unchanged despite the real income decline.

Household decision problem. I consider a single household that decides on consumption and labor supply, subject to the progressive income tax schedule from (3.1),

$$\max_{c,\ell} \frac{c^{1-\sigma}}{1-\sigma} - \varphi \frac{\ell^{1+\gamma}}{1+\gamma} + \log(G) \quad \text{s.t.} \quad c = \lambda \frac{(w\ell)^{1-\tilde{\tau}}}{1-\tilde{\tau}} (x)^{-\tilde{\tau}} + \mathcal{T}, \quad (3.4)$$

where c and ℓ are consumption and labor supply. The real wage is given by $w = W/P$, with W being the nominal wage. Parameters $\sigma \geq 0$ and $1/\gamma \geq 0$ denote relative risk aversion and the Frisch elasticity of labor supply, respectively. The parameter φ shifts disutility from labor and may be used to normalize equilibrium labor supply to unity. Finally, \mathcal{T} is a transfer from the government, and G is the level of public good provision by the government. Both are taken as given by the household.

Government. The government returns a fraction $\theta \in [0, 1]$ of the tax revenues to the household which yields the real transfer

$$\mathcal{T} = \theta \left(w\ell - \lambda \frac{(w\ell)^{1-\tilde{\tau}}}{1-\tilde{\tau}} (x)^{-\tilde{\tau}} \right). \quad (3.5)$$

The remaining tax revenues are used for government spending to finance the public good.²⁵ The parameter θ matters for the effects of bracket creep because it governs the strength of the income effects of taxation on labor supply.²⁶ For the comparative statics below, I assume the indexation gap x is exogenous. In Section 4, I embed the tax schedule into a quantitative general equilibrium framework with endogenous indexation gaps where the government chooses a time path for \mathcal{P}^g , and changes in the price level P are determined in general equilibrium.

3.2 Theoretical results

I study how the household's labor supply responds to bracket creep. Throughout, I let (c^*, ℓ^*) denote the optimal consumption and labor supply choice of the household. I further set φ such that labor supply equals unity in the stationary equilibrium.²⁷ The first proposition characterizes how the labor supply response to bracket creep depends on the share of tax revenues that are given back. The proof of this and all other propositions is in Appendix A.

Proposition 2. *Let $\sigma \geq 1$. Then, there exists a threshold value $\bar{\theta} \in [0, 1]$ such that*

$$\frac{d\ell^*}{dx} \geq 0 \iff \theta < \bar{\theta} \equiv \frac{\chi}{1 + \chi}, \quad (3.6)$$

with $\chi = (\sigma - 1) \frac{\lambda}{1 - \bar{\tau}} (xw)^{-\bar{\tau}} \geq 0$.

The proposition states that the labor supply response to bracket creep is ambiguous.²⁸ Intuitively, an increase in the indexation gap x raises average and marginal tax rates, giving rise to income and substitution effects on labor supply. It also generates additional tax revenues

²⁵The results below focus exclusively on labor supply, which is not affected by public good provision since preferences are additively separable.

²⁶All previous theoretical papers that study bracket creep assume lump-sum redistribution of tax revenues due to bracket creep, i.e., $\theta = 1$ (Edge and Rudd, 2007; Keinsley, 2016; Heer and Süßmuth, 2013).

²⁷Labor supply may still respond to exogenous changes in variables, e.g., to exogenous changes in x or w .

²⁸When the derivative $d\ell^*/dx$ is evaluated at the stationary equilibrium, then w and x in χ refer to the values of w and x in the stationary equilibrium that prevails absent the marginal increase dx . Similarly, one could also study the labor supply response where $x = w = 1$ in the stationary equilibrium.

for the government. Returning these tax revenues to the household diminishes the income effect. Hence, when θ is too high, the substitution effect dominates, and the household works less due to higher marginal tax rates. Moreover, the threshold $\bar{\theta}$ increases in the relative risk aversion σ since the income effect increases in this parameter. This means that more tax revenues must be given back to obtain a reduction in labor supply in response to bracket creep when risk aversion is high.

Next, I focus on bracket creep and real wage fluctuations jointly. It is useful to consider the first-order dynamics of labor supply around a stationary equilibrium without bracket creep, i.e., $x = 1$. The approximate labor supply response is

$$\hat{\ell} = \Gamma_w \hat{w} + \Gamma_x \hat{x}, \tag{3.7}$$

where $\hat{\ell} = \ell^*/\ell_0^* - 1$, and ℓ_0^* denotes optimal labor supply at the point of approximation, the stationary equilibrium, and similarly for \hat{w} and \hat{x} . The following proposition characterizes how the coefficients Γ_w and Γ_x depend on relative risk aversion σ and the usage of tax revenues θ .

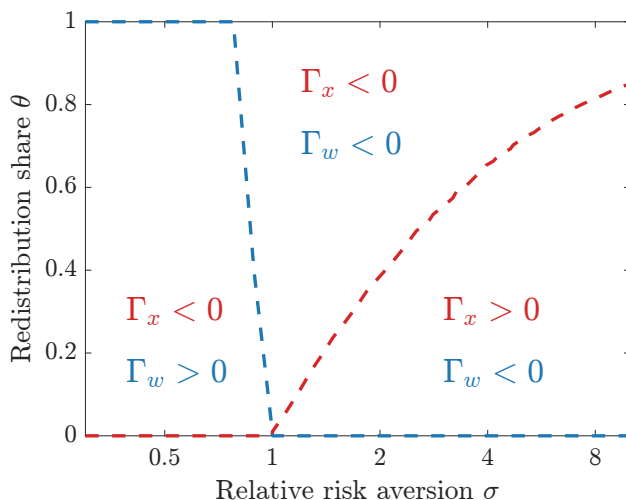
Proposition 3. *Conditional on σ , there exist threshold values $\bar{\theta}_x(\sigma)$ and $\bar{\theta}_w(\sigma)$ such that*

$$\theta \geq \bar{\theta}_x(\sigma) \implies \Gamma_x \leq 0 \quad \text{and} \quad \theta \geq \bar{\theta}_w(\sigma) \implies \Gamma_w \leq 0.$$

Moreover, if $\sigma > 1$, then $\bar{\theta}_x(\sigma) \in (0, 1)$ and $\bar{\theta}_w(\sigma) = 0$.

The proposition states that there are threshold values for the share of tax revenues returned to the household, the redistribution share θ , that determine the labor supply response to changes in the real wage and to changes in the indexation gap. In the empirically plausible case that relative risk aversion exceeds unity, we have that the threshold value for the indexation gap strictly exceeds the threshold for real wages.

Figure 3: Labor supply response regions



Notes: The figure shows parameter regions for which an increase in the real wage leads to higher labor supply ($\Gamma_w > 0$), and for which an increase in the indexation gap leads to higher labor supply ($\Gamma_x > 0$), based on the first-order dynamics from (3.7). The remaining parameters are $\bar{\tau} = 0.2$, $\lambda = 0.6$, $\gamma = 2$ and $w = 1$.

Examples. To illustrate the implications of the proposition, I display a numerical example in Figure 3. There are distinct parameter regions that govern whether or not increases in the real wage and in the indexation gap have opposing effects on labor supply.

For concreteness, suppose that the price level P and the nominal wage W increase with inflation at rate $\Pi > 1$, but the government keeps \mathcal{P}^g constant. Thus, the real wage stays constant, but the indexation gap increases, i.e., $\hat{x} = \Pi - 1 > 0$. This exemplifies what is commonly understood as bracket creep, i.e., an increase in the nominal wage that only compensates for inflation leads to higher average and marginal tax rates, which affect labor supply. The effect on labor supply is only negative when relative risk aversion is sufficiently small or the redistribution share is high enough, as illustrated in Figure 3.

Alternatively, consider that nominal wages remain unchanged, but the price level still grows at the rate Π , implying that the indexation gap increases and the real wage falls.²⁹ The overall effect on labor supply now depends on the response to both variables. When risk aversion is sufficiently low, then the decline in the real wage leads to less labor supply. This

²⁹This gives rise to bracket creep effects because tax rates do not fall as they would under full indexation to partly compensate for the real income loss; see the discussion along with (3.3).

is amplified by bracket creep, which further reduces labor supply.³⁰ When risk aversion and the redistribution share are sufficiently high, then the real wage loss leads to a higher labor supply, but bracket creep effects lead to a lower labor supply, dampening the overall effect. Finally, when risk aversion is sufficiently high and redistribution is not too high, then both the real wage loss and bracket creep lead to a higher labor supply. Thus, bracket creep amplifies the effects of the price level increase in the latter case.

Overall, this shows that bracket creep can either amplify or dampen the effects of progressive taxation that would prevail when the tax system is perfectly indexed to inflation.

3.3 Empirical indexation gaps

Next, I develop an approach to measure the indexation gap in the data. Based on this, I present two pieces of evidence that support the parametric tax schedule, which I introduced above. First, the resulting time series of the indexation gap is highly correlated with the bracket creep term based on the non-parametric decomposition. Second, I present regression results that directly deliver a test of a restriction derived from the tax schedule. Finally, the indexation gap series is useful to discipline the quantitative model in Section 4.

Estimation strategy. I use the empirical measure of the degree of indexation as defined in equation 2.3 to obtain an empirical measurement of the indexation gap. This only requires assuming the tax schedule specified in equation 3.1, but not the remainder of the analytical model. Consider the change in the average tax rate

$$ATR_t(y, x_t) - ATR_{t-1}(y, x_{t-1}) = \frac{\lambda}{1 - \tilde{\tau}} (yx_{t-1})^{-\tilde{\tau}} \left(1 - \left(\frac{\Pi_t}{\Pi_t^g} \right)^{-\tilde{\tau}} \right), \quad (3.8)$$

where $\Pi_t^g \equiv \mathcal{P}_t^g / \mathcal{P}_{t-1}^g$ determines the strength of bracket creep. When $\Pi_t > \Pi_t^g = 1$, then this corresponds to the change in average tax rates in the model under a full bracket creep

³⁰Note that the effects of \hat{w} and \hat{x} on labor supply have the same sign when Γ_w and Γ_x have opposite signs as x increases but w decreases in this example.

benchmark, analogously to the measurement of indexation in Section 2.1. Next, I define a model counterpart to the degree of indexation measured in the data based on

$$\tilde{\alpha}_t = 1 - \frac{ATR_t(y, x_t) - ATR_{t-1}(y, x_{t-1})}{ATR_t(y, x_{t-1}) - ATR_{t-1}(y, x_{t-1})} = 1 - \frac{1 - (\Pi_t/\Pi_t^g)^{-\tilde{\tau}}}{1 - (\Pi_t)^{-\tilde{\tau}}} \quad (3.9)$$

