# Online Appendix:
# Profit Taxation, R&D Spending, and Innovation

Andreas Lichter Max Löffler Ingo E. Isphording
Thu-Van Nguyen Felix Poege Sebastian Siegloch

# A Descriptive Statistics and Additional Results

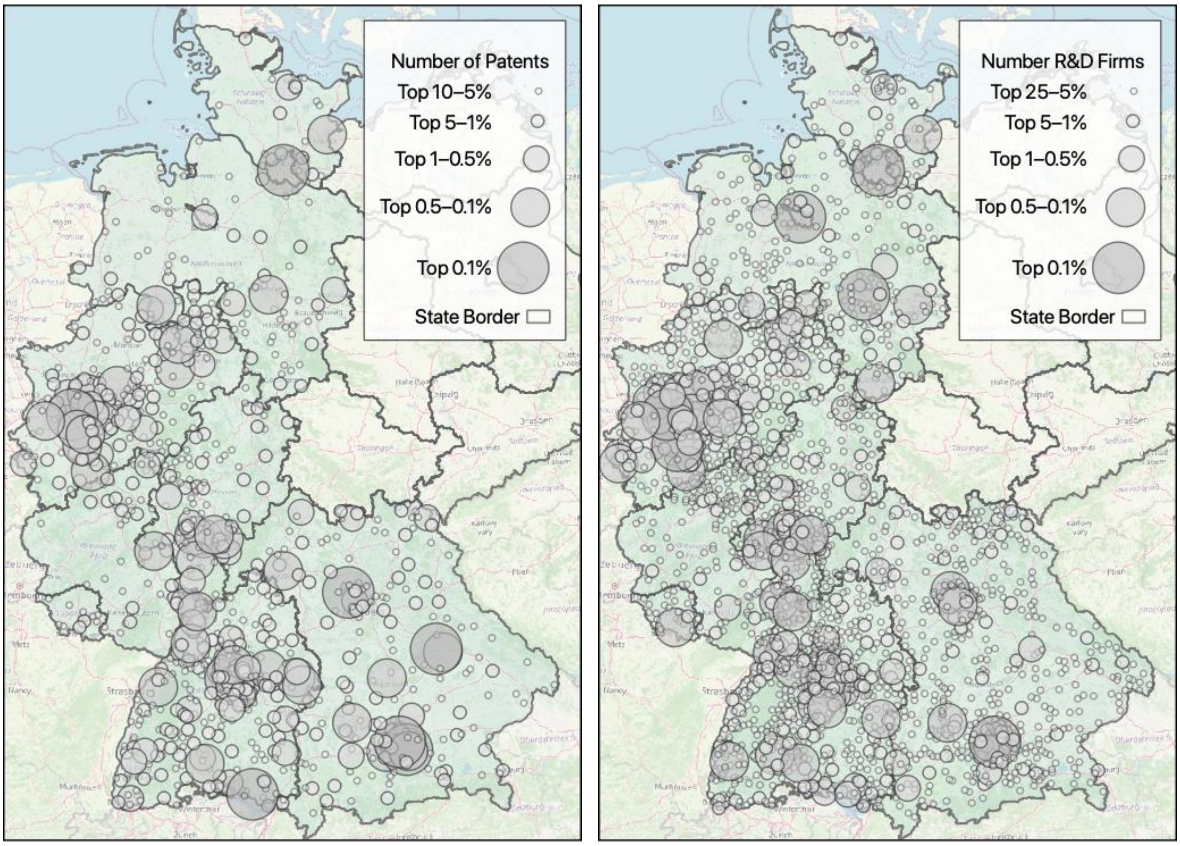
Table A.1: Descriptive Statistics for Baseline Sample

| | Mean | SD | *P*5 | *P*25 | *P*50 | *P*75 | *P*95 | *N* |
|---|---|---|---|---|---|---|---|---|
| **A. R&D Survey (Firm × Year Observations)** | | | | | | | | |
| *R&D Spending Categories* | | | | | | | | |
| Total R&D Spending (in k€) | 3,362.5 | 47,792.7 | 36.0 | 139.6 | 350.3 | 1,171.9 | 8,463.8 | 47,644 |
| Intramural R&D Spending (in k€) | 2,705.7 | 34,009.8 | 26.0 | 122.2 | 315.0 | 1,040.6 | 7,347.6 | 47,644 |
| Intramural R&D Spending on Personnel (in k€) | 1,667.1 | 17,131.4 | 16.1 | 79.9 | 210.4 | 701.0 | 4,916.3 | 47,644 |
| Intramural R&D Spending on Capital (in k€) | 828.3 | 16,380.4 | 2.0 | 20.8 | 60.5 | 217.6 | 1,926.5 | 47,644 |
| Firm Engaged in Extramural R&D (Dummy) | 0.4 | 0.5 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 | 47,644 |
| Extramural R&D Spending (in k€) | 1,616.8 | 24,249.8 | 6.4 | 27.3 | 80.1 | 258.8 | 2,524.6 | 19,354 |
| *Employment Information* | | | | | | | | |
| Total No. of Employees | 336.5 | 2,569.4 | 6.0 | 24.0 | 75.0 | 230.0 | 1,094.0 | 47,627 |
| No. of Employees Conducting R&D | 25.2 | 198.2 | 1.0 | 3.0 | 6.0 | 14.0 | 78.0 | 47,644 |
| No. of Employees Not Conducting R&D | 318.8 | 2,460.6 | 3.0 | 19.0 | 70.0 | 219.0 | 1,028.0 | 46,518 |
| No. of Scientists and Engineers in R&D | 19.5 | 138.6 | 0.8 | 2.3 | 4.5 | 11.0 | 62.0 | 47,590 |
| No. of Other Employees in R&D | 5.7 | 71.3 | 0.0 | 0.3 | 0.9 | 2.3 | 15.0 | 47,590 |
| Average Wage of Employees in R&D (in k€) | 46.1 | 33.5 | 8.3 | 27.0 | 40.2 | 62.1 | 94.0 | 47,032 |
| *Other Firm Characteristics* | | | | | | | | |
| Sales (in Million €) | 96.2 | 1,028.6 | 0.0 | 3.0 | 12.0 | 44.0 | 260.0 | 47,489 |
| Sales per Employee (in k€) | 203.7 | 908.1 | 56.1 | 104.1 | 148.3 | 216.9 | 444.2 | 47,485 |
| Firm Incorporated (Dummy) | 0.8 | 0.4 | 0.0 | 1.0 | 1.0 | 1.0 | 1.0 | 47,644 |
| Manufacturing Sector (Dummy) | 0.8 | 0.4 | 0.0 | 1.0 | 1.0 | 1.0 | 1.0 | 47,644 |
| Service Sector (Dummy) | 0.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 47,644 |
| Other Sector (Dummy) | 0.1 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 47,644 |
| **B. Bureau van Dijk Data (Firm × Year)** | | | | | | | | |
| Non-Current Liabilities to Sales Ratio | 0.6 | 11.1 | 0.0 | 0.1 | 0.3 | 0.5 | 1.2 | 24,345 |
| Part of Corporate Group (Dummy) | 0.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 47,644 |
| Total Investment (in k€) | 31,258.7 | 937,436.1 | 6.9 | 78.1 | 404.3 | 2,119.7 | 27,200.1 | 19,474 |
| Non-R&D Investment (in k€) | 34,159.0 | 981,053.6 | 9.9 | 100.4 | 484.1 | 2,422.8 | 29,491.8 | 17,712 |
| EBITDA (in k$) | 32,678.5 | 512,488.3 | -1,765.0 | 724.3 | 2,645.1 | 8,837.4 | 58,222.9 | 13,979 |
| **C. EPO Patent Data (Firm × Year)** | | | | | | | | |
| Any Patents Filed (Dummy) | 0.16 | 0.37 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 47,644 |
| Any Patents Filed and Cited (Dummy) | 0.11 | 0.31 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 47,644 |
| Number of Patents | 0.71 | 5.15 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 47,644 |
| Citation-Weighted Number of Patents | 0.83 | 8.56 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 47,644 |
| Citation-Weighted Process Innovations | 0.31 | 3.99 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 47,644 |
| Citation-Weighted Product Innovations | 0.40 | 3.84 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 47,644 |
| **D. Local Characteristics (Municipality × Year)** | | | | | | | | |
| STTR for Corporations (in %) | 36.6 | 7.8 | 27.0 | 28.4 | 36.8 | 40.6 | 49.2 | 16,635 |
| STTR Non-Corporate Firms (in %) | 50.2 | 5.1 | 44.5 | 46.8 | 47.8 | 52.2 | 62.2 | 16,635 |
| Local Business Tax Rate (in %) | 15.6 | 3.0 | 11.2 | 12.6 | 16.0 | 17.5 | 21.0 | 16,635 |
| Population | 26,926.9 | 76,983.5 | 1,845.0 | 5,350.0 | 11,330.0 | 22,770.0 | 80,692.0 | 16,635 |
| No. of Unemployed | 1,095.7 | 3,859.4 | 33.0 | 114.0 | 293.0 | 744.0 | 3,709.0 | 14,014 |
| Total Municipal Expenses (in k€) | 689.0 | 3,270.4 | 28.4 | 88.1 | 182.6 | 411.4 | 1,928.8 | 13,929 |
| Total Municipal Revenues (in k€) | 65,536.6 | 309,445.0 | 2,764.0 | 8,704.0 | 18,030.0 | 40,252.0 | 190,574.0 | 13,929 |
| GDP per capita | 28,907.9 | 10,540.0 | 19,246.8 | 23,308.1 | 26,892.3 | 31,134.5 | 43,689.4 | 16,240 |
| County-Level Unemployment Rate (in %) | 7.1 | 2.8 | 3.4 | 5.0 | 6.7 | 8.6 | 12.2 | 16,626 |

*Notes:* This table presents descriptive statistics for our set of outcome and control variables in the baseline sample. For each variable, we present mean and standard deviation (SD) along with selected percentiles of the respective distributions ($P\dots$) and the number of non-missing observations ($N$).

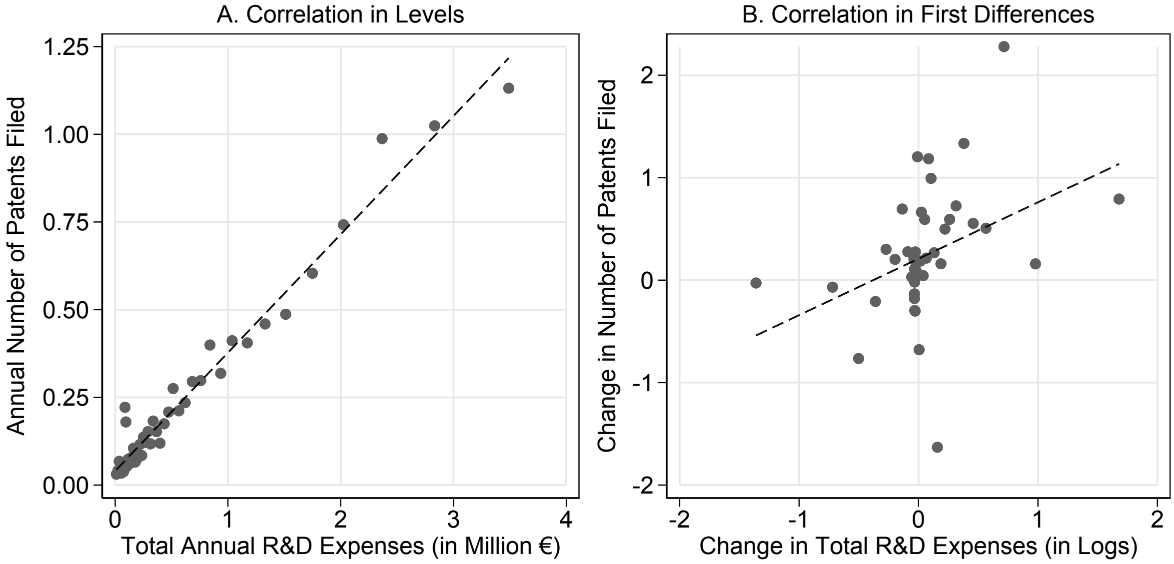
Figure A.1: Spatial Distribution of R&D Establishments and Patenting in West Germany

A. Distribution of R&D Establishments B. Distribution of Patents



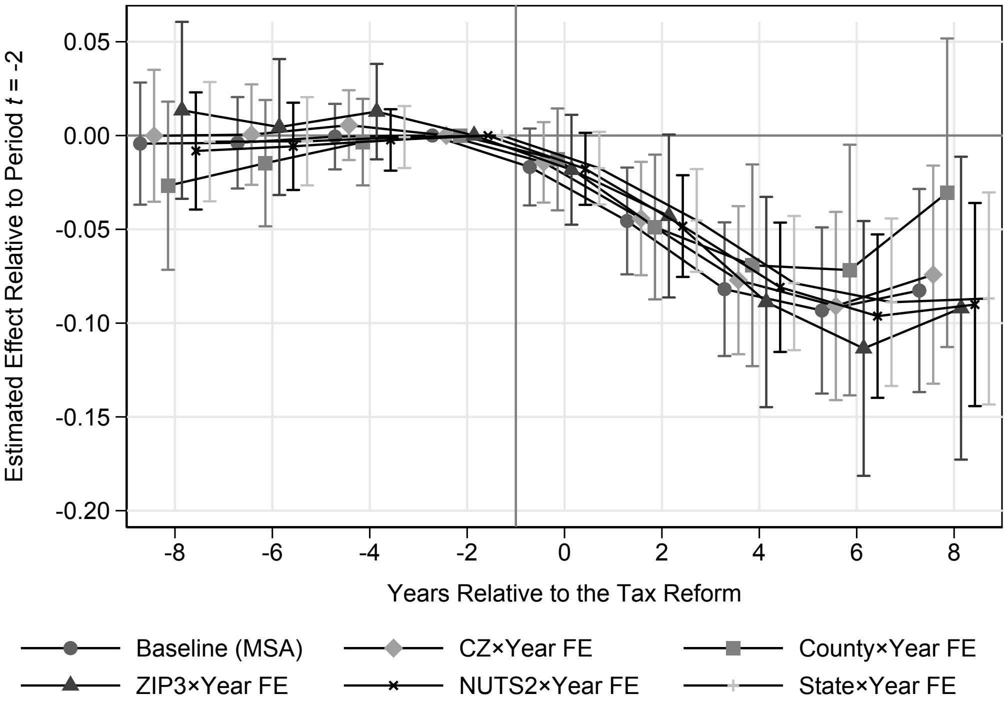

*Notes:* Panel A illustrates the distribution of establishments in the R&D Survey as of 2007 across West German municipalities. Larger circles indicate more R&D active establishments in a given municipality. Panel B plots the spatial distribution of patenting across West Germany. Larger circles indicate that more patents were filed in a given municipality throughout the observation period. Thick gray lines indicate federal state borders. *Maps: © GeoBasis-DE / BKG 2015* and *OpenStreetMap* contributors.