Imposing the empirical degree of indexation equals the model counterpart, i.e., $\alpha_t = \tilde{\alpha}_t$, yields $\Pi_t^g = (\alpha_t \Pi_t^{\tilde{\tau}} + (1 - \alpha_t))^{1/\tilde{\tau}}$. Hence, given the empirical degree of indexation α_t and an estimate of the progressivity parameter $\tilde{\tau}$, I can measure the growth rate of the indexation parameter \mathcal{P}_t^g . Under the assumption of no bracket creep at date zero, i.e., $\mathcal{P}_0^g = P_0$, I compute the indexation parameter as

$$\mathcal{P}_t^g = \begin{cases} \mathcal{P}_{t-1}^g \Pi_t^g & \text{if } \alpha_t > 0 \\ P_t & \text{otherwise,} \end{cases} \quad (3.10)$$

where full make-up for past bracket creep is assumed when $\alpha_t = 0$. I follow this approach because the empirical measure does not capture make-up for accumulated bracket creep from previous periods. Therefore, the implied indexation gap $x_t = P_t/\mathcal{P}_t^g$ is a lower bound of the true unobserved indexation gap, understating bracket creep effects. This requires the identifying assumption that the government only compensates past bracket creep but does not compensate for future bracket creep through over-compensating contemporaneous bracket creep. Maintaining this assumption is needed to disentangle bracket creep and indexation from discretionary tax changes.³¹

Implementation. To obtain the tax progressivity $\tilde{\tau}$, I follow [Heathcote et al. \(2017\)](#) and run an OLS regression of log real net-of-tax income on log real pre-tax income, using the full sample of taxpayers from 2002 until 2018. The coefficient on log pre-tax income is an estimate of $1 - \tilde{\tau}$. The results are given in Column (1) of Table 1, with standard errors clustered at

³¹Without such an assumption, it is not possible to discriminate between compensation for bracket creep and discretionary tax code changes that are unrelated to inflation. This is because any tax cut can be interpreted as only compensating for future inflation.

the taxpayer level in parenthesis. The estimate is significant at any conventional level and implies $\tilde{\tau} = 0.14$. It is further reassuring that my estimate is close to the estimate of 0.16 presented in [Heathcote et al. \(2020\)](#) for Germany in the year 2005. Given this estimate, I can readily compute indexation gaps at the taxpayer level.³²

Table 1: Estimated tax parameters

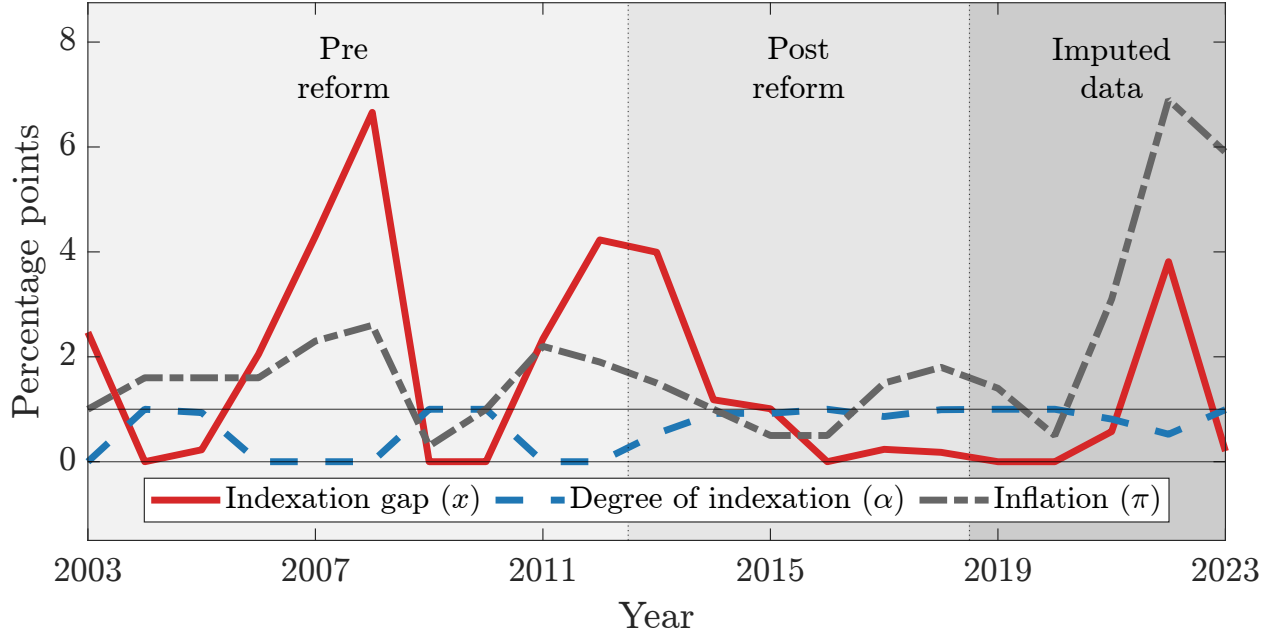
	(1)	(2)
Real pre-tax income: $\log(y)$	0.86 (0.0001)	0.86 (0.0001)
Indexation gap: $\log(x)$		-0.12 (0.0004)
Constant	0.70 (0.0005)	0.70 (0.0007)
R^2	0.999	0.999
Taxpayer FE	✓	✓
Observations (Mio.)	14.371	9.203

Notes: The table shows OLS regression results based on equation (3.11) using the administrative tax records from 2002 until 2018, as presented in Section 2.2. Standard errors are clustered at the taxpayer level and provided in parentheses.

I compute indexation gaps at the taxpayer level (since α_t is measured at this level) and then aggregate in the cross-section of taxpayers for each year. The resulting time series is presented in Figure 4. I further display the degree of indexation and the inflation rate to illustrate how both relate to indexation gaps. There is sizable time variation in the indexation gap, which peaks at 6.7 percentage points in 2008. Despite the tax reform in 2012, it took until 2016 to close the measured indexation gap. During the 2022 inflation surge, a sizable indexation gap is visible, albeit less pronounced than the peak gap in 2008. This reflects the fact that the lack of indexation was very transitory during the recent inflation surge. In this period, the increase in the indexation gap is primarily driven by the inflation surge and less by the degree of indexation, which remains relatively high. Overall, the indexation gap

³²I use the baseline results for α_t where deductions are assumed to grow at the inflation rate.

Figure 4: Time variation in the indexation gap



Notes: The figure shows the time series of the indexation gap, based on equations (3.8)-(3.10); the empirical degree of indexation based on equation (2.3); and the inflation rate. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018. The imputed data is based on average household income growth as explained in Section 2.3.

is strongly correlated with the bracket creep term from the decomposition in Section 2.3. It suggests that the parametric tax schedule from (3.1) and the resulting indexation gaps are consistent with the non-parametric decomposition results.

Testing the tax schedule. My approach of estimating indexation gaps imposes the tax function from equation 3.1. To check whether this tax function is supported by the data, I consider the following regression

$$\log y_{i,t}^{net} = a_i + b \log(y_{i,t}) + c \log(x_{i,t}) + v_{i,t} \quad (3.11)$$

where i and t index individual taxpayers and years, and a_i are taxpayer fixed effects. A testable prediction of the model is that $1 - b = -c = \tilde{\tau}$. It follows from taking the log of real net-of-tax income from equation (3.2). The OLS estimates of this specification are presented in Column (2) of Table 1. The results are remarkably close to the theoretical prediction as

the OLS estimates of b and c imply a degree of progressivity of 0.14 and 0.12, respectively.³³ I interpret this result as supporting the formulation of the proposed tax schedule.

4 A New Keynesian model with bracket creep

I study how nominal progressive taxation affects the propagation of macroeconomic shocks through the bracket creep channel. The analysis is based on a New Keynesian model with incomplete markets. Calibrating the model to the German economy before the indexation reform in 2012, I show that indexation of the tax schedule amplifies the short-run output effects of monetary policy.

4.1 Model

The model is a closed economy populated by a continuum of households with unit mass and time is discrete.

Households. I consider a generalized version of the household setup in the analytical model from Section 3. Households consume a final good, supply labor, and may save in a liquid bond, $b_{i,t}$. All households are ex-ante identical and solve the following dynamic problem

$$\begin{aligned}
 V_t(e_{i,t}, b_{i,t-1}) &= \max_{c_{i,t}, \ell_{i,t}, b_{i,t}} \left(\frac{c_{i,t}^{1-\sigma}}{1-\sigma} - \varphi \frac{\ell_{i,t}^{1-\gamma}}{1-\gamma} + \log(G) + \beta \mathbb{E}_t \left[V_{t+1}(e_{i,t+1}, b_{i,t}) \right] \right) & (4.1) \\
 \text{s.t. } c_{i,t} + b_{i,t} &= \lambda \frac{(w_t e_{i,t} \ell_{i,t})^{1-\tilde{\tau}}}{1-\tilde{\tau}} (x_t)^{-\tilde{\tau}} + b_{i,t-1}(1+r_t) + \mathcal{T}_{i,t} + d_{i,t}, \\
 -\underline{b} &\leq b_{i,t}, \quad \text{and} \quad \ln(e_{i,t+1}) = \rho_e \ln(e_{i,t}) + v_{i,t+1},
 \end{aligned}$$

³³Ex-ante a concern could be that the regression to obtain $\tilde{\tau}$ in the first place (without indexation gaps) was misspecified. Ex-post, however, it turns out that including indexation gaps in the specification does not change the implied $\tilde{\tau}$ estimate.

where $e_{i,t}$ is the idiosyncratic endowment of labor efficiency units and $v_{i,t} \stackrel{iid}{\sim} N(0, \sigma_e)$, and $|\rho_e| < 1$. Borrowing must not exceed $-b$. The government transfer $\mathcal{T}_{i,t}$ and dividends from the firms $d_{i,t}$ are distributed proportionally to labor efficiency units as in (Auclert et al., 2021). Both are taken as given by households. The level of public good provision is given by G . Aggregate variables w_t , r_t , and x_t denote the real wage, the real interest rate, and the indexation gap, respectively. Flow utility is additively separable and depends on constant relative risk aversion σ , inverse Frisch elasticity of labor supply γ , and a labor disutility shifter φ . The beginning-of-period bond holdings $b_{i,t-1}$ are given, and households choose labor supply $\ell_{i,t}$ and allocate the disposable income to consumption $c_{i,t}$ and liquid bond holdings $b_{i,t}$.