Figure A.2: Assessing the Link between Establishment-Level R&D Spending and Patenting



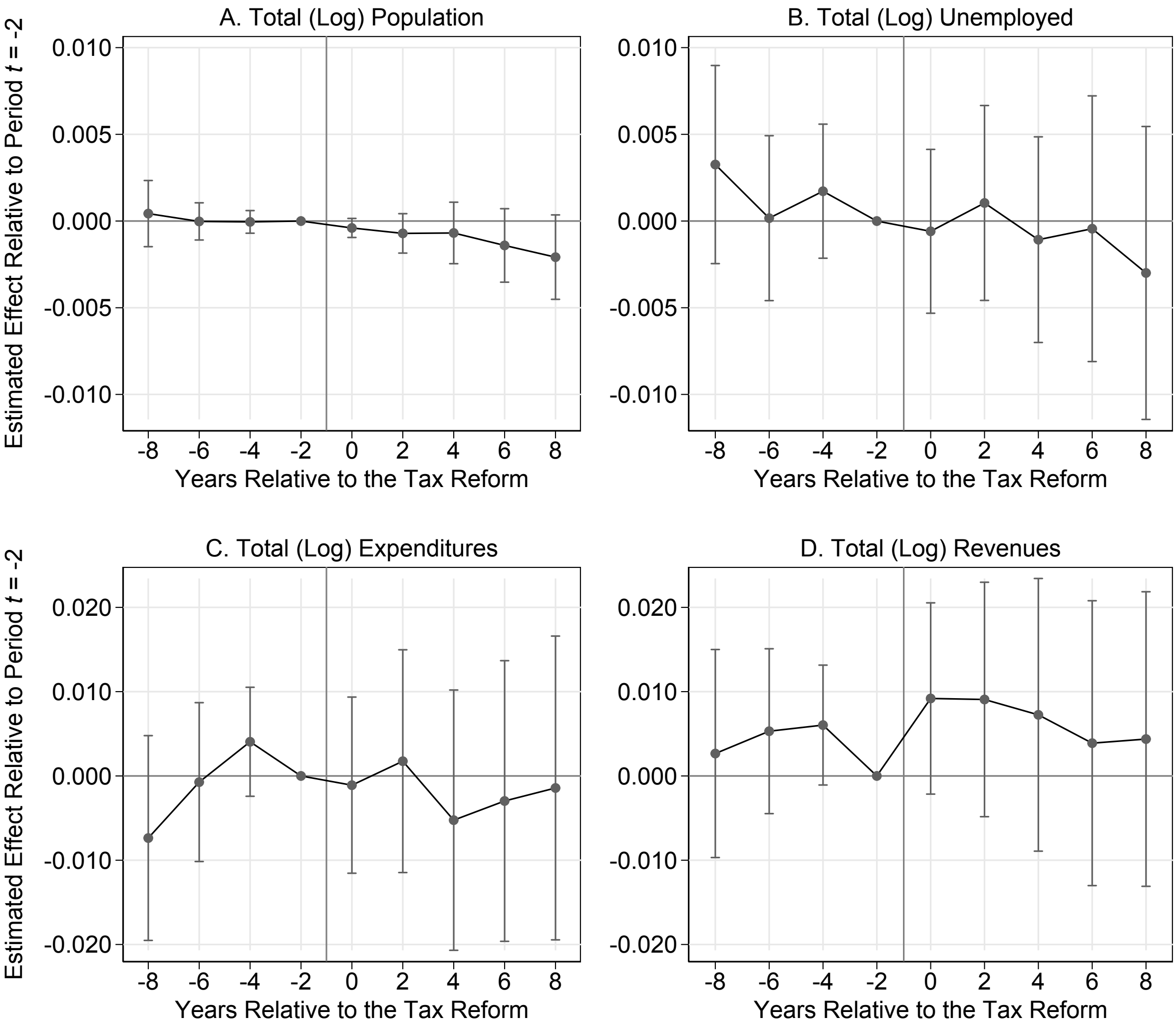

*Notes:* These binned scatter plots illustrate the relationship between establishments' total annual R&D spending and their respective number of filed patents in our baseline sample. We plot the overall relationship in Panel A and the correlation in first differences in Panel B.

Figure A.3: Identification Test: Toward A Border Design



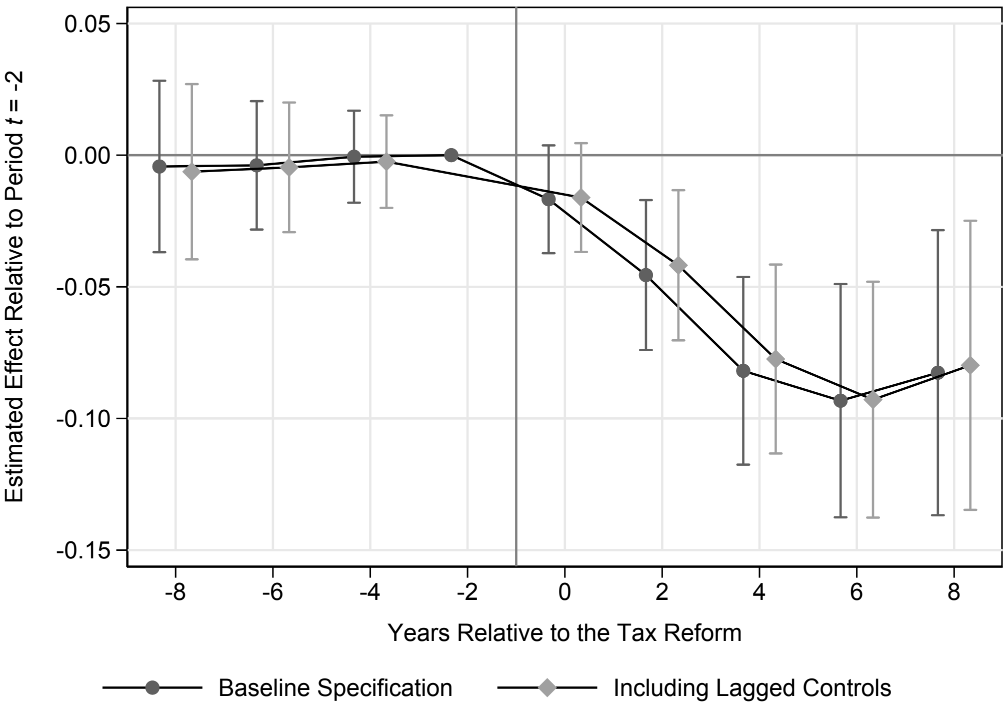

*Notes:* This figure plots the point estimates, $\widehat{\beta}_k$ ($k \in [-8, -6, \ldots, 8]$), and corresponding 95% confidence intervals for a one percentage point increase in the statutory total tax rate on establishments' annual total R&D spending (in logs) using the event study model as defined in Equation (5). The baseline specification replicates the results displayed in Panel A of Figure 3, using legal-form specific MSA-by-year fixed effects. Specifications (2)–(4) account for more fine-grained local shocks at the level of the commuting zone (CZ), county, and 3-digit zip code (ZIP3) level, respectively. In specifications (5) and (6), we account for time-varying regional shocks at broader levels compared to our baseline specification—absorbing common shocks at the NUTS-2 and federal state level, respectively. In all panels, the STTR changed in year $t = 0$ or $t = -1$ for the treated establishments. Standard errors are clustered at the municipality level. The corresponding regression coefficients are provided in Appendix Table D.3.

Figure A.4: Identification Test: Confounders as Outcomes



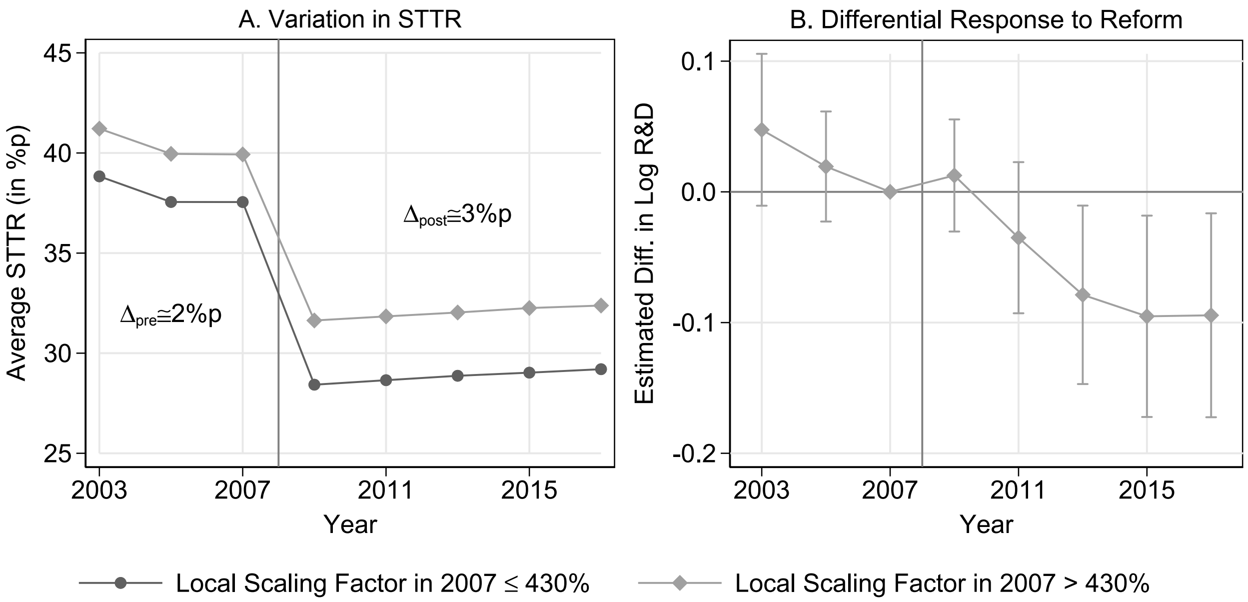

*Notes:* This figure plots the point estimates, $\widehat{\beta}_k$ ($k \in [-8, -6, \ldots, 8]$), and corresponding 95% confidence intervals for a one percentage point increase in the local business tax rate on municipality-level outcomes (in logs) using the event study model as defined in Equation (5). The dependent variable refers to municipality's annual population level in Panel A, annual stock of unemployed in Panel B, total annual expenditures in Panel C, and total annual revenues in Panel D, respectively. The sample comprises all West German municipalities. The regressions include municipality, state $\times$ year, as well as commuting zone $\times$ year fixed effects. In all panels, the STTR changed in year $t = 0$ or $t = -1$ for the treated establishments. Standard errors are clustered at the district level. The corresponding regression coefficients are provided in Appendix Table D.3.

Figure A.5: Identification Test: Lagged Local Confounders as Controls



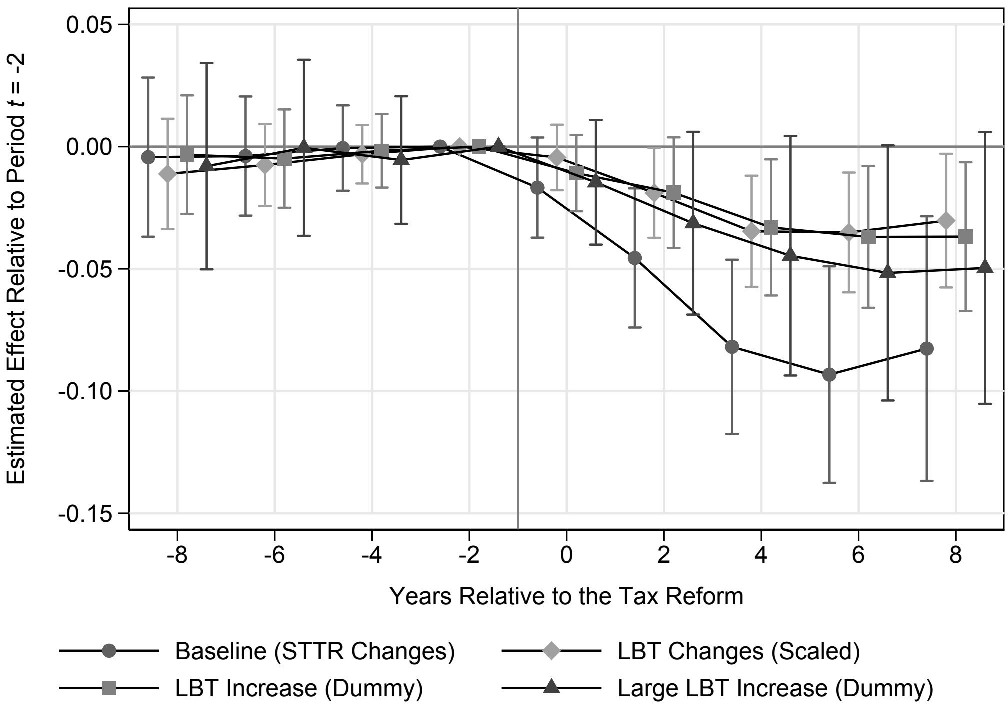

*Notes:* This figure plots the point estimates, $\widehat{\beta}_k$ ($k \in [-8, -6, \ldots, 8]$), and corresponding 95% confidence intervals for a one percentage point increase in the statutory total business tax rate on establishments' annual total R&D spending (in logs) using the event study model as defined in Equation (5). The baseline specification replicates the results displayed in Panel A of Figure 3. In specification (2), we additionally control for municipalities' log population, log GDP, as well as the corresponding county's unemployment rate (all lagged by one year). The regressions further include establishment as well as legal-form specific MSA-by-year and sector-by-year fixed effects. The STTR changed in year $t = 0$ or $t = -1$ for the treated establishments. Standard errors are clustered at the municipality level. The corresponding regression coefficients are provided in Appendix Table D.3.

Figure A.6: Identification Test: Exploiting the 2008 Federal Tax Reform



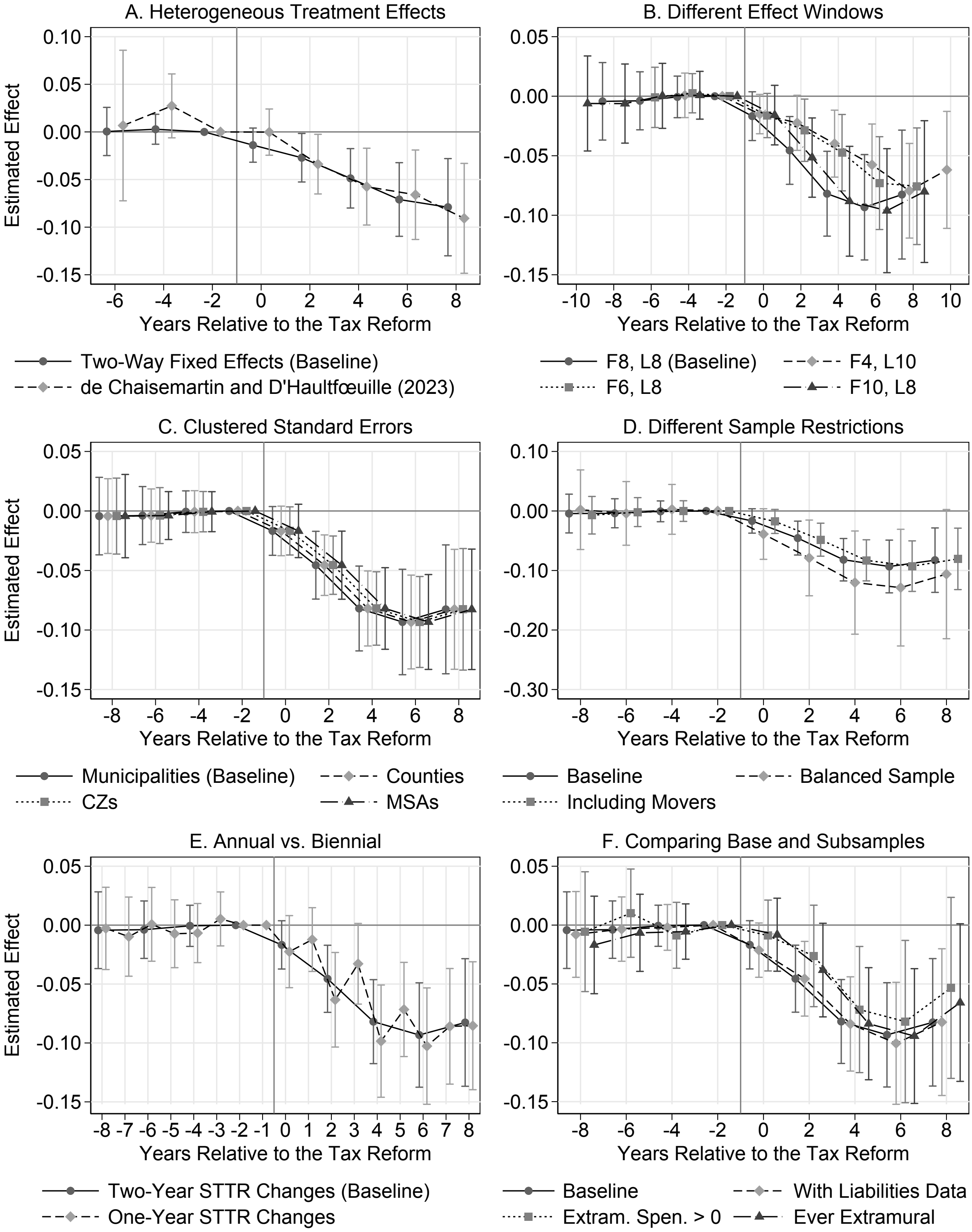

*Notes:* This figure presents the results of an identification test that only relies on local variation in the statutory total tax rate (STTR) induced by the 2008 federal tax reform. Panel A illustrates the reform-induced variation STTR. In detail, it depicts the average STTR before and after the tax reform for establishments in municipalities with 2007 local scaling factors smaller than or equal to 4.3 (corresponding to the bottom 75% of the 2007 scaling factor distribution, dark dots) and for those establishments in municipalities with scaling factors above 4.3 (the top 25% of the 2007 scaling factor distribution, bright diamonds). Panel B plots the point estimates, $\widehat{\gamma}_k$ ($k \in [2003, 2005, \ldots, 2017]$), and corresponding 95% confidence intervals of a dynamic difference-in-differences model that compares the evolution of establishments' (log) R&D spending located in municipalities more affected by the reform-induced tax cut to the corresponding evolution of establishments' (log) R&D spending located in municipalities that were less affected by the reform (see Equation (7)). The control group, i.e., municipalities with a local scaling factor equal to or below 430, saw relatively stronger cuts in the STTR compared to the treatment group—the average tax cut in the STTR amounted to nine percentage points in the control group and eight percentage points in the treatment group. The difference-in-differences model further accounts for establishment fixed effects as well as MSA-by-year and sector-by-year fixed effects. Standard errors are clustered at the municipality level. The corresponding regression coefficients are provided in Appendix Table D.3.

Figure A.7: Identification Tests: (Large) Increases in the LBT



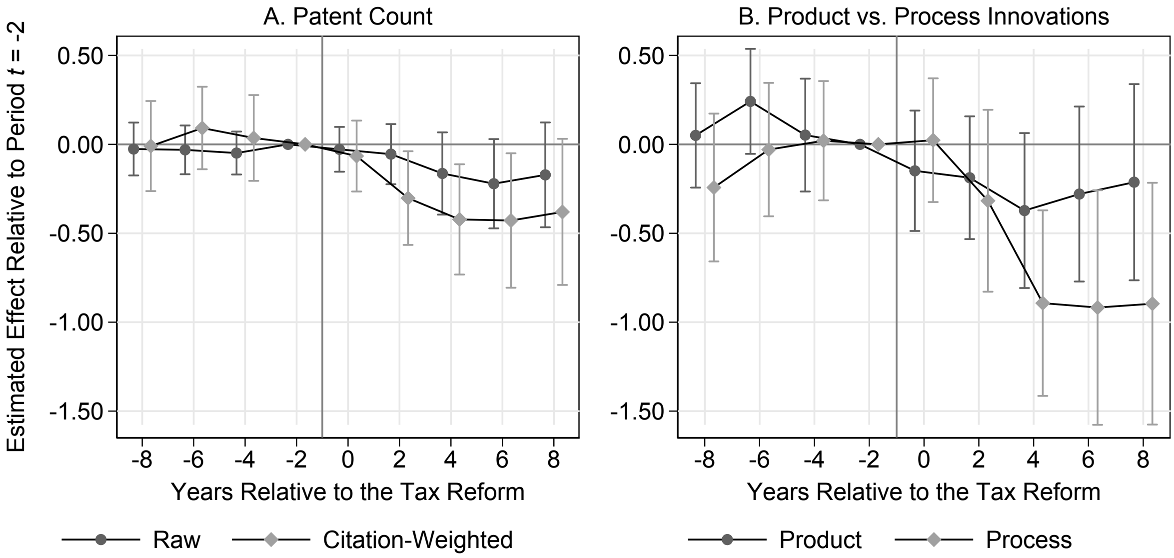

*Notes:* This figure plots the point estimates, $\widehat{\beta}_k$ ($k \in [-8, -6, \ldots, 8]$), and corresponding 95% confidence intervals for a one percentage point increase in the statutory total tax rate / the local business tax rate on establishments' annual total R&D spending (in logs) using the event study model as defined in Equation (5). The baseline specification replicates Panel A of Figure 3 using all STTR changes. Specification (2) restricts the identifying variation to scaled changes in the local business tax rate. In specification (3), we limit identification to increases in the local business tax rate and implement a classical event study design that does not scale events, i.e., tax rate changes, by their size. In this case, treatment refers to a dummy variable indicating an increase in the local scaling factor. Last, in specification (4), we limit variation to large local tax increases. The treatment indicator variable turns one if a given tax increase is above the median of all local scaling factor increases. The regressions include establishment as well as legal-form specific MSA-by-year and sector-by-year fixed effects. The STTR changed in year $t = 0$ or $t = -1$ for the treated establishments. Standard errors are clustered at the municipality level. The corresponding regression coefficients are provided in Appendix Table D.3.

Figure A.8: The Effect of Profit Taxes on R&D Spending: Further Robustness Checks