Production. The final consumption good is produced from a continuum of varieties by a representative final good firm based on a technology with constant elasticity of substitution given by $\mu/(\mu - 1)$. The varieties are produced by intermediate good firms $j \in [0, 1]$ that use a constant returns-to-scale technology, and labor is the only production input. The intermediate good producers are monopolistically competitive and take the demand schedule of the final good firm as given when setting retail prices $p_{j,t}$, subject to quadratic adjustment costs $\mathcal{C}_t = \mathcal{K} \log(p_{j,t}/p_{j,t-1})^2 Y_t$, with Y_t being aggregate output and the firm discount rate is given by the real interest rate.³⁴ The adjustment cost parameter $\mathcal{K} = \frac{\mu}{2(\mu-1)\kappa}$ is defined such that κ will represent the slope of the Phillips curve. Solving the firm problem and imposing a symmetric equilibrium across intermediate good producers gives rise to a standard New Keynesian Phillips curve

$$\log(\Pi_t) = \kappa \left(\frac{w_t}{Z_t} - \frac{1}{\mu} \right) + \frac{1}{1 + r_{t+1}} \frac{Y_{t+1}}{Y_t} \log(\Pi_{t+1}), \quad (4.2)$$

³⁴I assume a price and not a wage rigidity because endogenous labor supply is key for my mechanism. In contrast, rigid wages are typically implemented via a labor union that sets wages and hours uniformly for all households, implying that agents are not on their individual labor supply curves (e.g., Auclert et al., 2021).

where $\Pi_t = P_t/P_{t-1}$ is the gross inflation rate, and Z_t is total factor productivity. The slope of the Phillips curve is given by κ , which measures the price adjustment costs. Finally, profits or losses of the firm are distributed to households through dividends $d_t = Y_t - w_t N_t - C_t$, where N_t is total labor demand.³⁵

Government. The government consists of a fiscal and a monetary authority. The fiscal authority issues the liquid bond, collects real tax revenues from progressive income taxation R_t , and decides on the amount of aggregate transfers \mathcal{T}_t and government spending for the public good G_t . It faces the following period-by-period real budget constraint

$$R_t = r_t B^g + G_t + \mathcal{T}_t. \quad (4.3)$$

Let variables without time subscript denote the steady-state values, then the government behavior (for deviations from the steady-state) is described by

$$G_t - G = \phi_g (R_t - r_t B^g - G - \mathcal{T}) \quad \text{and} \quad \mathcal{T}_t - \mathcal{T} = (1 - \phi_g) (R_t - r_t B^g - G - \mathcal{T}).$$

The equations state that a fraction ϕ_g from the tax revenues after paying interest, as well as steady-state transfers and government spending, is used for additional government spending, and the remainder constitutes an additional transfer to households. I follow this approach because it allows me to calibrate ϕ_g such that the composition of government expenses for public good provision and transfers is kept constant in response to shocks. This is important because it ensures that the results are not driven by the government using bracket creep tax revenues to alter the composition of government expenses.³⁶ Finally, the fiscal authority decides the indexation parameter \mathcal{P}_t^g that determines the indexation gap $x_t = P_t/\mathcal{P}_t^g$ such

³⁵Note that firms must always serve demand and there is no firm exit. Negative profits imply a negative dividend, which can be interpreted that the firms are raising additional equity from the household sector.

³⁶It would be desirable to measure how tax revenues due to bracket creep are used in the data. Unfortunately, this is infeasible because it would require exogenous variation in bracket creep that does not affect the government budget constraint through other channels.

that

$$(x_t - x) = \phi_x(x_{t-1} - x) + (1 - \alpha)(\Pi_t - 1), \quad (4.4)$$

where α determines how much of inflation is instantaneously compensated and ϕ_x governs how fast \mathcal{P}^g is adjusted given the already accumulated indexation gap x_{t-1} . Importantly, the tax system is fully indexed when $\alpha = 1$ such that the indexation gap is always at its steady-state value, i.e., $x_t = x, \forall t$. Finally, the model is closed with a standard Taylor rule that governs the behavior of the monetary authority

$$i_t = \phi_\Pi(\Pi_t - \Pi) + m_t, \quad (4.5)$$

where i_t is the nominal interest rate that maps into the real rate via the Fisher equation $r_t = (1 + i_t)/\Pi_t - 1$, and m_t is an autocorrelated monetary policy shock that follows a stable auto-regressive process with $m_t = \rho_m m_{t-1} + \varepsilon_t^{mp}$ and standard normal innovations ε_t^{mp} .

Model solution. An equilibrium consists of sequences for all household, firm, and governmental variables such that all private agents behave optimally (given prices and the transfer) and such that the goods-, labor- and asset markets clear at any date t . The model is solved based on a first-order perturbation in sequence space (Auclert et al., 2021) around a steady state with zero inflation and zero indexation gaps, i.e., $\Pi_t - 1 = x_t - 1 = 0$. By studying an economy with zero trend inflation, I follow most of the New Keynesian literature (e.g., Galí, 2015; Auclert et al., 2023).

Calibration. The model is calibrated to the German economy before the 2012 tax reform that reduced bracket creep and a period is a quarter. All parameters are summarized in Table 2. Relative risk aversion and the inverse Frisch elasticity of labor supply are set to conventional values. The discount factor and the labor disutility shifter are set to match

an annualized real interest rate of two percent and an effective steady-state labor supply of unity under the normalization that TFP $Z_t = 1$. The parameters that govern the endowment with idiosyncratic labor efficiency units are set to match the annual moments according to the GRID database, which is constructed from German administrative data. The remaining supply-side parameters are set to standard values. The borrowing limit corresponds to the average monthly income in the steady-state. The supply of government bonds from the government matches an annual debt-to-GDP ratio of 60%. The tax progressivity parameter is set to $\tilde{\tau} = 0.14$, in line with my estimation results from above, and the tax level is set to match the ratio of aggregate tax payments to income in the same data.³⁷ The government spending to GDP ratio is set to 12.5%, which implies that 40% of the tax revenues net of interest payments are used for government spending to provide the public good G_t , and the remainder is redistributed to households. The parameter ϕ_g is set to keep the ratio of government spending to transfers constant in response to shocks. Finally, I set $\alpha = 0$ as there were multiple periods with no compensation for bracket creep before 2012 and estimate the degree of mean reversion ϕ_x based on the computed indexation gaps.³⁸ The Taylor rule coefficients and the autocorrelation of the monetary shock are set to conventional values.

4.2 Results

The baseline calibration corresponds to the German economy before the 2012 tax reform that reduced bracket creep. In this setup, I study how the propagation of macroeconomic shocks is altered through the presence of bracket creep. The underlying idea is that any shock that affects inflation impacts tax rates through the bracket creep channel. In the context of monetary policy, it implies a new dimension of fiscal-monetary interaction because monetary shocks partly propagate through fiscal instruments via inflation.

In Figure 5, I display the responses to an expansionary monetary policy shock that equals a

³⁷Note that the tax data does not include social security contributions. Thus, I only consider progressive income taxes but not the entire tax and transfer system.

³⁸Since the indexation gap series is annual, I interpolate to quarterly frequency by assuming that the indexation gap remains constant within a given year and estimate ϕ_x using OLS.

Table 2: Calibration

Variable		Value	Target/Source
Relative risk aversion	σ	2.00	standard value
Inverse Frisch elasticity	γ	4.00	standard value
Discount factor	β	0.99	Annual real rate of 2%
Labor disutility shifter	φ	0.66	Steady-state labor $\int e_i l_i di = 1$
Borrowing limit	\underline{b}	0.33	Steady-state monthly average income
SD of idiosy. endowment	σ_e	0.25	Annual SD of income
Autocorr. of idiosy. endowment	ρ_e	0.90	Annual autocorr. of income
Steady-state markup	μ	1.10	10% markup
Slope of the Phillips curve	κ	0.025	standard value
Steady-state TFP	Z	1.00	Normalization
Tax progressivity	$\tilde{\tau}$	0.14	Estimated based on tax data
Tax level	λ	0.65	Tax-income ratio in tax data
Gov't bond supply	B^g	2.40	Debt-to-GDP of 60%
Steady-state share of G	G/Y	0.125	Spending-transfer ratio of 40%
G spending response	ϕ_g	0.40	Steady-state spending-transfer ratio
Degree of indexation	α	0.00	Full bracket creep
Autocorr. of indexation gap	ϕ_x	0.66	Estimated based on tax data
Taylor rule coefficient	ϕ_Π	1.50	standard value
Autocorr. of MP shock	ρ_m	0.85	standard value

Notes: Calibration for the baseline economy, corresponding to Germany for the period 2003 until 2012 before the bracket creep tax reform. The annual income data moments are taken from the GRID database.

25 basis point rate cut on impact. The blue solid line shows the baseline economy without indexation, and the dashed red line shows the same economy but with a perfectly indexed tax code, i.e., $\alpha = 1.0$. Panel (a) displays the response of the indexation gap. In the bracket creep economy, the indexation gap equals the rate of inflation on impact but then further builds up because the fiscal authority adjusts the tax code only slowly to the new price level.

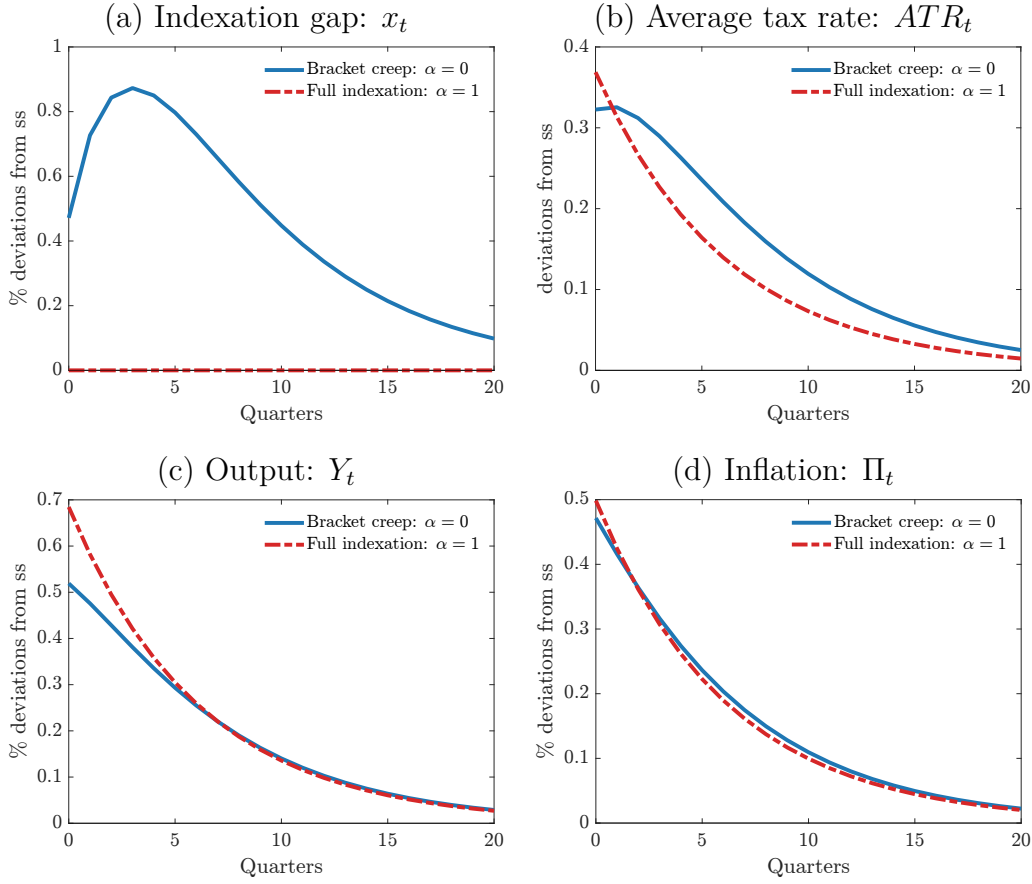
In contrast, under full indexation, the indexation gap is always closed and remains at the steady-state level. In Panel (b), I show the implied effects on average tax rates. Already under full indexation, the average tax rate increases because of larger real income. In the bracket creep economy, this is further amplified through bracket creep effects. Quantitatively, the increase in the average tax rate is 36% larger after one year. Note that the (first-order) response of the marginal tax rate coincides with the average tax rate response under the tax schedule that I assume. Moving to the output response in Panel (c), one can see that bracket creep dampens the expansionary effects of monetary policy. Intuitively, the increase in the tax rate induces a substitution effect that discourages labor supply. On the other hand, the income effect is not sufficiently strong under the calibration assumption that the composition of government spending and transfers is kept constant. Finally, the inflation responses are given in Panel (d). While ex-ante, it is unclear whether the presence of bracket creep meaningfully alters inflation dynamics, it turns out that it is quantitatively irrelevant for a monetary policy shock.