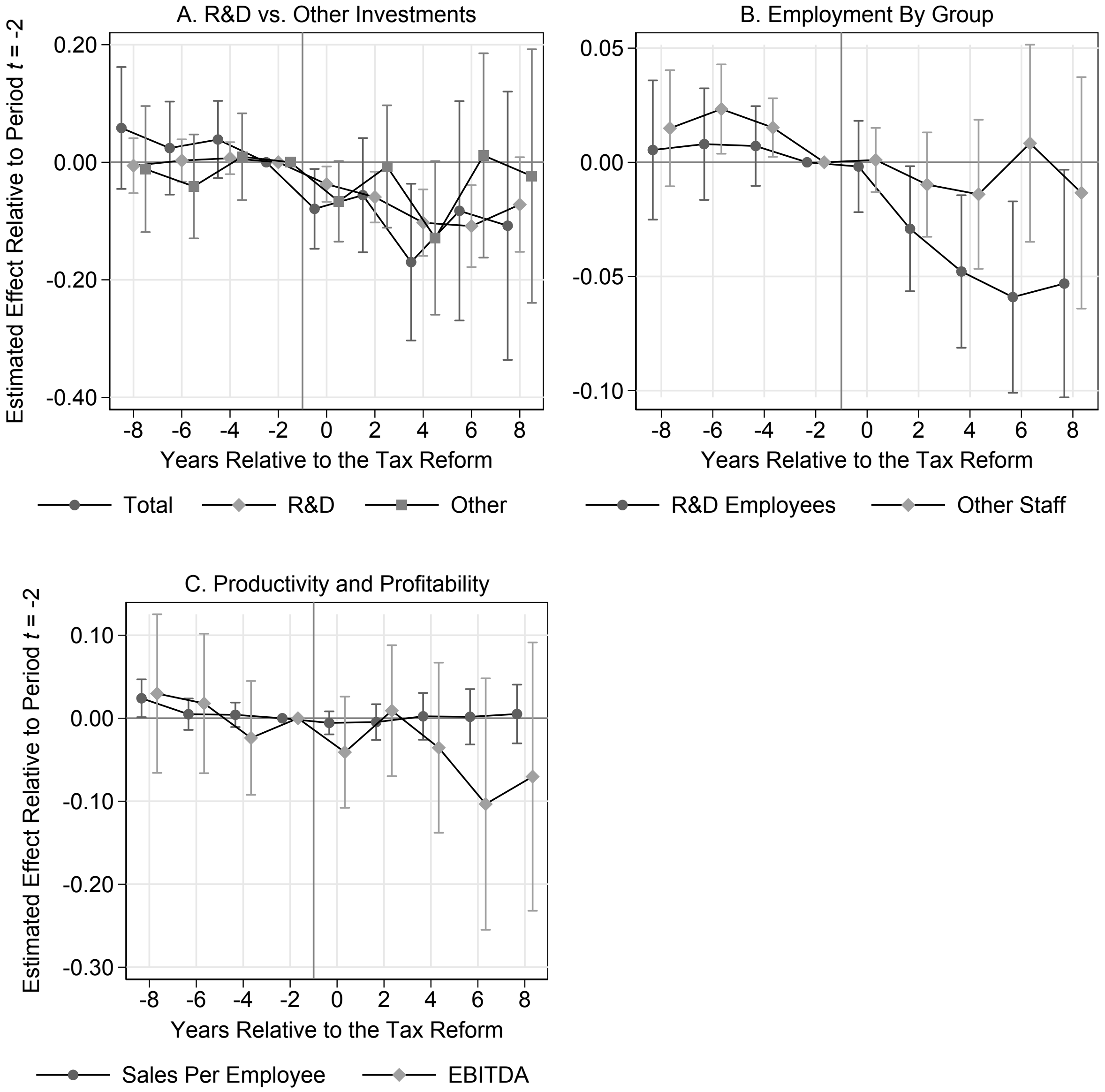

*Notes:* This figure provides additional robustness checks for the baseline effect as displayed in Panel A of Figure 3. In Panel A, we contrast the results from our baseline specification with the estimator proposed by de Chaisemartin et al. (2023) to account for heterogeneous effects across treatment cohorts. We shorten the event window and control for state-by-year shocks to ensure a minimum number of switchers informing coefficients. In Panel B, we plot estimates for different effect windows: four leads/ten lags, six leads/eight lags, and ten leads/eight lags. When shortening the number of leads to six (four) years, the survey waves 2015 (and 2017) enter the sample. In Panel C, we show results for alternative ways of drawing inference. Panel D presents results when using a balanced sample and including establishments that change locations, respectively. In Panel E, we use one-year instead of two-year differences in the STTR as treatment. Last, in Panel F we show results on total R&D spending when limiting the sample to establishments with (i) information on their non-current liabilities, or (ii) positive external R&D spending, respectively. All regressions in Panels B–F include establishment as well as legal-form specific MSA-by-year and sector-by-year fixed effects. In all panels, The STTR changed in year $t = 0$ or $t = -1$ for the treated establishments. In Panels A, B, and D–F, standard errors are clustered at the municipal level. The corresponding regression coefficients are provided in Appendix Table D.4.

Figure A.9: The Effect of Profit Taxes on Patents: Poisson Pseudo-Maximum Likelihood Estimation




*Notes:* This figure plots the point estimates, $\widehat{\beta}_k$ ($k \in [-8, -6, \ldots, 8]$), and corresponding 95% confidence intervals for a one percentage point increase in the statutory total tax rate on establishments' patenting activities using the event study model as defined in Equation (5) and Poisson pseudo-maximum likelihood estimation. The dependent variable refers to an establishment's annual (citation-weighted) number of patents filed in Panel A and the annual citation-weighted number of product and process patents in Panel B, respectively. The regressions include establishment as well as legal-form specific MSA-by-year and sector-by-year fixed effects. In both panels, the STTR changed in year $t = 0$ or $t = -1$ for the treated establishments. Standard errors are clustered at the municipality level. The corresponding regression coefficients are provided in Appendix Table D.5.

Figure A.10: The Effect of Profit Taxes on Non-R&D Outcomes




*Notes:* This figure plots the point estimates, $\widehat{\beta}_k$ ($k \in [-8, -6, \ldots, 8]$), and corresponding 95% confidence intervals for a one percentage point increase in the statutory total tax rate on firms' non-R&D outcomes using the event study model as defined in Equation (5). In Panel A, we contrast the effect on establishments' internal R&D spending on capital with the effect on overall and non-R&D investments (at the firm level). In Panel B, we report effects on R&D and non-R&D employment. Last, in Panel C we look at the effect on firm-level productivity (measured by sales per employee) and profitability (measured by EBITDA). All outcomes are in logs. All regressions include establishment as well as legal-form specific MSA-by-year and sector-by-year fixed effects. In all panels, the STTR changed in year $t = 0$ or $t = -1$ for the treated establishments. Standard errors are clustered at the municipality level. The corresponding regression coefficients are provided in Appendix Table D.5.

## B Data Appendix

Below, we provide additional information on the different datasets merged for the empirical analysis.

**R&D Survey.** The main data source of the empirical analysis is the biennial longitudinal survey dataset *Survey on Research and Development of the German Business Enterprise Sector* (henceforth: *R&D Survey*), collected and administrated by the *Stifterverband* on behalf of the German Federal Ministry of Education and Research. It was first conducted in 1995 and has been used as the basis of Germany's official reporting of its entrepreneurial R&D activities to EU authorities and the OECD ever since.

To capture Germany's entrepreneurial R&D activities in full, the *Stifterverband* maintains a continuously updated register that targets the universe of research-active firms in Germany. In general, the survey's methodology follows the methodological recommendations for the collection and interpretation of R&D data of the OECD.[1] The target population contains all researching and developing firms as well as institutions for collaborative research that are based in Germany and have at least one employee. A firm is included in the survey if it is known that it was or is R&D-active or if this can be assumed with a certain degree of probability. To this end, new firms are added to the inventory if there is a reasonable chance that they are conducting R&D. Candidates are identified through the regular screening of different sources: federal funding data, the CORDIS database of the European Commission, firm information (financial statements and annual reports), media information, commercial business databases (e.g., the *Markus* database), patent applications and member lists of business associations with an innovative focus of business activity.[2] To further ensure the comprehensiveness of the firm register, regular surveys are conducted among firms in R&D active industries (in particular, automotive engineering, mechanical engineering, electrical and chemical engineering), which have not been known for their R&D activity so far. Results of these short surveys indicate that a very high share of all R&D-active firms in Germany is indeed covered by the dataset.

The survey targets research-active establishments of research-active firms. Around 96% of the surveyed firms only have one research-active establishment—either because it is a single-establishment R&D firm or because it is a multi-establishment firm with only one R&D site. Around 4% of the firms state that the reported numbers represent the R&D activities of more than one establishment within the firm. For those firms, we know that they have to be multi-establishment entities, but we do not know how many R&D sites there are, how activities are distributed across sites and where these other sites are located (we only know the location of the reporting R&D site). Accordingly, we drop these firms from the baseline sample. Thus, our sample consists of research-active establishments that conduct all R&D of a given firm. The surveyed R&D sites additionally report some firm-level information: total (=R&D and non-R&D) employees, sales, industry classification, and organizational structure. Unfortunately, we do not observe if other non-R&D establishments exist.

[1] See, e.g., `https://ec.europa.eu/eurostat/ramon/statmanuals/files/Frascati_Manual_2015_de.pdf`

[2] Among others, these associations encompass the *Bundesverband der Energie- und Wasserwirtschaft e.V*, *Forschungskreis der Ernährungsindustrie e.V.*, *Verband der Chemischen Industrie e.V.*, *Verband der Automobilindustrie e. V.*, *Verband Deutscher Maschinen- und Anlagenbau e.V.*, *Verband Forschender Arzneimittelhersteller e.V.*, *Zentralverband der Elektrotechnik und Elektroindustrie e. V.*, *Hauptverband der Deutschen Bauindustrie e.V.*, and *BITKOM e.V.*.

**Patent Data.** We match administrative information on the patenting activities of the establishments covered in the *R&D Survey* from the *European Patent Office* (EPO, *PATSTAT* dataset as of 4/2023) to the *R&D Survey*. As establishments often register the very same innovation at multiple intellectual property (IP) protection institutions, worldwide patent databases focus on "patent families", i.e., pool those inventions that show the very same content and priority date. The latter refers to the date of the first patent application within a patent family at any institution and determines the start of the IP protection period. The focus on patent families effectively rules out the threat of double-counting the very same patented innovation within and across different IP systems. Within the EPO system, double-counting of patents in cases such as divisional applications is also avoided.

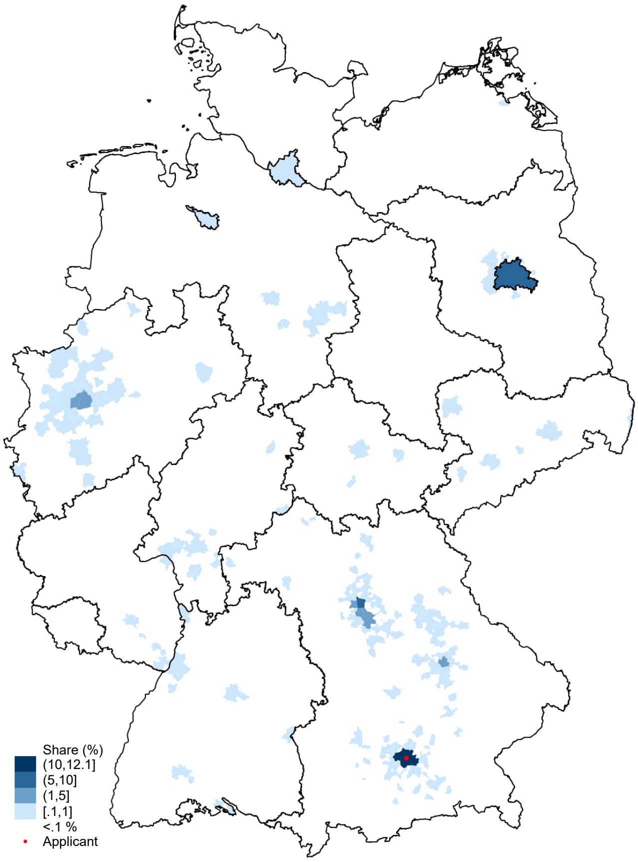
To best match the EPO information with the establishment-level survey, we limit ourselves to patent families that were first registered between 1995 and 2017 and identify each patent family's initial applicant(s). This is particularly important in the context of our analysis: we want to identify the establishment where the initial invention occurred, not the current IP holder. We next drop all patent applications that have not been (co-)filed by an establishment (as classified by *PATSTAT*), and geocode all remaining patents. In a final step, we use detailed information on the applicants' name(s) and location(s) of residence to merge the number of filed patents to the survey by means of a fuzzy matching algorithm. In case multiple actors jointly invented a new product or process, we only assign the respective share of a patent to a given establishment. Overall, the surveyed establishments account for around 60% of all patents filed with a German applicant during the sample period.

For firms with multiple R&D units, one of them is often listed as the applicant on all patents of that firm. For the patent-survey match, we have chosen the training data to focus on address information, so that treatment assignment is precise. On the flip-side, for multi-establishment firms this implies that the matching may become incorrect, as patents generated at one R&D site of that firm are registered by another R&D site. Figure B.1 visualizes this feature of IPP management for the Siemens AG, which has most of their inventors located around Munich, Nuremburg/Erlangen and Berlin—but just one applicant location (Munich). As this makes the correct assignment of a given patent to the true location of creation very challenging and imprecise, we exclude firms with multiple R&D sites when looking at the effect of changes in business taxes on patent outcomes.

As the value of patents differs substantially (Scherer, 1965, Hall et al., 2005), we focus on both the simple patent count and an outcome measure that weights each patent family according to the number of citations it receives from patents filed at the EPO within the first five years after its registration.[3] Citation-adjusted weighted counts are widely used in the literature and have been shown to correlate well with real-world measures of innovation quality such as profitability (see, e.g., Harhoff et al., 2003, Kogan et al., 2017, Moser et al., 2018). Relying on data from Danzer et al. (2020), we further distinguish product from process innovations. To group patents along this margin, information from the highly-standardized patents' claims texts is used. Patents are classified as process innovation if the claim text of a patent includes terms such as "method", "process" or "procedure". Note that some patent applications do not provide enough information to classify a

[3] Effects remain unaffected when using citations from patents filed at the United States Patent and Trademark Office (USTPO). Citations counts are quite different in these two institutions as the USPTO requires patent applicants to list all relevant patents prior art, whereas such a requirement does not exist at the EPO. Because citation data is taken from PATSTAT 4/2023 and our sample lasts until 2017 attrition is unlikely.

Figure B.1: The Spread of Inventors for Siemens AG across Germany




*Notes:* This shows the location of each inventor of patents for the Siemens AG over the period 1995–2017. *Source:* PATSTAT.

patent as a product or process innovation. Excluding these patents from the baseline regressions does not affect estimates (not reported).