The results for a contractionary monetary policy shock are symmetric. A given reduction in inflation via a contractionary monetary policy shock leads to substantially smaller short-run output costs in an economy with bracket creep. Put differently, the output costs are aggravated when the tax code is indexed to inflation, revealing a potential caveat of such indexation schemes.

The magnitude of the presented effects depends on various parameters. In particular, the slope of the Phillips curve determines the inflation response to the shock and, hence, the strength of bracket creep. While many recent estimates suggest fairly low parameters (e.g., [Hazell et al., 2022](#)), the recent inflation surge may be hard to reconcile with a very flat Phillips curve.

Overall, the model results suggest that bracket creep (or indexation) may alter the transmission of monetary policy shocks in a meaningful way.

Figure 5: Responses to an expansionary monetary policy shock



Notes: The figure shows impulse responses based on the one asset New Keynesian model with incomplete markets as specified in Section 4.1. The expansionary monetary policy shock is a nominal interest rate cut of 25 basis points.

5 Conclusion

Bracket creep effects occur when inflation changes tax rates because the progressive income tax schedule is not adjusted. I document the quantitative importance of bracket creep over time using German administrative tax records. I find that bracket creep played an important role in changes in tax rates until around 2012. In 2012, a tax reform led to a substantial decline in bracket creep because tax code adjustments based on inflation forecasts performed well when inflation was relatively low and stable. However, the post-Covid inflation surge led to a resurgence with sizable bracket creep effects. Moving to the theoretical results, I characterize how bracket creep affects labor supply decisions in a partial equilibrium framework. Further, I estimate a theory-consistent measure of bracket creep, the indexation gap,

which is used to discipline a New Keynesian model with incomplete markets. The model predicts that a given reduction in inflation via a monetary contraction leads to less output costs in an economy with bracket creep.

Going forward, there are several avenues for expanding this research. First, not only the income tax schedule but also many other government policies are specified in nominal terms, including unemployment insurance, childcare subsidies, and more. Inflation adjustments are often infrequent and incomplete. Thus, quantifying the effects of imperfect inflation adjustments would be valuable to investigate whether they impact shock transmission, and to understand where large gains from indexation are available. Second, potentially inefficient fluctuations in taxes due to bracket creep and delayed compensation may amplify the welfare costs of inflation. This provides a motive for a lower inflation target by the central bank when imperfectly indexed taxes are taken as given. Future work may quantify the importance of this channel. Finally, extending the empirical analysis to more countries within and beyond the Euro Area would be important to quantify bracket creep effects more broadly.³⁹

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³⁹For example, as of 2022, Italy and Spain have not adjusted their tax parameters since 2007 and 2015, respectively (see OECD: [Tax Database Table I.1 Central Government Personal Income Tax Rates and Thresholds](#)).

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A Derivations

Proof of Proposition 1. Inserting Definition 1 in Ψ_t^{bc} yields

$$\begin{aligned}\Psi_t^{bc} &= t_t^{\mathcal{I}} \left(Z_t^{\Pi}, Z_{t-1} \right) - t_{t-1} (Z_{t-1}) \\ &= \left[(1 - \alpha_t) t_{t-1} \left(Z_t^{\Pi} \right) + \alpha_t t_{t-1} (Z_{t-1}) \right] - t_{t-1} (Z_{t-1}) \\ &= (1 - \alpha_t) \left[t_{t-1} \left(Z_t^{\Pi} \right) - t_{t-1} (Z_{t-1}) \right].\end{aligned}$$

When $\Pi_t > 1$ and $Z_t > 0$ (the latter being assumed throughout in the main text), then $Z_t^{\Pi} > Z_t$. As $\frac{\partial t_{t-1}(Z)}{\partial Z} > 0$, $\forall Z \in [Z_{t-1}, Z_t^{\Pi}]$, it follows that $t_{t-1}(Z_t^{\Pi}) > t_{t-1}(Z_{t-1})$, which completes the proof. \square

Proof of Proposition 2. Substituting the budget constraint for c in the household problem yields the first-order condition

$$\begin{aligned}0 &= (c^*)^{-\sigma} \lambda w^{1-\tau} x^{-\tau} - \varphi(\ell^*)^{\gamma+\tau} \\ &= \left(\theta \ell^* w + (1 - \theta) \frac{\lambda}{1 - \tau} (w \ell^*)^{1-\tau} x^{-\tau} \right)^{-\sigma} \lambda w^{1-\tau} x^{-\tau} - \varphi(\ell^*)^{\gamma+\tau},\end{aligned}\tag{A.1}$$

where the second equality uses the budget constraint and the definition of \mathcal{T} . Totally differentiating with respect to x and ℓ^* gives

$$\begin{aligned}0 &= \left(-\tau (c^*)^{-\sigma} \lambda w^{1-\tau} x^{-\tau-1} \left[1 - \sigma (c^*)^{-1} (1 - \theta) \frac{\lambda}{1 - \tau} (w \ell^*)^{1-\tau} x^{-\tau} \right] \right) dx \\ &\quad + \left(-\sigma (c^*)^{-\sigma-1} \left[\theta \lambda w^{2-\tau} x^{-\tau} + (1 - \theta) \left(\lambda w^{1-\tau} x^{-\tau} \right)^2 (\ell^*)^{-\tau} \right] - (\gamma + \tau) \varphi(\ell^*)^{\gamma+\tau-1} \right) d\ell^* \\ \iff \frac{d\ell^*}{dx} &= \frac{-\tau (c^*)^{-\sigma} \lambda w^{1-\tau} x^{-\tau-1} \left[1 - \sigma (c^*)^{-1} (1 - \theta) \frac{\lambda}{1 - \tau} (w \ell^*)^{1-\tau} x^{-\tau} \right]}{\sigma (c^*)^{-\sigma-1} \left[\theta \lambda w^{2-\tau} x^{-\tau} + (1 - \theta) \left(\lambda w^{1-\tau} x^{-\tau} \right)^2 (\ell^*)^{-\tau} \right] + (\gamma + \tau) \varphi(\ell^*)^{\gamma+\tau-1}}.\end{aligned}$$

The denominator is strictly positive as all parameters, as well as the real wage, the indexation gap and equilibrium choices c^* , ℓ^* are strictly positive. For the same reason, it follows that the sign of $d\ell^*/dx$ is pinned down by the term in square brackets as the multiplicative term

in front of it is strictly negative. Hence, the cutoff $\bar{\theta}$ is determined via

$$\begin{aligned}
0 &= 1 - \sigma (c^*)^{-1} (1 - \bar{\theta}) \frac{\lambda}{1 - \tau} (w\ell^*)^{1-\tau} x^{-\tau} \\
&= \bar{\theta}\ell^*w + (1 - \bar{\theta}) \frac{\lambda}{1 - \tau} (w\ell^*)^{1-\tau} x^{-\tau} - \sigma(1 - \bar{\theta}) \frac{\lambda}{1 - \tau} (w\ell^*)^{1-\tau} x^{-\tau} \\
&= \bar{\theta} - (\sigma - 1)(1 - \bar{\theta}) \frac{\lambda}{1 - \tau} (xw\ell^*)^{-\tau} \\
&= \bar{\theta} - (1 - \bar{\theta})\chi
\end{aligned}$$

where the second equality follows from multiplying with c^* . Since $\chi \geq 0 \iff \sigma \geq 1$, it follows that $0 < \theta - (1 - \theta)\chi \iff \theta > \bar{\theta}$ which implies $d\ell^*/dx < 0$, and analogously for $\theta < \hat{\theta}$. Note that the last equality also uses that $\ell^* = 1$ as stated in the main text. \square

Proof of Proposition 3. I first establish a Lemma that will be useful for this proof.

Lemma 1. *The coefficients from equation (3.7) in the main text are*

$$\Gamma_x = \frac{\tau \vartheta_0}{\gamma + \tau + \sigma \vartheta_1} \quad \text{and} \quad \Gamma_w = \frac{1 - \tau - \sigma \vartheta_1}{\gamma + \tau + \sigma \vartheta_1},$$

with

$$\vartheta_0 = \frac{(\sigma - 1)(1 - \theta)\lambda(1 - \tau)^{-1}(w\ell^*)^{-\tau} - \theta}{\theta + (1 - \theta)\lambda(1 - \tau)^{-1}(w\ell^*)^{-\tau}} \quad \text{and} \quad \vartheta_1 = \frac{\theta + (1 - \theta)\lambda(w\ell^*)^{-\tau}}{\theta + (1 - \theta)\lambda(1 - \tau)^{-1}(w\ell^*)^{-\tau}}.$$

Proof. A first order approximation of (A.1) around (ℓ^*, w, x) with $x = 1$ yields

$$\begin{aligned}
0 &= \left[-\sigma (c^*)^{-\sigma-1} \left(\theta w\ell^* + (1 - \theta)\lambda (w\ell^*)^{1-\tau} \right) - (\gamma + \tau) \varphi (\ell^*)^{\gamma+\tau} \right] \hat{\ell} \\
&+ \left[-\sigma (c^*)^{-\sigma-1} \left(\theta w\ell^* + (1 - \theta)\lambda (w\ell^*)^{1-\tau} \right) \lambda w^{1-\tau} + (c^*)^{-\sigma} \lambda (1 - \tau) w^{1-\tau} \right] \hat{w} \\
&+ \left[\sigma (c^*)^{-\sigma-1} (1 - \theta) \lambda^2 (w\ell^*)^{1-\tau} (1 - \tau)^{-1} \tau w^{1-\tau} - (c^*)^{-\sigma} \lambda w^{1-\tau} \tau \right] \hat{x}
\end{aligned}$$

Inserting the household budget constraint and equilibrium transfers \mathcal{T} for c^* , and inserting (A.1) for $\varphi (\ell^*)^{\gamma+\tau}$, and rearranging gives the result. \square

Now I turn to the proof of Proposition 3 from the main text.

Existence of $\bar{\theta}_x(\sigma)$. Lemma 1 implies $\vartheta_1 \geq 0$ and that the denominator of Γ_x is strictly positive under the parameter restrictions stated in the main text. It also implies that the denominator of ϑ_0 is strictly positive. It follows that, conditional on σ , the sign of Γ_x is

pinned down by

$$f(\theta; \sigma) \equiv \tau \left[(\sigma - 1)(1 - \theta)\lambda(1 - \tau)^{-1} (w\ell^*(\theta; \sigma))^{-\tau} - \theta \right],$$

where I make explicit that $\ell^* > 0$ depends on σ and θ . First, consider $\sigma \in [0, 1]$. In this case, I have $f(\theta; \sigma) \leq 0$, and hence, $\Gamma_x \leq 0$, regardless of θ . This implies that $\bar{\theta}_x(\sigma) = 0$ for $\sigma \in [0, 1]$. Second, consider $\sigma > 1$. Now, I have $f(1; \sigma) < 0$ and $f(0, \sigma) > 0$. The existence of $\bar{\theta}_x(\sigma) \in (0, 1)$ such that $f(\bar{\theta}_x(\sigma); \sigma) = 0$ follows from the intermediate value theorem. Taken together, a threshold $\bar{\theta}_x(\sigma)$ exists for all $\sigma \geq 0$ such that $\Gamma_x \leq 0$ if $\theta \geq \bar{\theta}_x(\sigma)$.

Existence of $\bar{\theta}_w(\sigma)$. From Lemma 1 (using the same arguments as for $\bar{\theta}_x(\sigma)$), we can see that the sign of Γ_w is determined by

$$g(\theta; \sigma) \equiv 1 - \tau - \sigma\vartheta_1(\theta; \sigma).$$

Note that $\vartheta_1 \equiv \vartheta_1(\theta; \sigma) \in [1 - \tau, 1]$ and $\partial\vartheta_1/\partial\theta > 0, \forall\theta$. Consider $\sigma \in [0, 1 - \tau]$. Then $g(1; \sigma) = 1 - \tau - \sigma \geq 0$. As $\partial\vartheta_1/\partial\theta > 0$, we have $g(\theta; \sigma) \geq 0, \forall\theta$ which implies $\bar{\theta}_w(\sigma) = 1$ in this parameter region. Consider $\sigma \in (1 - \tau, 1]$ where $g(1; \sigma) < 0$ but $g(0; \sigma) = (1 - \tau)(1 - \sigma) \geq 0$. The intermediate value theorem implies existence of $\bar{\theta}_w(\sigma)$ such that $g(\bar{\theta}_w(\sigma); \sigma) = 0$ and it is easy to see that $\bar{\theta}_w(1) = 0$. Finally, for $\sigma > 1$, we have $g(0; \sigma) < 0$ and hence, $g(\theta; \sigma) < 0 \forall\theta$ which implies that $\bar{\theta}_w(\sigma) = 0$. Taken together, this establishes the existence of $\bar{\theta}_w(\sigma)$.

□

B Empirical analysis

Table B.1: Descriptive statistics

	Mean	SD	N
(a) All years (2002-2018)			
Market income: Y	49168.67	90315.72	14394702
Deductions: D	7683.13	12972.97	14394702
Taxable income: Z	41485.54	84983.04	14394702
Tax payment: $T(Z)$	8753.28	36689.79	14394702
(b) Pre reform (2002-2012)			
Market income: Y	45854.74	88134.82	8828636
Deductions: D	6616.06	12698.82	8828636
Taxable income: Z	39238.68	83306.25	8828636
Tax payment: $T(Z)$	8110.09	36043.61	8828636
(c) Post reform (2013-2018)			
Market income: Y	54555.22	93502.15	5566066
Deductions: D	9417.57	13224.18	5566066
Taxable income: Z	45137.65	87517.12	5566066
Tax payment: $T(Z)$	9798.75	37693.08	5566066

Notes: The table shows descriptive statistics of selected variables, computed from German administrative tax records.

Table B.2: CPI inflation and average household income growth

Year	Household income growth	CPI inflation
2019	2.9	1.4
2020	0.0	0.5
2021	5.6	3.1
2022	6.4	6.9
2023	6.5	5.9

Notes: The table shows the average household income growth rate between 2019 and 2023 that is used to extrapolate the administrative tax records. For comparison, the table also includes the CPI inflation rate.

Table B.3: Decomposition of average and marginal tax rates

	ATR			MTR			N
	Bracket creep Ψ^{bc}	Tax change Ψ^{tc}	Real growth Ψ^{rg}	Bracket creep Ψ^{bc}	Tax change Ψ^{tc}	Real growth Ψ^{rg}	
(a) All years (2002-2018)							
All taxpayers	0.11 (0.0000)	-0.14 (0.0001)	0.02 (0.0006)	0.12 (0.0000)	-0.17 (0.0002)	0.04 (0.0006)	9724120
Q1 of tax. inc.	0.12 (0.0001)	-0.15 (0.0002)	0.16 (0.0014)	0.12 (0.0001)	-0.17 (0.0005)	0.19 (0.0013)	2431131
Q2 of tax. inc.	0.12 (0.0001)	-0.14 (0.0002)	-0.02 (0.0012)	0.13 (0.0001)	-0.17 (0.0004)	-0.03 (0.0012)	2431069
Q3 of tax. inc.	0.10 (0.0001)	-0.14 (0.0002)	-0.08 (0.0010)	0.13 (0.0001)	-0.14 (0.0002)	-0.04 (0.0009)	2431055
Q4 of tax. inc.	0.08 (0.0001)	-0.26 (0.0004)	-0.30 (0.0011)	0.02 (0.0001)	-0.42 (0.0007)	-0.22 (0.0009)	2430865
(b) Pre reform (2002-2012)							
All taxpayers	0.17 (0.0001)	-0.21 (0.0002)	-0.08 (0.0008)	0.16 (0.0001)	-0.26 (0.0003)	-0.05 (0.0008)	5520740
Q1 of tax. inc.	0.18 (0.0001)	-0.21 (0.0004)	0.05 (0.0018)	0.15 (0.0001)	-0.25 (0.0007)	0.10 (0.0017)	1380266
Q2 of tax. inc.	0.18 (0.0001)	-0.21 (0.0004)	-0.12 (0.0016)	0.17 (0.0002)	-0.27 (0.0006)	-0.14 (0.0016)	1380237
Q3 of tax. inc.	0.15 (0.0001)	-0.21 (0.0004)	-0.16 (0.0013)	0.15 (0.0001)	-0.23 (0.0004)	-0.11 (0.0013)	1380212
Q4 of tax. inc.	0.11 (0.0001)	-0.41 (0.0006)	-0.35 (0.0017)	0.03 (0.0001)	-0.68 (0.0011)	-0.32 (0.0014)	1380025
(c) Post reform (2013-2018)							
All taxpayers	0.03 (0.0000)	-0.05 (0.0000)	0.14 (0.0009)	0.08 (0.0000)	-0.04 (0.0002)	0.15 (0.0009)	4203380
Q1 of tax. inc.	0.02 (0.0000)	-0.06 (0.0001)	0.31 (0.0020)	0.08 (0.0001)	-0.05 (0.0006)	0.32 (0.0020)	1050865
Q2 of tax. inc.	0.03 (0.0000)	-0.05 (0.0001)	0.11 (0.0017)	0.09 (0.0001)	-0.04 (0.0005)	0.10 (0.0019)	1050832
Q3 of tax. inc.	0.04 (0.0000)	-0.03 (0.0001)	0.02 (0.0014)	0.09 (0.0001)	-0.02 (0.0000)	0.04 (0.0014)	1050843
Q4 of tax. inc.	0.04 (0.0000)	-0.01 (0.0000)	-0.21 (0.0015)	0.00 (0.0001)	-0.00 (0.0000)	-0.06 (0.0006)	1050840

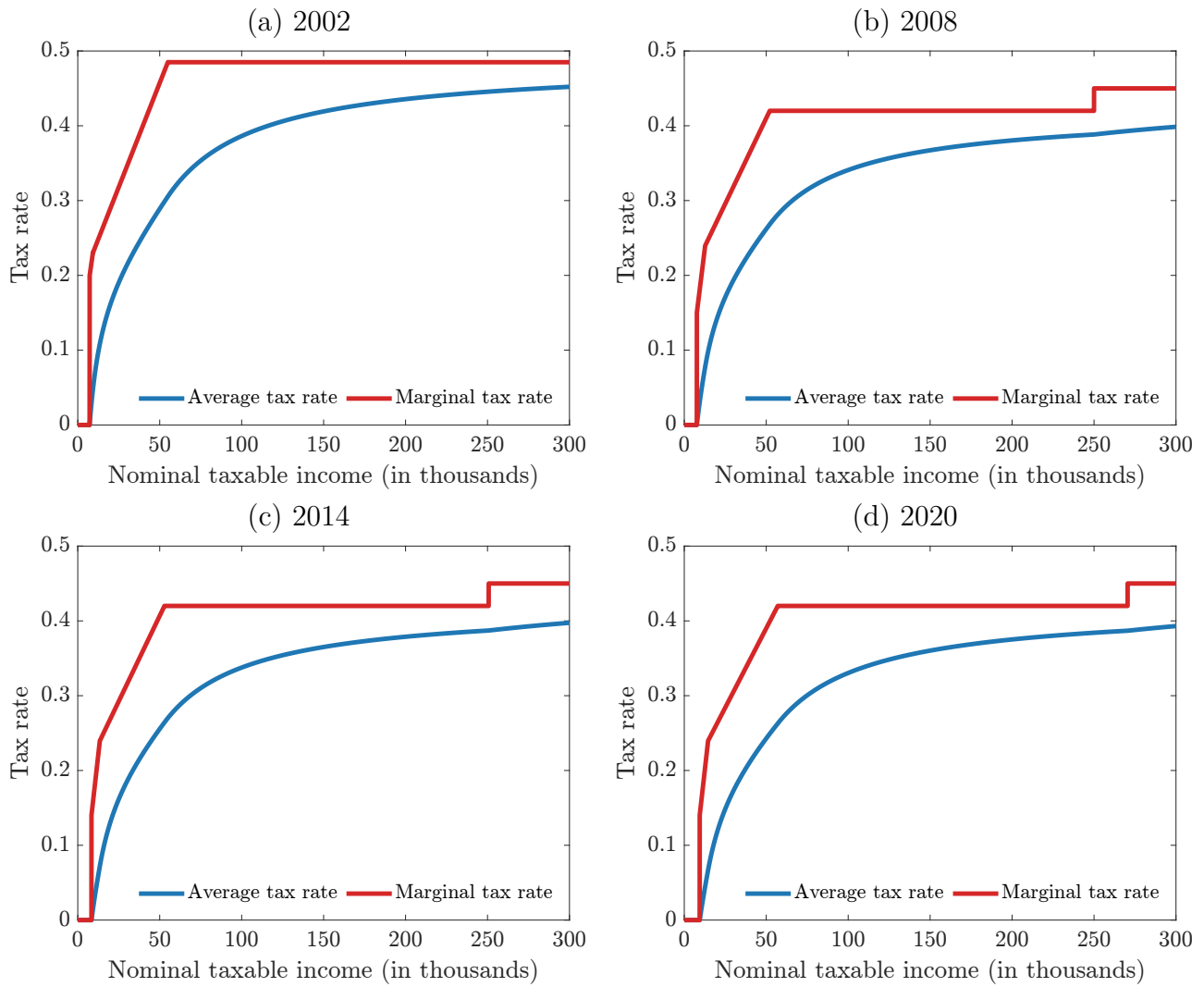
Notes: The table shows the decomposition of year-over-year changes in average and marginal tax rates, see equation (2.2). *Bracket creep* refers to the change in the tax rate that a taxpayer with constant real income experiences, absent discretionary tax reforms, whereas *Tax change* refers to changes due to discretionary tax reforms. *Real growth* refers to changes in tax rates due to real income growth under the contemporaneous tax schedule. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018. Standard errors are in parentheses.