**Bureau van Dijk Data.** In order to assess firms' financial situation as well as their non-R&D outcomes, we link additional information from the Bureau van Dijk's (BvD) *Amadeus* and *Orbis* databases to the surveyed establishments.[4] The match between the *R&D Survey* and the BvD data has been established by the *Stifterverband* as part of the survey's implementation strategy. The two BvD datasets offer a variety of financial information at the *firm* level, i.e., we assign firm-level information to establishments in case they are part of a multi-establishment firm. As the BvD datasets predominantly cover larger and oftentimes stock-listed establishments or firms, we cannot match all surveyed establishments to the BvD data.

To prepare the BvD data for the purposes of our empirical analysis, we follow Kalemli-Özcan et al. (2015) and Gopinath et al. (2017). We first combine multiple vintages of the *Amadeus* and *Orbis* datasets to increase coverage over time. Ultimately, we use vintages of the *Amadeus* database from 2001, 2002, 2007 and 2010, as well as the 2016 *Orbis* version. When a given establishment appears in more than one vintage, we follow Gopinath et al. (2017) and take those information from the most recent vintage. When multiple financial accounts are available for a given establishment in a given

[4] The data was kindly made available by the LMU-ifo Economics & Business Data Center (`https://www.ifo.de/EBDC`).

year, we always refer to accounts with higher quality. Here, we prefer those accounts that cover the full twelve months of a given year. Moreover, we prefer accounts in accordance with IFRS guidelines over GAAP accounts or those with unknown reporting standards. Last, we choose unconsolidated over consolidated accounts. We make use of the accounting data to measure firms' financial situation (via the non-current liabilities to sales ratio), their profitability (via EBITDA), as well as their total investments. Investment is defined as the (log) yearly change in fixed assets plus depreciation, adjusted by a gross fixed capital formation deflator. From the *Orbis* database, we further derive information about firms' global ultimate owner (GUO). We consider R&D establishments to belong to one corporate group if they have the same GUO.

**Administrative Regional Data.** Information on local business tax scaling factors (*Realsteuerhebesätze der Gewerbesteuer*) for all West German municipalities were collected from the Federal Statistical Office and the Statistical Offices of the German States. In more detail, we constructed a balanced panel dataset for the universe of municipalities by combining the data as follows. Information for the period from 1985–2000 were obtained by filing requests to the respective Statistical Offices of the German States. Information for the period 2001–2021 were taken from the publicly accessible annual reports *Hebesätze der Realsteuern*, published by the Statistical Offices of the German States.

Data on local expenses and spending for all West German municipalities over the period from 1998–2017 were obtained from the Federal Statistical Office and the Statistical Offices of the German States. Since 2001, information on local expenses have been publicly available via the annual reports *Statistik Lokal*, published by the Statistical Offices of the German States. For the period from 1998–2000, we filed data requests to the Statistical Offices of the German States. We account for inflation by using the consumer price index and express expenses/spending in 2010 prices.

Information on population levels is available for the period 1987–2017 and was taken from the Federal Statistical Office and the Statistical Offices of the German States. We combine two different sources to construct a balanced panel for the universe of West German municipalities. Data for the period from 1987 to 1999 are based on data requests to the Statistical Offices of the German States. Data on population levels from 2000 onward are publicly available via the annual German municipality register (*Gemeindeverzeichnis*).

Last, we collect information on the number of unemployed individuals per municipality for the period 1998–2016 from the annual report *Bestand an Arbeitslosen, Rechtskreise SGB III und SGB II, Insgesamt*, published by the German Federal Employment Agency.

## C Institutional Setting

This appendix provides additional details on the paper's underlying institutional setting as well as the calculation of statutory total tax rates (STTR), introduced in Section II.B.

**Statutory Total Tax Rates.** The local business tax (LBT) applies to both corporate and non-corporate firms. Subject to their legal status, firms face additional taxes at the federal level. Corporate firms are subject to the corporate income tax (CIT), non-corporate firms are subject to the personal income tax (PIT). As a consequence, the calculation of the STTR differs for corporate and non-corporate firms in a given year $t$.

For corporate firms the STTR is defined as follows:

$$\tau_{corp} = \begin{cases} \left(\tau^{CIT} \cdot \left(1 + \tau^{SUR}\right) + \phi^{LBT}_{fed} \cdot \sigma^{LBT}_{mun}\right) \,/\, \left(1 + \phi^{LBT}_{fed} \cdot \sigma^{LBT}_{mun}\right) & \text{if } year \leq 2007 \\ \left(\tau^{CIT} \cdot \left(1 + \tau^{SUR}\right) + \phi^{LBT}_{fed} \cdot \sigma^{LBT}_{mun}\right) & \text{if } year \geq 2008, \end{cases} \tag{C.1}$$

where $\tau^{CIT}$ refers to the corporate profit tax rate (*Körperschaftsteuer*) and $\tau^{SUR}$ to the tax surcharge (*Solidaritätszuschlag*). The local business tax rate (*Gewerbesteuer*) combines two parameters: the basic federal rate (*Steuermesszahl*, denoted by $\phi^{LBT}_{fed}$) and the municipal scaling factors (*Gewerbesteuerhebesatz*, denoted by $\sigma^{LBT}_{mun}$). Until 2000, the corporate profit tax applied differential tax rates to retained earnings, $\tau^{CIT}_{ret}$, and dividends paid to shareholders, $\tau^{CIT}_{div}$. We calculate the statutory corporate income tax rate, $\tau^{CIT}$, as the average of these two rates in the relevant years.

For non-corporate firms the STTR is defined as follows:

$$\tau_{non\text{-}corp} = \begin{cases} \left(\tau^{PIT}_{top} \cdot \left(1 + \tau^{SUR}\right) + \phi^{LBT}_{fed} \cdot \sigma^{LBT}_{mun}\right) \,/\, \left(1 + \phi^{LBT}_{fed} \cdot \sigma^{LBT}_{mun}\right) & \text{if } t \leq 2000 \\ \left(\left[\tau^{PIT}_{top} - \tau^{LBT}_{fed} \cdot \bar{\sigma}^{LBT}_{max}\right] \cdot \left[1 + \tau^{SUR}\right] + \phi^{LBT}_{fed} \cdot \sigma^{LBT}_{mun}\right) \,/\, \left(1 + \phi^{LBT}_{fed} \cdot \sigma^{LBT}_{mun}\right) & \text{if } t \in [2001, 2007] \\ \left(\tau^{PIT}_{top} - \tau^{LBT}_{fed} \cdot \min\left[\bar{\sigma}^{LBT}_{max}, \sigma^{LBT}_{mun}\right]\right) \cdot \left(1 + \tau^{SUR}\right) + \phi^{LBT}_{fed} \cdot \sigma^{LBT}_{mun} & \text{if } t \geq 2008, \end{cases} \tag{C.2}$$

where $\tau^{PIT}_{top}$ refers to the top marginal personal income tax rate (*Reichensteuersatz der Einkommenssteuer*). We apply the top marginal income tax rate of the progressive personal income tax schedule to all non-corporate firms regardless of the taxable income of their owners. We ignore tax surcharges by the catholic or protestant church when calculating personal income tax rates. Term $\bar{\sigma}^{LBT}_{max}$ refers to the maximum amount of LBT payments to be credited against PIT duties (*Ermäßigungshöchstbetrag*).

Table C.1 depicts all levels and changes of these policy variables during our sample period (Columns (2)–(8)). Columns (9) and (10) show the resulting statutory total tax rates for corporate and non-corporate firms assuming a constant local scaling factor of $\sigma^{LBT}_{mun} = 3.3$ (the sample mean).

**Federal-Level Tax Reforms.** Reforms of the CIT and PIT at the federal level create indirect variation in the STTR at the municipality level because the actual size of the reform-induced tax change is often subject to the local scaling factor—most importantly due to the change in the multiplicative basic federal rate in 2008 but also because of the deductibility of the local business tax payments

Table C.1: Parameters of Statutory Total Tax Rate Calculation

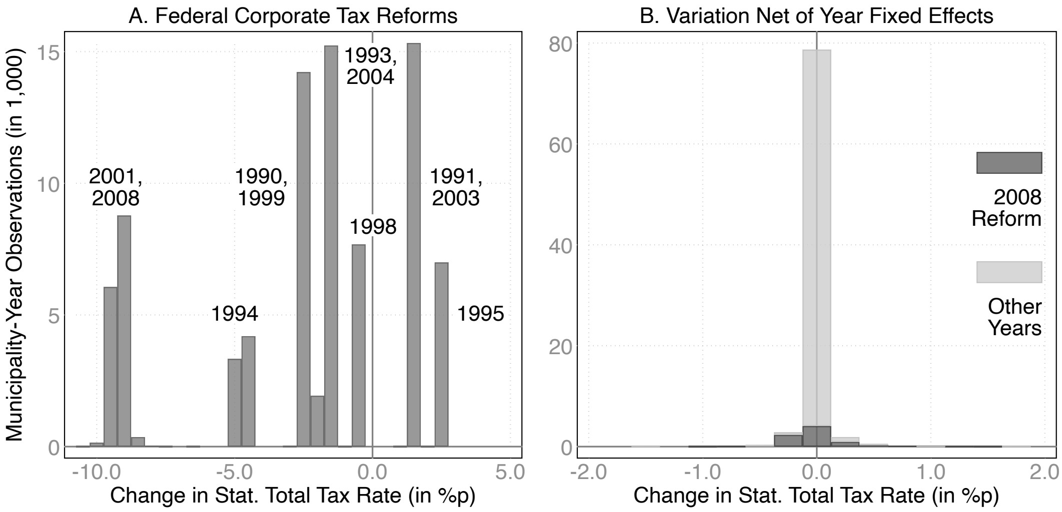
| | Federal Taxes | | | | | Local Tax Variation | | | |
|---|---|---|---|---|---|---|---|---|---|
| | CIT | | | PIT | Soli. | LBT | | Resulting STTR | |
| Year | $\tau^{CIT}_{ret}$ (1) | $\tau^{CIT}_{div}$ (2) | $\tau^{CIT}$ (3) | $\tau^{PIT}_{top}$ (4) | $\tau^{SUR}$ (5) | $\phi^{LBT}_{fed}$ (6) | $\bar{\sigma}^{LBT}_{max}$ (7) | $\tau_{corp}$ (8) | $\tau_{non\text{-}corp}$ (9) |
| 1985 | 56.0 | 36.0 | 46.0 | 56.0 | | 5.0 | | 53.6 | 62.2 |
| 1986 | 56.0 | 36.0 | 46.0 | 56.0 | | 5.0 | | 53.6 | 62.2 |
| 1987 | 56.0 | 36.0 | 46.0 | 56.0 | | 5.0 | | 53.6 | 62.2 |
| 1988 | 56.0 | 36.0 | 46.0 | 56.0 | | 5.0 | | 53.6 | 62.2 |
| 1989 | 56.0 | 36.0 | 46.0 | 56.0 | | 5.0 | | 53.6 | 62.2 |
| 1990 | 50.0 | 36.0 | 43.0 | 50.0 | | 5.0 | | 51.1 | 57.1 |
| 1991 | 50.0 | 36.0 | 43.0 | 50.0 | 3.75 | 5.0 | | 52.5 | 58.7 |
| 1992 | 50.0 | 36.0 | 43.0 | 50.0 | 3.75 | 5.0 | | 52.5 | 58.7 |
| 1993 | 50.0 | 36.0 | 43.0 | 50.0 | | 5.0 | | 51.1 | 57.1 |
| 1994 | 45.0 | 30.0 | 37.5 | 45.0 | | 5.0 | | 46.4 | 52.8 |
| 1995 | 45.0 | 30.0 | 37.5 | 45.0 | 7.50 | 5.0 | | 48.8 | 55.7 |
| 1996 | 45.0 | 30.0 | 37.5 | 45.0 | 7.50 | 5.0 | | 48.8 | 55.7 |
| 1997 | 45.0 | 30.0 | 37.5 | 45.0 | 7.50 | 5.0 | | 48.8 | 55.7 |
| 1998 | 45.0 | 30.0 | 37.5 | 53.0 | 5.50 | 5.0 | | 48.1 | 62.2 |
| 1999 | 40.0 | 30.0 | 35.0 | 53.0 | 5.50 | 5.0 | | 45.9 | 62.2 |
| 2000 | 40.0 | 30.0 | 35.0 | 51.0 | 5.50 | 5.0 | | 45.9 | 60.3 |
| 2001 | | | 25.0 | 48.5 | 5.50 | 5.0 | 1.8 | 36.8 | 49.9 |
| 2002 | | | 25.0 | 48.5 | 5.50 | 5.0 | 1.8 | 36.8 | 49.9 |
| 2003 | | | 26.5 | 48.5 | 5.50 | 5.0 | 1.8 | 38.2 | 49.9 |
| 2004 | | | 25.0 | 45.0 | 5.50 | 5.0 | 1.8 | 36.8 | 46.8 |
| 2005 | | | 25.0 | 42.0 | 5.50 | 5.0 | 1.8 | 36.8 | 44.0 |
| 2006 | | | 25.0 | 42.0 | 5.50 | 5.0 | 1.8 | 36.8 | 44.0 |
| 2007 | | | 25.0 | 45.0 | 5.50 | 5.0 | 1.8 | 36.8 | 46.8 |
| 2008 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2009 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2010 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2011 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2012 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2013 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2014 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2015 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2016 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2017 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2018 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2019 | | | 15.0 | 45.0 | 5.50 | 3.5 | 3.8 | 27.4 | 46.8 |
| 2020 | | | 15.0 | 45.0 | 5.50 | 3.5 | 4.0 | 27.4 | 46.8 |
| 2021 | | | 15.0 | 45.0 | 5.50 | 3.5 | 4.0 | 27.4 | 46.8 |

*Notes:* This table shows the parameters for the calculation of statutory total tax rates for corporations and non-corporates over time (Columns (2)–(7)). Columns (8) and (9) present the two resulting STTR rates assuming a constant local scaling factor of $\sigma^{mun}_{LBT} = 3.3$.

from the tax base of the CIT and PIT before 2008.