Table B.4: Decomposition of average and marginal tax rates by year

Year	ATR			MTR			N
	Bracket creep Ψ^{bc}	Tax change Ψ^{tc}	Real growth Ψ^{rg}	Bracket creep Ψ^{bc}	Tax change Ψ^{tc}	Real growth Ψ^{rg}	
2003	0.17 (0.0000)	0.00 (0.0000)	0.07 (0.0038)	0.14 (0.0001)	0.00 (0.0000)	0.07 (0.0033)	745290
2004	0.00 (0.0000)	-1.44 (0.0003)	0.28 (0.0038)	0.00 (0.0000)	-1.49 (0.0018)	0.33 (0.0038)	757885
2005	0.04 (0.0001)	-0.24 (0.0004)	0.10 (0.0035)	0.01 (0.0001)	-0.83 (0.0009)	0.08 (0.0031)	797060
2006	0.25 (0.0001)	0.00 (0.0000)	0.09 (0.0034)	0.23 (0.0001)	0.00 (0.0000)	0.06 (0.0030)	827996
2007	0.36 (0.0001)	0.00 (0.0001)	0.21 (0.0035)	0.32 (0.0002)	0.01 (0.0002)	0.16 (0.0031)	815173
2008	0.41 (0.0001)	0.00 (0.0000)	0.15 (0.0036)	0.37 (0.0002)	0.00 (0.0000)	0.12 (0.0031)	807104
2009	0.00 (0.0000)	-0.37 (0.0001)	0.07 (0.0039)	0.00 (0.0000)	-0.30 (0.0010)	0.14 (0.0037)	782609
2010	0.00 (0.0000)	-0.11 (0.0000)	-0.16 (0.0036)	0.01 (0.0000)	-0.07 (0.0005)	-0.16 (0.0034)	800770
2011	0.36 (0.0001)	0.00 (0.0000)	0.22 (0.0034)	0.33 (0.0002)	0.00 (0.0000)	0.18 (0.0031)	839959
2012	0.31 (0.0001)	0.00 (0.0000)	0.22 (0.0036)	0.29 (0.0002)	0.00 (0.0000)	0.18 (0.0033)	708472
2013	0.14 (0.0000)	-0.00 (0.0000)	0.26 (0.0032)	0.21 (0.0001)	0.00 (0.0000)	0.23 (0.0029)	911690
2014	0.02 (0.0000)	-0.05 (0.0001)	0.39 (0.0032)	0.13 (0.0001)	-0.03 (0.0007)	0.37 (0.0030)	932753
2015	0.01 (0.0000)	-0.03 (0.0000)	0.46 (0.0032)	0.06 (0.0000)	-0.02 (0.0005)	0.42 (0.0030)	950161
2016	0.00 (0.0000)	-0.16 (0.0000)	0.41 (0.0031)	0.00 (0.0000)	-0.15 (0.0007)	0.40 (0.0030)	974531
2017	0.07 (0.0000)	-0.00 (0.0000)	0.27 (0.0031)	0.13 (0.0001)	-0.00 (0.0001)	0.24 (0.0028)	981555
2018	0.05 (0.0000)	-0.00 (0.0000)	0.26 (0.0031)	0.07 (0.0001)	-0.00 (0.0000)	0.23 (0.0028)	976609
2019	0.00 (0.0000)	-0.02 (0.0000)	0.15 (0.0000)	0.00 (0.0000)	-0.02 (0.0001)	0.14 (0.0001)	1051350
2020	0.00 (0.0000)	-0.23 (0.0000)	-0.14 (0.0000)	0.00 (0.0000)	-0.20 (0.0006)	-0.16 (0.0006)	1051350
2021	0.18 (0.0001)	-0.00 (0.0000)	0.23 (0.0001)	0.29 (0.0005)	-0.00 (0.0000)	0.25 (0.0007)	1051350
2022	0.66 (0.0002)	0.00 (0.0000)	-0.30 (0.0001)	0.87 (0.0005)	0.00 (0.0000)	-0.28 (0.0002)	1051350
2023	0.15 (0.0001)	-0.00 (0.0000)	-0.11 (0.0001)	0.06 (0.0002)	-0.01 (0.0000)	-0.11 (0.0001)	1051350

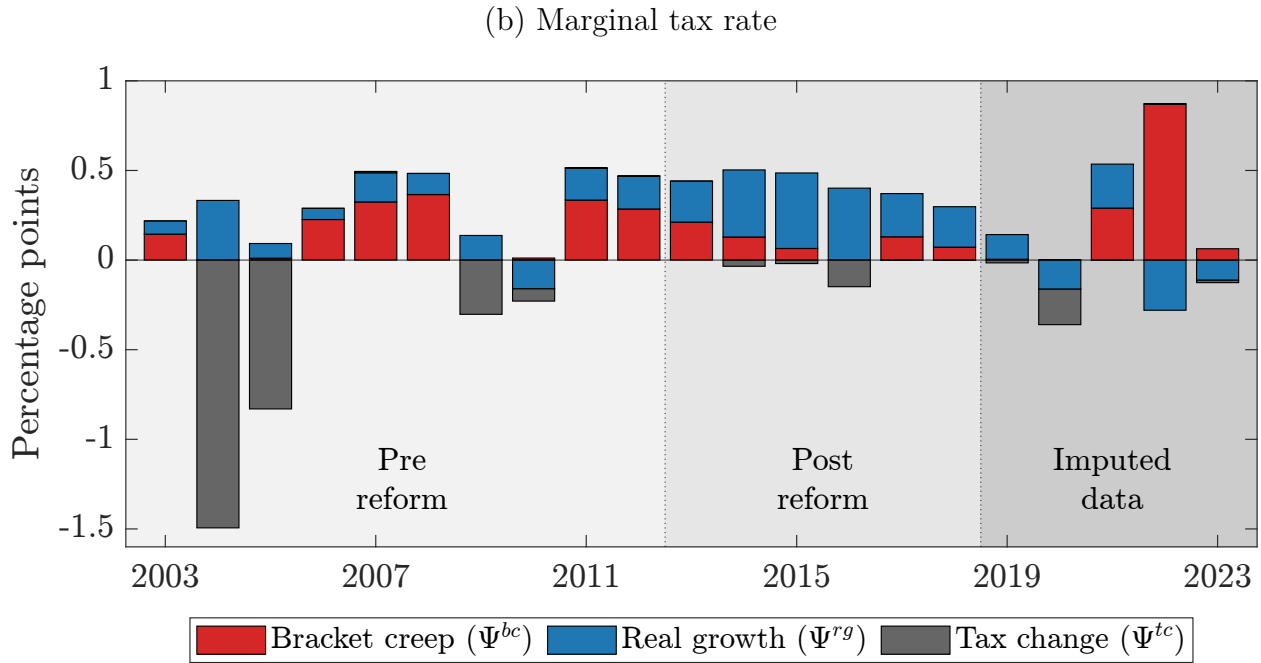
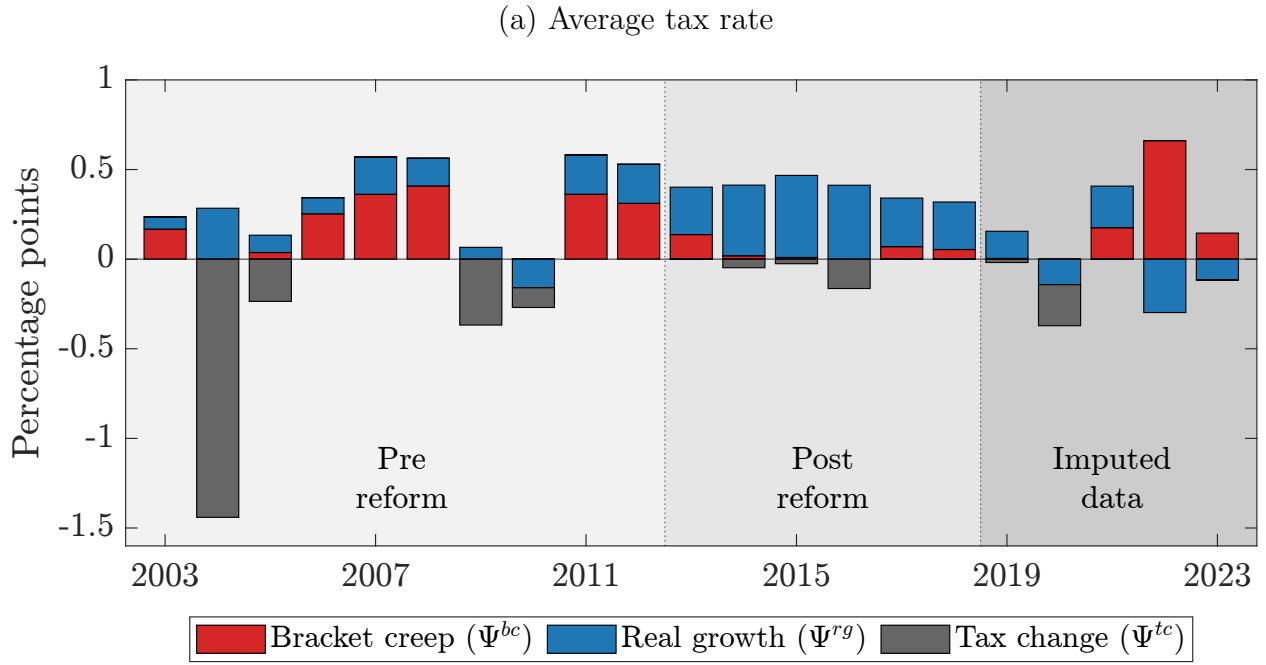
Notes: The table shows the decomposition of year-over-year changes in average and marginal tax rates, see equation (2.2). *Bracket creep* refers to the change in the tax rate that a taxpayer with constant real income experiences, absent discretionary tax reforms, whereas *Tax change* refers to changes due to discretionary tax reforms. *Real growth* refers to changes in tax rates due to real income growth under the contemporaneous tax schedule. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018. Standard errors are in parentheses.

Figure B.1: German tax schedules



Notes: The figure illustrates the personal income tax schedule in Germany for selected years.

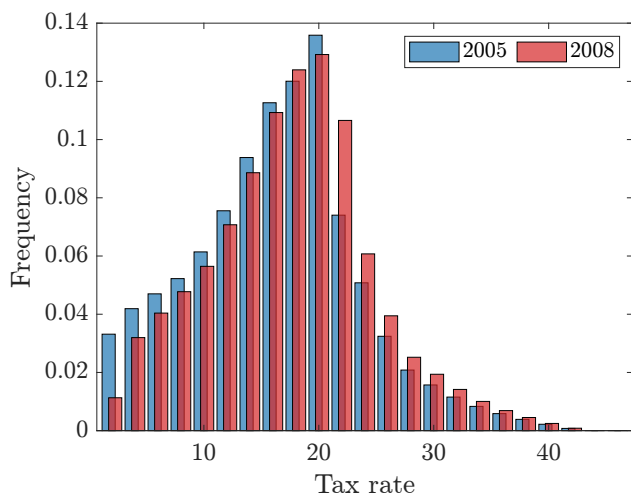
Figure B.2: Time variation in the tax rate decomposition



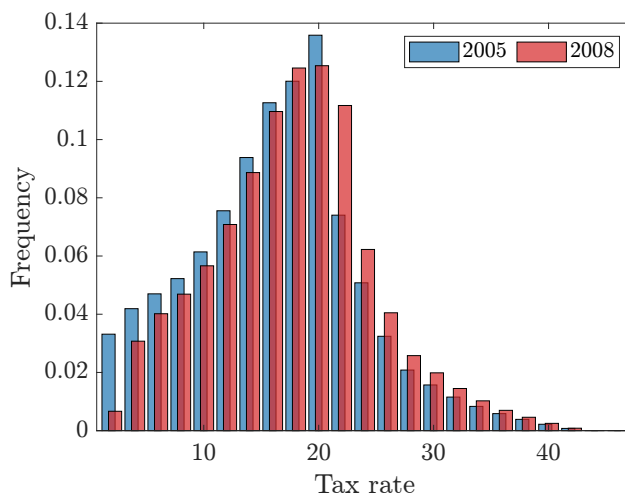
Notes: The figure shows the decomposition of year-over-year changes in average and marginal tax rates, see equation (2.2). *Bracket creep* refers to the change in the tax rate that a taxpayer with constant real income experiences, absent discretionary tax reforms, whereas *Tax change* refers to changes due to discretionary tax reforms. *Real growth* refers to changes in tax rates due to real income growth under the contemporaneous tax schedule. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018; all non-zero estimates are significant at the 5% level, for standard errors, see Table B.4. The imputed data is based on average household income growth as explained in Section 2.3.. Panel (a) and (b) show the results for the average and marginal tax rate, respectively.

Figure B.3: Distributional changes of average tax rates during bracket creep episodes

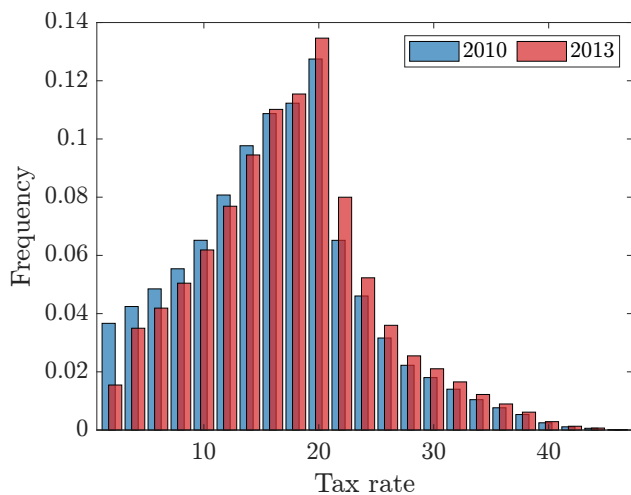
(a) 2005-2008 episode: baseline



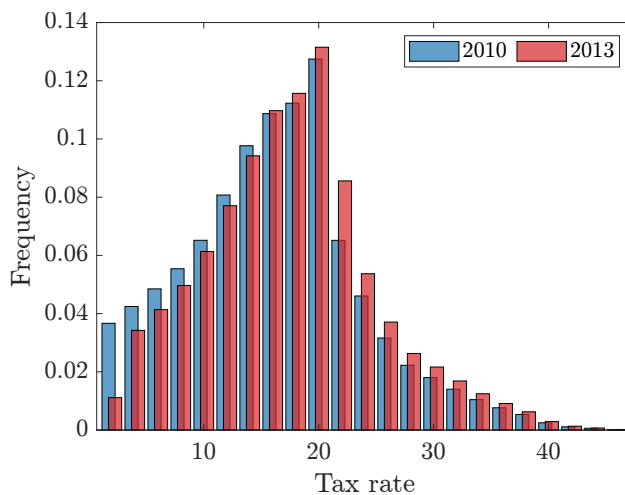
(b) 2005-2008 episode: deductions fixed



(c) 2010-2013 episode: baseline

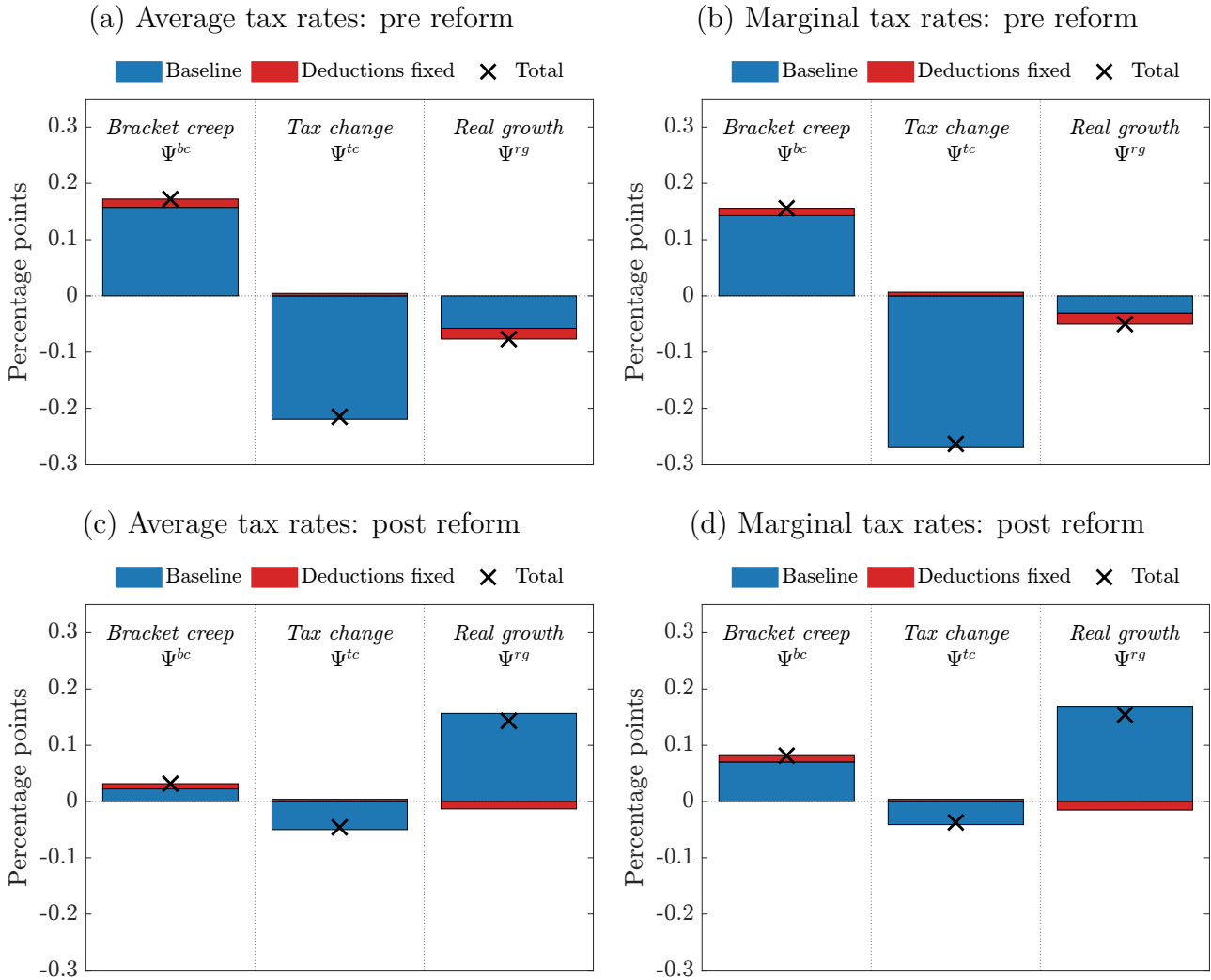


(d) 2010-2013 episode: deductions fixed



Notes: The figure shows the how the distribution of average tax rates shifts over time under constant real income during the bracket creep episodes from 2005-2008 and 2010-2013, respectively.