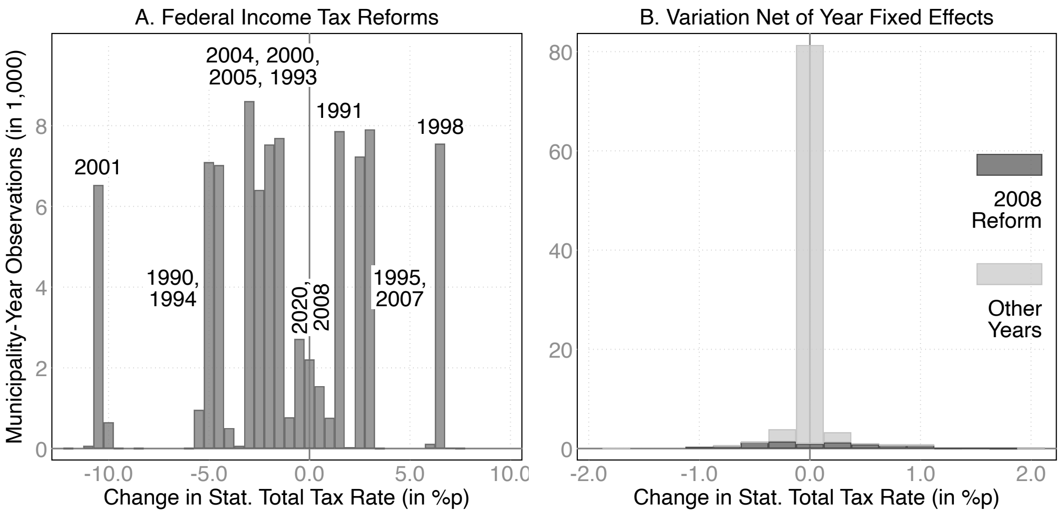
In Figures C.1 and C.2, we plot the resulting (indirect) variation in the STTR arising from all reforms of the CIT and PIT during our sample period, respectively. The left-hand side panel of both figures depicts all changes in the statutory total tax rate (in percentage points) due to tax reforms at the federal level. Note that most of reforms have had predominantly common effects across municipalities. For instance, the federal tax reform in 2001 lowered the statutory corporate tax rate from 35% to 25% but did so equally across the country. Local variation is only induced because of the deductibility of the LBT payments from the CIT tax base. Consequently, most of the variation arising from federal tax reforms is absorbed by year fixed effects. The right-hand side panels of Figures C.1 and C.2 illustrate this fact by depicting the variation in statutory total tax rates due to federal level tax reforms conditional on year fixed effects. Much of the total variation is absorbed. Most of the remaining variation is induced by the 2008 tax reform that did not only reduce $\tau^{CIT}$ but also altered the basic federal rate of the LBT, $\phi^{LBT}_{fed}$, and changed the maximum amount of LBT payments $\bar{\sigma}^{LBT}_{max}$ to be credited against the personal income tax base.

Figure C.1: Reforms of Corporate Income at the Federal Level




*Notes:* This graph depicts the variation in statutory total tax rates due to federal-level reforms of the corporate income tax. Panel A illustrates the raw data. Panel B shows the variation in the STTR conditional on year fixed effects.

Figure C.2: Reforms of the Personal Income Tax at the Federal Level




*Notes:* This graph depicts the variation in statutory total tax rates due to federal-level reforms of the personal income tax. Panel A illustrates the raw data. Panel B shows the variation in the STTR conditional on year fixed effects.

**Regional Classifications.** Figure C.3 depicts different regional subdivisions of Germany for the example of Bavaria. We control for time-varying shocks at these layers in our empirical specifications.

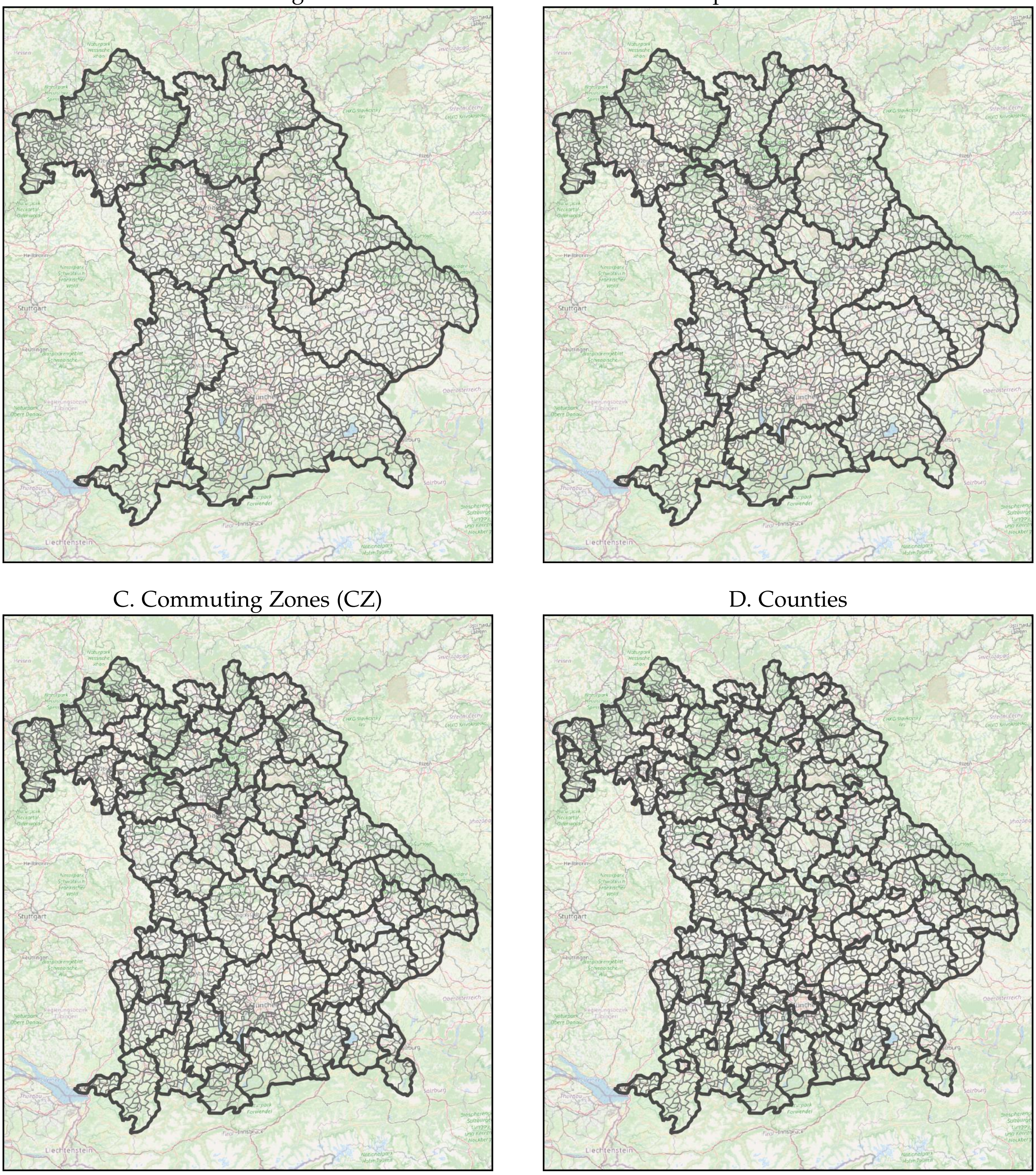
Figure C.3: Regional Classifications of Municipalities in the Free State of Bavaria

A. NUTS-2 Regions

B. Metropolitan Statistical Areas

C. Commuting Zones (CZ)

D. Counties



*Notes:* This figure depicts different regional subdivisions of Germany, focusing on the 2,056 municipalities in the Free State of Bavaria for the purpose of illustration (thin black lines indicate municipality borders as of December 31, 2010). Panel A plots municipalities along with the seven administrative districts (*Regierungsbezirke*, NUTS 2), Panel B municipalities along with the 18 metropolitan statistical areas (*Raumordnungsregionen*, MSA). We control for time-varying shocks at the MSA level in our baseline specification. Panel C shows the 56 commuting zones in Bavaria (*Arbeitsmarktregionen*, CZ), Panel D shows the 96 counties and city counties (*Kreise und kreisfreie Städte*). *Maps:* © GeoBasis-DE / BKG 2015, OpenStreetMap contributors.

# D Regression Tables

Table D.1: Estimation Results Baseline

| | Total R&D Spending | | | Internal R&D Spending | | | R&D Employment | | |
|---|---|---|---|---|---|---|---|---|---|
| | Base | Increases | Decreases | Total | Labor | Capital | Total | Scie./Eng. | Other |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | Fig. 3.A | Fig. 3.B | | Fig. 4.A | | | Fig. 4.C | Fig. 4.D | |
| $t-8$ | -0.004 | -0.005 | 0.007 | 0.005 | 0.000 | -0.006 | 0.005 | -0.006 | 0.010 |
| | (0.017) | (0.019) | (0.030) | (0.018) | (0.018) | (0.024) | (0.016) | (0.018) | (0.021) |
| $t-6$ | -0.004 | -0.007 | -0.005 | 0.002 | 0.001 | 0.003 | 0.008 | 0.005 | 0.009 |
| | (0.012) | (0.015) | (0.023) | (0.013) | (0.013) | (0.018) | (0.012) | (0.013) | (0.018) |
| $t-4$ | -0.001 | -0.003 | -0.005 | 0.002 | 0.001 | 0.007 | 0.007 | 0.002 | 0.014 |
| | (0.009) | (0.011) | (0.018) | (0.009) | (0.009) | (0.014) | (0.009) | (0.009) | (0.013) |
| $t$ | -0.017 | -0.018 | 0.010 | -0.021$^{*}$ | -0.013 | -0.037$^{**}$ | -0.002 | -0.002 | 0.010 |
| | (0.010) | (0.012) | (0.018) | (0.011) | (0.011) | (0.015) | (0.010) | (0.010) | (0.015) |
| $t+2$ | -0.046$^{***}$ | -0.044$^{**}$ | 0.044$^{**}$ | -0.049$^{***}$ | -0.041$^{**}$ | -0.059$^{***}$ | -0.029$^{**}$ | -0.024$^{*}$ | -0.012 |
| | (0.015) | (0.020) | (0.020) | (0.015) | (0.016) | (0.022) | (0.014) | (0.014) | (0.020) |
| $t+4$ | -0.082$^{***}$ | -0.081$^{***}$ | 0.079$^{***}$ | -0.091$^{***}$ | -0.084$^{***}$ | -0.103$^{***}$ | -0.048$^{***}$ | -0.042$^{**}$ | -0.064$^{**}$ |
| | (0.018) | (0.029) | (0.023) | (0.019) | (0.020) | (0.029) | (0.017) | (0.017) | (0.026) |
| $t+6$ | -0.093$^{***}$ | -0.090$^{***}$ | 0.096$^{***}$ | -0.092$^{***}$ | -0.084$^{***}$ | -0.109$^{***}$ | -0.059$^{***}$ | -0.057$^{***}$ | -0.040 |
| | (0.023) | (0.033) | (0.030) | (0.024) | (0.024) | (0.036) | (0.021) | (0.022) | (0.032) |
| $t+8$ | -0.083$^{***}$ | -0.068$^{*}$ | 0.098$^{***}$ | -0.070$^{**}$ | -0.074$^{**}$ | -0.072$^{*}$ | -0.053$^{**}$ | -0.051$^{*}$ | -0.046 |
| | (0.028) | (0.036) | (0.032) | (0.028) | (0.029) | (0.041) | (0.025) | (0.027) | (0.037) |
| Avg. $\widehat{\beta}_{+}$ | -0.064 | -0.060 | 0.065 | -0.065 | -0.059 | -0.076 | -0.038 | -0.035 | -0.030 |
| $N$ | 46,123 | 46,123 | | 45,541 | 45,502 | 44,116 | 45,496 | 45,365 | 38,198 |
| Adj.-$R^2$ | 0.917 | 0.917 | | 0.915 | 0.914 | 0.856 | 0.888 | 0.881 | 0.847 |