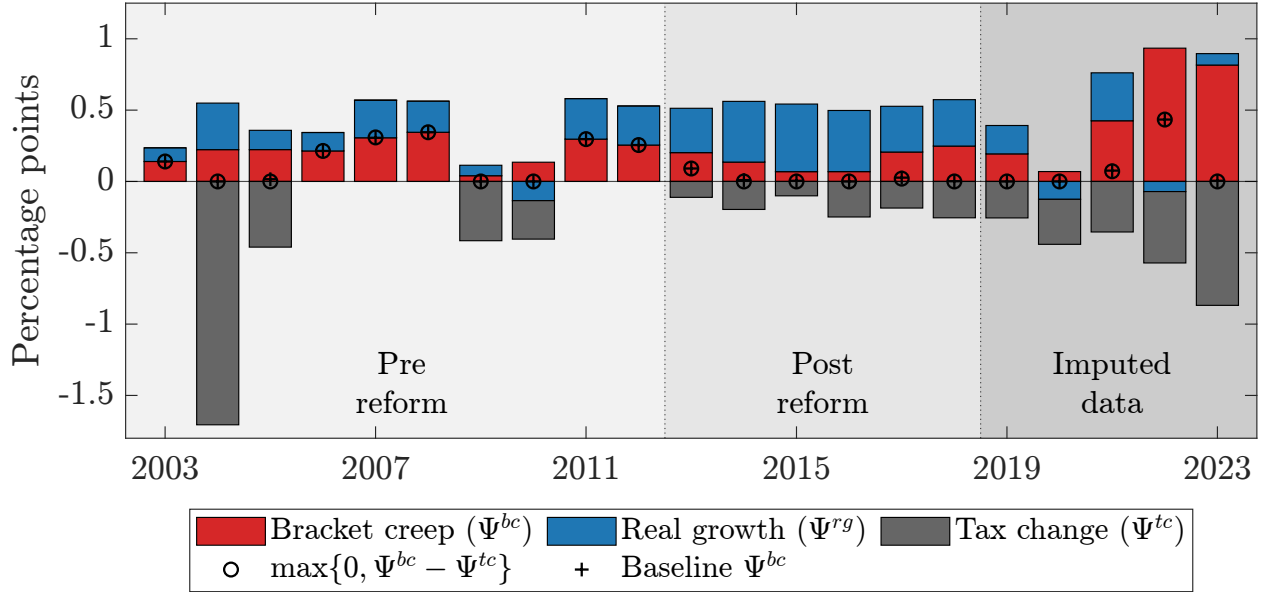
Figure B.4: Decomposition of tax rates before and after the 2012 indexation reform



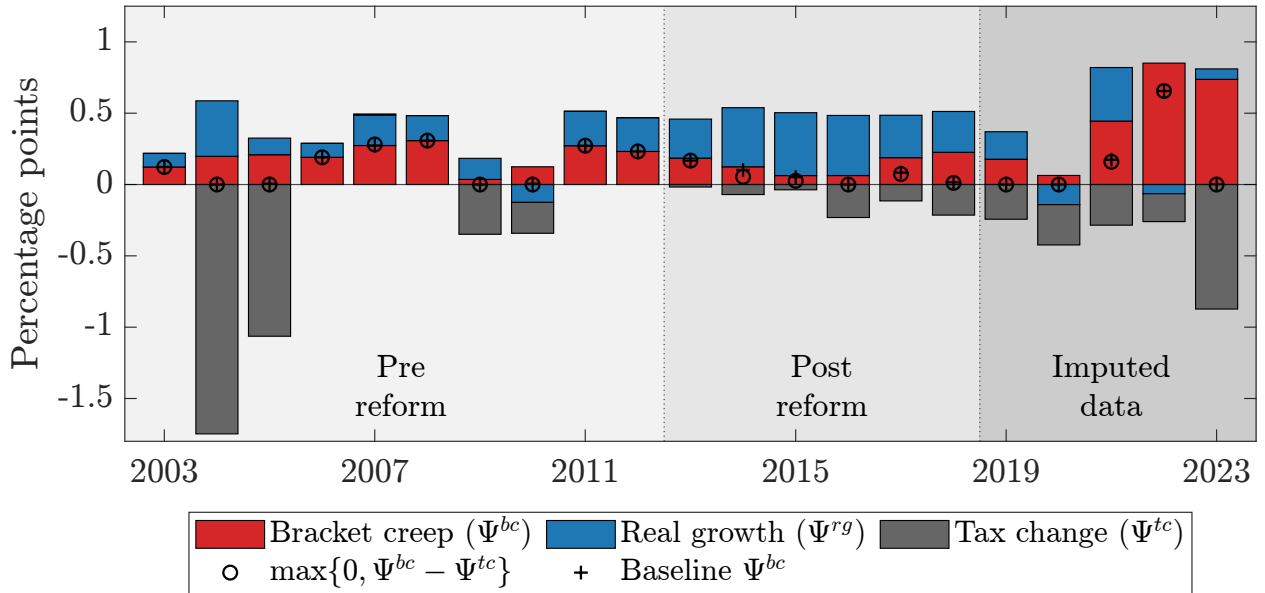
Notes: The figure shows the decomposition of year-over-year changes in average and marginal tax rates, see equation (2.2). *Bracket creep* refers to the change in the tax rate that a taxpayer with constant real income experiences, absent discretionary tax reforms, whereas *Tax change* refers to changes due to discretionary tax reforms. *Real growth* refers to changes in tax rates due to real income growth under the contemporaneous tax schedule. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018; all estimates are significant at the 5% level, for standard errors, see Table B.3. The top row presents the results for the years 2002 until 2012 and the bottom row for the years 2013 until 2018. For reference, the average annual inflation rate over the two sample periods was 1.61 and 1.13 percentage points, respectively.

Figure B.5: Mechanical decomposition with $\alpha_t = 0$

(a) Average tax rate

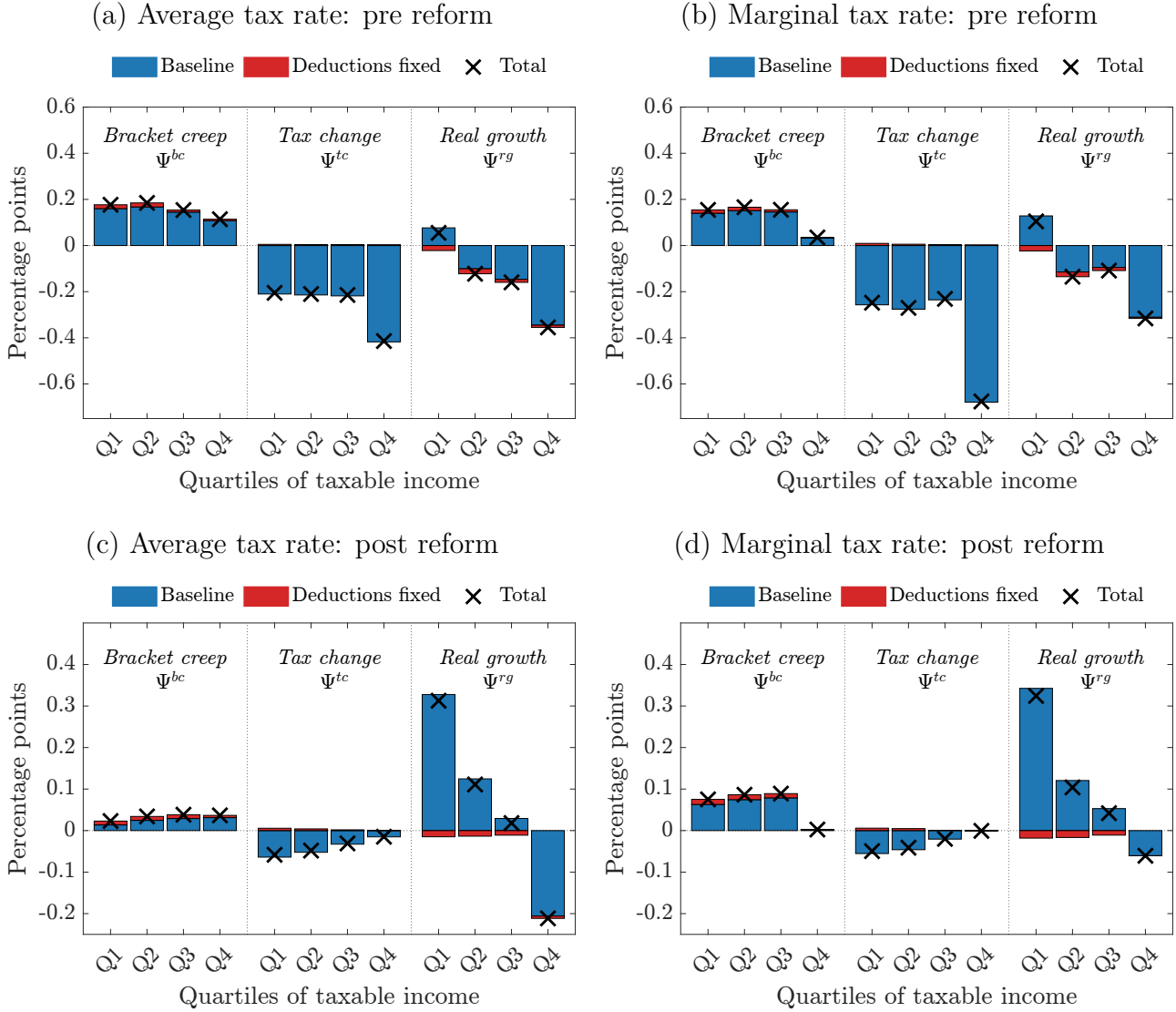


(b) Marginal tax rate



Notes: The figure shows the decomposition of year-over-year changes in average and marginal tax rates, see equation (2.2). *Bracket creep* refers to the change in the tax rate that a taxpayer with constant real income experiences, absent discretionary tax reforms, whereas *Tax change* refers to changes due to discretionary tax reforms. *Real growth* refers to changes in tax rates due to real income growth under the contemporaneous tax schedule. The results refer to the mechanical decomposition where $\alpha_t = 0$ is imposed. The circle markers indicate the differences between the bracket creep term and the tax change term, which is set to zero when the difference is negative. The plus markers indicate the value of the bracket creep term from the baseline decomposition. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018. The imputed data is based on average household income growth as explained in Section 2.3. Panel (a) and (b) show the results for the average and marginal tax rate, respectively.

Figure B.6: Decomposition of tax rates before and after the 2012 indexation reform



Notes: The figure shows the decomposition of year-over-year changes in average and marginal tax rates, see equation (2.2). *Bracket creep* refers to the change in the tax rate that a taxpayer with constant real income experiences, absent discretionary tax reforms, whereas *Tax change* refers to changes due to discretionary tax reforms. *Real growth* refers to changes in tax rates due to real income growth under the contemporaneous tax schedule. The results are arithmetic averages based on 10 Mio. German administrative tax records between 2002 and 2018; all estimates are significant at the 5% level, for standard errors, see Table B.3. The top row presents the results for the years 2002 until 2012 and the bottom row for the years 2013 until 2018. For reference, the average annual inflation rate over the two sample periods was 1.61 and 1.13 percentage points, respectively.