| | Internal | Outsourced R&D | | Patents Filed | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Extensive Margin | | Total Count | | By Type | |
| | Wages | Ext. M. | Int. M. | Raw | Cit.-W. | Raw | Cit.-W. | Prod. | Proc. |
| | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
| | Fig. 4.C | Fig. 4.B | | Fig. 6.A | | Fig. 6.B | | Fig. 6.C | |
| $t-8$ | -0.005 | -0.002 | -0.017 | 0.001 | -0.005 | 0.009 | 0.026 | 0.027 | -0.004 |
| | (0.014) | (0.011) | (0.042) | (0.008) | (0.007) | (0.026) | (0.041) | (0.022) | (0.023) |
| $t-6$ | -0.007 | -0.001 | -0.003 | -0.002 | -0.003 | 0.001 | 0.040 | 0.033$^{*}$ | 0.014 |
| | (0.012) | (0.009) | (0.036) | (0.007) | (0.006) | (0.019) | (0.035) | (0.019) | (0.021) |
| $t-4$ | -0.006 | 0.001 | -0.019 | 0.005 | -0.002 | -0.007 | 0.015 | 0.019 | 0.000 |
| | (0.009) | (0.007) | (0.028) | (0.006) | (0.005) | (0.015) | (0.031) | (0.021) | (0.014) |
| $t$ | -0.011 | 0.009 | -0.004 | -0.007 | -0.003 | -0.005 | -0.041$^{*}$ | -0.018 | -0.015 |
| | (0.010) | (0.007) | (0.028) | (0.006) | (0.005) | (0.015) | (0.021) | (0.016) | (0.014) |
| $t+2$ | -0.012 | 0.008 | -0.015 | -0.008 | -0.009 | -0.017 | -0.086$^{***}$ | -0.034$^{*}$ | -0.037$^{*}$ |
| | (0.013) | (0.011) | (0.040) | (0.008) | (0.007) | (0.023) | (0.029) | (0.018) | (0.019) |
| $t+4$ | -0.036$^{**}$ | -0.004 | -0.073 | -0.010 | -0.010 | -0.039 | -0.092$^{**}$ | -0.020 | -0.055$^{**}$ |
| | (0.017) | (0.014) | (0.050) | (0.011) | (0.008) | (0.031) | (0.038) | (0.023) | (0.023) |
| $t+6$ | -0.025 | 0.003 | -0.153$^{***}$ | -0.025$^{**}$ | -0.020$^{**}$ | -0.050 | -0.095$^{**}$ | -0.020 | -0.061$^{**}$ |
| | (0.020) | (0.016) | (0.059) | (0.012) | (0.010) | (0.035) | (0.047) | (0.027) | (0.030) |
| $t+8$ | -0.021 | 0.013 | -0.101 | -0.007 | -0.013 | -0.040 | -0.082 | 0.007 | -0.084$^{***}$ |
| | (0.021) | (0.020) | (0.070) | (0.013) | (0.011) | (0.040) | (0.054) | (0.033) | (0.031) |
| Avg. $\widehat{\beta}_{+}$ | -0.021 | 0.006 | -0.069 | -0.011 | -0.011 | -0.030 | -0.079 | -0.017 | -0.050 |
| $N$ | 45,496 | 46,123 | 17,942 | 41,416 | 41,416 | 41,416 | 41,416 | 41,416 | 41,416 |
| Adj.-$R^2$ | 0.708 | 0.592 | 0.826 | 0.283 | 0.201 | 0.374 | 0.220 | 0.092 | 0.188 |

*Notes:* This table shows the regression estimates for our baseline results presented in Figures 3, 4, and 6 in the main text. See the respective figure notes for details on the exact specification. The row labeled Avg. $\widehat{\beta}_{+}$ depicts the average post-treatment estimate.

Table D.2: Estimation Results – Heterogeneous Effects

| | By Liab. to Sales | | By Employees | | By Corp. Structure | | Including |
|---|---|---|---|---|---|---|---|
| | Low/Med. (1) | High (2) | Small (3) | Big (4) | Single (5) | Group (6) | Multi-Sites (7) |
| | Fig. 5.A | | Fig. 5.B | | Fig. 5.D | | |
| $t-8$ | 0.004 | -0.030 | -0.022 | 0.013 | -0.008 | 0.008 | 0.002 |
| | (0.023) | (0.027) | (0.021) | (0.021) | (0.018) | (0.034) | (0.015) |
| $t-6$ | -0.002 | -0.006 | -0.016 | 0.008 | -0.008 | 0.006 | -0.002 |
| | (0.016) | (0.022) | (0.017) | (0.017) | (0.014) | (0.027) | (0.012) |
| $t-4$ | 0.002 | -0.010 | -0.009 | 0.008 | -0.003 | 0.008 | 0.002 |
| | (0.012) | (0.017) | (0.013) | (0.012) | (0.010) | (0.020) | (0.009) |
| $t$ | -0.009 | -0.044** | -0.021 | -0.011 | -0.011 | -0.043* | -0.017* |
| | (0.013) | (0.021) | (0.014) | (0.014) | (0.011) | (0.023) | (0.010) |
| $t+2$ | -0.029 | -0.075*** | -0.038** | -0.053*** | -0.034** | -0.100*** | -0.043*** |
| | (0.019) | (0.025) | (0.018) | (0.020) | (0.015) | (0.033) | (0.014) |
| $t+4$ | -0.058** | -0.134*** | -0.070*** | -0.096*** | -0.064*** | -0.167*** | -0.072*** |
| | (0.024) | (0.029) | (0.024) | (0.024) | (0.019) | (0.039) | (0.018) |
| $t+6$ | -0.086*** | -0.124*** | -0.087*** | -0.100*** | -0.075*** | -0.176*** | -0.090*** |
| | (0.032) | (0.038) | (0.031) | (0.029) | (0.025) | (0.047) | (0.022) |
| $t+8$ | -0.061 | -0.122** | -0.063 | -0.100*** | -0.080*** | -0.115** | -0.083*** |
| | (0.038) | (0.047) | (0.039) | (0.035) | (0.030) | (0.052) | (0.027) |
| Avg. $\widehat{\beta}_{+}$ | -0.048 | -0.100 | -0.056 | -0.072 | -0.053 | -0.120 | -0.061 |
| $N$ | 34,833 | | 46,123 | | 46,123 | | 50,661 |
| Adj.-$R^2$ | 0.914 | | 0.918 | | 0.917 | | 0.930 |

| | By Firm Employment Quartiles | | | | By Firm Sales Quartiles | | | |
|---|---|---|---|---|---|---|---|---|
| | First (8) | Second (9) | Third (10) | Fourth (11) | First (12) | Second (13) | Third (14) | Fourth (15) |
| | Fig. 5.C | | | | | | | |
| $t-8$ | -0.008 | -0.037 | -0.043 | 0.076** | -0.058** | -0.017 | -0.002 | 0.050* |
| | (0.030) | (0.029) | (0.027) | (0.030) | (0.029) | (0.028) | (0.029) | (0.029) |
| $t-6$ | 0.001 | -0.034 | -0.028 | 0.048** | -0.027 | -0.022 | -0.008 | 0.033 |
| | (0.024) | (0.023) | (0.021) | (0.024) | (0.024) | (0.023) | (0.023) | (0.022) |
| $t-4$ | -0.013 | -0.005 | -0.009 | 0.025 | -0.029 | -0.002 | 0.006 | 0.018 |
| | (0.018) | (0.018) | (0.016) | (0.018) | (0.019) | (0.017) | (0.017) | (0.017) |
| $t$ | -0.002 | -0.042** | -0.010 | -0.006 | -0.016 | -0.026 | 0.001 | -0.020 |
| | (0.019) | (0.019) | (0.019) | (0.018) | (0.021) | (0.018) | (0.019) | (0.016) |
| $t+2$ | -0.037 | -0.038 | -0.052** | -0.046* | -0.049* | -0.025 | -0.036 | -0.065** |
| | (0.025) | (0.025) | (0.026) | (0.028) | (0.027) | (0.025) | (0.026) | (0.025) |
| $t+4$ | -0.081** | -0.058* | -0.085** | -0.100*** | -0.086** | -0.035 | -0.077** | -0.125*** |
| | (0.035) | (0.032) | (0.033) | (0.033) | (0.034) | (0.031) | (0.034) | (0.031) |
| $t+6$ | -0.116** | -0.063 | -0.099** | -0.099** | -0.119*** | -0.039 | -0.103** | -0.114*** |
| | (0.047) | (0.042) | (0.040) | (0.039) | (0.044) | (0.041) | (0.042) | (0.039) |
| $t+8$ | -0.107** | -0.030 | -0.156*** | -0.041 | -0.100* | -0.048 | -0.109** | -0.079* |
| | (0.054) | (0.051) | (0.046) | (0.044) | (0.052) | (0.048) | (0.046) | (0.045) |
| Avg. $\widehat{\beta}_{+}$ | -0.069 | -0.046 | -0.081 | -0.059 | -0.074 | -0.035 | -0.065 | -0.081 |
| $N$ | 46,123 | | | | 46,123 | | | |
| Adj.-$R^2$ | 0.918 | | | | 0.918 | | | |

*Notes:* This table shows the regression estimates for heterogeneous effects by firm characteristics presented in Figure 5 in the main text. See the figure note for details on the exact specification. The row labeled Avg. $\widehat{\beta}_{+}$ depicts the average post-treatment estimate.

Table D.3: Estimation Results – Identification Tests

| | Alternative Region-by-Year Fixed Effects | | | | | Lagged | Fed. Tax |
|---|---|---|---|---|---|---|---|
| | CZ (1) | County (2) | ZIP3 (3) | NUTS2 (4) | State (5) | Controls (6) | Ref. '08 (7) |
| | Fig. A.3 | | | | | Fig. A.5 | Fig. A.6.B |
| $t-8$ | -0.000 | -0.027 | 0.013 | -0.008 | -0.003 | -0.006 | |
| | (0.018) | (0.023) | (0.024) | (0.016) | (0.016) | (0.017) | |
| $t-6$ | 0.000 | -0.015 | 0.005 | -0.006 | -0.003 | -0.005 | 0.047 |
| | (0.014) | (0.017) | (0.018) | (0.012) | (0.012) | (0.013) | (0.030) |
| $t-4$ | 0.006 | -0.004 | 0.013 | -0.002 | -0.001 | -0.002 | 0.019 |
| | (0.009) | (0.012) | (0.013) | (0.008) | (0.008) | (0.009) | (0.021) |
| $t$ | -0.014 | -0.013 | -0.018 | -0.018* | -0.017* | -0.016 | 0.013 |
| | (0.011) | (0.014) | (0.015) | (0.010) | (0.010) | (0.011) | (0.022) |
| $t+2$ | -0.044*** | -0.049** | -0.043* | -0.048*** | -0.045*** | -0.042*** | -0.035 |
| | (0.015) | (0.020) | (0.022) | (0.014) | (0.014) | (0.015) | (0.029) |
| $t+4$ | -0.077*** | -0.069** | -0.089*** | -0.081*** | -0.079*** | -0.077*** | -0.079** |
| | (0.020) | (0.027) | (0.029) | (0.018) | (0.018) | (0.018) | (0.035) |
| $t+6$ | -0.091*** | -0.072** | -0.113*** | -0.096*** | -0.089*** | -0.093*** | -0.095** |
| | (0.026) | (0.034) | (0.035) | (0.022) | (0.023) | (0.023) | (0.039) |
| $t+8$ | -0.074** | -0.031 | -0.092** | -0.090*** | -0.087*** | -0.080*** | -0.094** |
| | (0.030) | (0.042) | (0.041) | (0.028) | (0.029) | (0.028) | (0.040) |
| Avg. $\widehat{\beta}_+$ | -0.060 | -0.047 | -0.071 | -0.067 | -0.063 | -0.062 | -0.058 |
| $N$ | 45,622 | 45,161 | 44,287 | 46,151 | 46,151 | 45,330 | 44,090 |
| Adj. $R^2$ | 0.917 | 0.917 | 0.915 | 0.917 | 0.917 | 0.918 | 0.926 |

| | Local Confounders as Outcomes | | | | Large (Local) Increases | | |
|---|---|---|---|---|---|---|---|
| | Popul. (8) | Unemp. (9) | Exp. (10) | Rev. (11) | ΔLBT (12) | LBT Inc. (13) | Large Inc. (14) |
| | Fig. A.4.A | Fig. A.4.B | Fig. A.4.C | Fig. A.4.D | Fig. A.7 | | |
| $t-8$ | 0.000 | 0.003 | -0.007 | 0.003 | -0.011 | -0.003 | -0.008 |
| | (0.001) | (0.003) | (0.006) | (0.006) | (0.012) | (0.012) | (0.022) |
| $t-6$ | -0.000 | 0.000 | -0.001 | 0.005 | -0.008 | -0.005 | -0.000 |
| | (0.001) | (0.002) | (0.005) | (0.005) | (0.009) | (0.010) | (0.018) |
| $t-4$ | -0.000 | 0.002 | 0.004 | 0.006* | -0.003 | -0.002 | -0.006 |
| | (0.000) | (0.002) | (0.003) | (0.004) | (0.006) | (0.008) | (0.013) |
| $t$ | -0.000 | -0.001 | -0.001 | 0.009 | -0.004 | -0.011 | -0.015 |
| | (0.000) | (0.002) | (0.005) | (0.006) | (0.007) | (0.008) | (0.013) |
| $t+2$ | -0.001 | 0.001 | 0.002 | 0.009 | -0.019** | -0.019 | -0.031 |
| | (0.001) | (0.003) | (0.007) | (0.007) | (0.009) | (0.012) | (0.019) |
| $t+4$ | -0.001 | -0.001 | -0.005 | 0.007 | -0.035*** | -0.033** | -0.045* |
| | (0.001) | (0.003) | (0.008) | (0.008) | (0.012) | (0.014) | (0.025) |
| $t+6$ | -0.001 | -0.000 | -0.003 | 0.004 | -0.035*** | -0.037** | -0.052* |
| | (0.001) | (0.004) | (0.008) | (0.009) | (0.012) | (0.015) | (0.027) |
| $t+8$ | -0.002* | -0.003 | -0.001 | 0.004 | -0.030** | -0.037** | -0.050* |
| | (0.001) | (0.004) | (0.009) | (0.009) | (0.014) | (0.016) | (0.028) |
| Avg. $\widehat{\beta}_+$ | -0.001 | -0.001 | -0.002 | 0.007 | -0.025 | -0.027 | -0.038 |
| $N$ | 67,779 | 67,193 | 67,586 | 67,580 | 46,123 | 46,123 | 46,123 |
| Adj. $R^2$ | 0.999 | 0.986 | 0.981 | 0.981 | 0.917 | 0.917 | 0.917 |

*Notes:* This table shows the regression estimates for auxiliary results presented in Appendix Figures A.3, A.4, A.5, A.6, and A.7. See the respective figure notes for details on the exact specification. The row labeled Avg. $\widehat{\beta}_+$ depicts the average post-treatment estimate.

Table D.4: Estimation Results – Robustness Checks

| | | Het. Treat. Eff. | | Effect Windows | | | |
|---|---|---|---|---|---|---|---|
| | Base | F6L8 S#Y | dC/D'H | F4/L10 | F6/L8 | F10/L8 | One-Year |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $t-10$ | | | | | | -0.006 | |
| | | | | | | (0.020) | |
| $t-8$ | -0.004 | | | | | -0.006 | -0.003 |
| | (0.017) | | | | | (0.017) | (0.018) |
| $t-7$ | | | | | | | -0.010 |
| | | | | | | | (0.017) |
| $t-6$ | -0.004 | 0.000 | 0.007 | | -0.001 | 0.000 | 0.001 |
| | (0.012) | (0.013) | (0.040) | | (0.013) | (0.014) | (0.016) |
| $t-5$ | | | | | | | -0.007 |
| | | | | | | | (0.015) |
| $t-4$ | -0.001 | 0.003 | 0.027 | 0.001 | 0.002 | 0.001 | -0.007 |
| | (0.009) | (0.008) | (0.017) | (0.010) | (0.008) | (0.010) | (0.013) |
| $t-3$ | | | | | | | 0.005 |
| | | | | | | | (0.012) |
| $t$ | -0.017 | -0.014 | -0.000 | -0.015* | -0.016* | -0.016 | -0.023 |
| | (0.010) | (0.009) | (0.012) | (0.008) | (0.009) | (0.013) | (0.016) |
| $t+1$ | | | | | | | -0.012 |
| | | | | | | | (0.014) |
| $t+2$ | -0.046*** | -0.027** | -0.034** | -0.022* | -0.029** | -0.052*** | -0.063*** |
| | (0.015) | (0.013) | (0.016) | (0.012) | (0.013) | (0.017) | (0.020) |
| $t+3$ | | | | | | | -0.033* |
| | | | | | | | (0.017) |
| $t+4$ | -0.082*** | -0.049*** | -0.057*** | -0.040*** | -0.047*** | -0.088*** | -0.098*** |
| | (0.018) | (0.016) | (0.021) | (0.014) | (0.016) | (0.024) | (0.024) |
| $t+5$ | | | | | | | -0.072*** |
| | | | | | | | (0.020) |
| $t+6$ | -0.093*** | -0.071*** | -0.066*** | -0.058*** | -0.073*** | -0.096*** | -0.103*** |
| | (0.023) | (0.020) | (0.024) | (0.017) | (0.020) | (0.027) | (0.025) |
| $t+7$ | | | | | | | -0.086*** |
| | | | | | | | (0.025) |
| $t+8$ | -0.083*** | -0.079*** | -0.091*** | -0.079*** | -0.076*** | -0.080*** | -0.085*** |
| | (0.028) | (0.026) | (0.029) | (0.020) | (0.025) | (0.030) | (0.028) |
| $t+10$ | | | | -0.062** | | | |
| | | | | (0.025) | | | |
| Avg. $\widehat{\beta}_+$ | -0.064 | -0.048 | -0.050 | -0.046 | -0.048 | -0.066 | -0.064 |
| $N$ | 46,123 | 54,455 | 25,326 | 61,115 | 54,426 | 37,247 | 46,123 |
| Adj.-$R^2$ | 0.917 | 0.914 | | 0.915 | 0.914 | 0.917 | 0.917 |

| | Alternative Clustering | | | Sample Restrictions | | Comparing to Subsamples | | |
|---|---|---|---|---|---|---|---|---|
| | County | CZ | MSA | Balanced | Incl. Mov. | Extram.> 0 | Ev. Extram. | With Liab. |
| | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
| $t-8$ | -0.004 | -0.004 | -0.004 | 0.002 | -0.007 | -0.006 | -0.017 | -0.008 |
| | (0.016) | (0.016) | (0.018) | (0.034) | (0.016) | (0.026) | (0.021) | (0.019) |
| $t-6$ | -0.004 | -0.004 | -0.004 | -0.004 | -0.002 | 0.010 | -0.007 | -0.003 |
| | (0.011) | (0.012) | (0.010) | (0.027) | (0.012) | (0.019) | (0.017) | (0.014) |
| $t-4$ | -0.001 | -0.001 | -0.001 | 0.003 | -0.000 | -0.009 | -0.005 | -0.002 |
| | (0.009) | (0.009) | (0.008) | (0.021) | (0.009) | (0.014) | (0.012) | (0.010) |
| $t$ | -0.017 | -0.017 | -0.017 | -0.039* | -0.018* | -0.009 | -0.008 | -0.021* |
| | (0.011) | (0.010) | (0.011) | (0.022) | (0.010) | (0.015) | (0.016) | (0.012) |
| $t+2$ | -0.046*** | -0.046*** | -0.046*** | -0.079** | -0.048*** | -0.026 | -0.038* | -0.046*** |
| | (0.013) | (0.012) | (0.014) | (0.032) | (0.014) | (0.022) | (0.020) | (0.016) |
| $t+4$ | -0.082*** | -0.082*** | -0.082*** | -0.120*** | -0.083*** | -0.072*** | -0.084*** | -0.084*** |
| | (0.016) | (0.016) | (0.017) | (0.044) | (0.018) | (0.027) | (0.024) | (0.020) |
| $t+6$ | -0.093*** | -0.093*** | -0.093*** | -0.129** | -0.093*** | -0.082** | -0.094*** | -0.100*** |
| | (0.020) | (0.019) | (0.020) | (0.050) | (0.022) | (0.035) | (0.029) | (0.026) |
| $t+8$ | -0.083*** | -0.083*** | -0.083*** | -0.106* | -0.080*** | -0.053 | -0.066* | -0.082*** |
| | (0.026) | (0.026) | (0.025) | (0.055) | (0.026) | (0.039) | (0.034) | (0.032) |
| Avg. $\widehat{\beta}_+$ | -0.064 | -0.064 | -0.064 | -0.095 | -0.064 | -0.048 | -0.058 | -0.067 |
| $N$ | 46,123 | 46,123 | 46,123 | 8,527 | 47,597 | 17,942 | 28,493 | 34,833 |
| Adj.-$R^2$ | 0.917 | 0.917 | 0.917 | 0.913 | 0.917 | 0.936 | 0.907 | 0.914 |

*Notes:* This table shows the regression estimates for auxiliary results presented in Appendix Figure A.8. See the respective figure notes for details on the exact specification. The row labeled Avg. $\widehat{\beta}_+$ depicts the average post-treatment estimate.

Table D.5: Estimation Results – PPML Patent Results and Other Outcomes

| | PPML Patent Count | | PPML Prod. vs. Proc. | |
|---|---|---|---|---|
| | Raw (1) | Cit-W. (2) | Prod. (3) | Proc. (4) |
| | Fig. A.9.A | | Fig. A.9.B | |
| $t-8$ | -0.026 | -0.010 | 0.050 | -0.243 |
| | (0.076) | (0.129) | (0.150) | (0.212) |
| $t-6$ | -0.031 | 0.092 | 0.242 | -0.030 |
| | (0.070) | (0.118) | (0.151) | (0.191) |
| $t-4$ | -0.049 | 0.036 | 0.052 | 0.020 |
| | (0.062) | (0.123) | (0.162) | (0.171) |
| $t$ | -0.028 | -0.066 | -0.149 | 0.024 |
| | (0.064) | (0.102) | (0.173) | (0.178) |
| $t+2$ | -0.055 | -0.302** | -0.188 | -0.317 |
| | (0.086) | (0.134) | (0.176) | (0.261) |
| $t+4$ | -0.164 | -0.422*** | -0.372* | -0.893*** |
| | (0.118) | (0.158) | (0.222) | (0.266) |
| $t+6$ | -0.221* | -0.428** | -0.279 | -0.918*** |
| | (0.128) | (0.193) | (0.251) | (0.337) |
| $t+8$ | -0.171 | -0.380* | -0.213 | -0.896*** |
| | (0.150) | (0.210) | (0.281) | (0.347) |
| Avg. $\widehat{\beta}_+$ | -0.128 | -0.320 | -0.240 | -0.600 |
| $N$ | 12,768 | 8,578 | 5,699 | 3,918 |

| | Investment | | | Employment Group | | Product. and Profit. | |
|---|---|---|---|---|---|---|---|
| | Total (5) | R&D (6) | Other (7) | R&D (8) | Other (9) | Sales/Empl. (10) | EBITDA (11) |
| | Fig. A.10.A | | | Fig. A.10.B | | Fig. A.10.C | |
| $t-8$ | 0.058 | -0.006 | -0.012 | 0.005 | 0.015 | 0.024** | 0.030 |
| | (0.053) | (0.024) | (0.055) | (0.016) | (0.013) | (0.012) | (0.049) |
| $t-6$ | 0.024 | 0.003 | -0.041 | 0.008 | 0.023** | 0.005 | 0.018 |
| | (0.040) | (0.018) | (0.045) | (0.012) | (0.010) | (0.010) | (0.043) |
| $t-4$ | 0.039 | 0.007 | 0.009 | 0.007 | 0.015** | 0.004 | -0.024 |
| | (0.034) | (0.014) | (0.038) | (0.009) | (0.007) | (0.008) | (0.035) |
| $t$ | -0.079** | -0.037** | -0.067* | -0.002 | 0.001 | -0.006 | -0.041 |
| | (0.035) | (0.015) | (0.035) | (0.010) | (0.007) | (0.007) | (0.034) |
| $t+2$ | -0.056 | -0.059*** | -0.007 | -0.029** | -0.010 | -0.005 | 0.009 |
| | (0.050) | (0.022) | (0.053) | (0.014) | (0.012) | (0.011) | (0.040) |
| $t+4$ | -0.170** | -0.103*** | -0.129* | -0.048*** | -0.014 | 0.002 | -0.036 |
| | (0.068) | (0.029) | (0.067) | (0.017) | (0.017) | (0.014) | (0.052) |
| $t+6$ | -0.083 | -0.109*** | 0.012 | -0.059*** | 0.008 | 0.002 | -0.103 |
| | (0.095) | (0.036) | (0.089) | (0.021) | (0.022) | (0.017) | (0.077) |
| $t+8$ | -0.108 | -0.072* | -0.024 | -0.053** | -0.013 | 0.005 | -0.070 |
| | (0.116) | (0.041) | (0.110) | (0.025) | (0.026) | (0.018) | (0.082) |
| Avg. $\widehat{\beta}_+$ | -0.099 | -0.076 | -0.043 | -0.038 | -0.006 | -0.000 | -0.048 |
| $N$ | 17,325 | 44,116 | 15,395 | 45,496 | 44,925 | 45,962 | 10,682 |
| Adj.-$R^2$ | 0.812 | 0.856 | 0.793 | 0.888 | 0.960 | 0.784 | 0.782 |

*Notes:* This table shows the regression estimates for auxiliary results presented in Appendix Figures A.9 and A.10. See the respective figure notes for details on the exact specification. The row labeled Avg. $\widehat{\beta}_+$ depicts the average post-treatment estimate.