The Impact of Single Sales Factor Apportionment on State Tax Revenues: Short- and Long-Run Effects: Online Appendix

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Appendix

This Online Appendix to The Impact of Single Sales Factor Apportionment on State Tax Revenues: Short- and Long-Run Effects provides supplementary information on background, data, and methods, as well as additional tables and figures. Section A provides a supplement to General Background. Section B provides expanded Background Information to the paper. Section C provides additional Results Information and associated formulas. Additional sources are compiled in the References Section, followed by Additional Tables and Figures.

A. General Background

Section A.1 outlines state specific policies impacting the corporate income tax base. Section A.2 presents a Throwback Rule example. Section A.3 presents the probit discrete time hazard model for SSFA adoption.

A.1. State Specific Policies that Impact the Corporate Income Tax Base

Whether a state has a throwback or throwout rule in place will impact the amount of nowhere income multi-state corporations are able to generate. Throwback and throwout rules are policies designed by states to "capture" sales made into a state that does not have standing to tax that income (i.e., nowhere income) or does not tax corporate income. A throwback rule comes into practice when a corporation has nexus in a state and generates income from sales into another state, and the corporation does not have nexus in that other state. Under a throwback rule regime, those sales are "thrown back" or added to the sales made in the "nexus" state.[1] In this process, income generated from these sales is still taxable. Over the past several decades, nearly half of states have repealed their throwback or throwout rule (Appendix Table 1). Given the role of these policies in increasing or decreasing nowhere income, their presence or absence is an important consideration for empirical analysis. Though the variation in the throwback and throwout provisions across states makes it reasonable to treat them as a distinct policy dimension.[2]

A.2. Throwback Rule Example

A company headquartered in North Dakota (which has throwback rule) earns $100,000 in net income and has operations and sales in South Dakota (No corporate income tax) and Nebraska; 80% of their property is in ND, 80% of their payroll is in ND, and 33% of their sales are in ND. Further, 10% of their property is in SD and NE, 10% of their payroll is in SD and NE, and 33% of their sales are in each state as well. Given corporate income tax rates of 4.31% for ND, and 7.25% for NE, their state corporate income tax apportionment under the three-factor formula would be as follows: In ND: (1/3*(.8+.1))+(1/3*(.8+.1))+(1/3*(.333+.333))= .822. In SD: There is no corporate income tax, but because of the throwback rule, the factor income that would have been apportioned to SD (.1 and .333 added above) is thrown back in the numerator to ND. In NE: (1/3*.1)+(1/3*.1)+(1/3*.333)= .1777.

[1] An example is given in the Appendix B for clarity.

[2] A full estimate on the effects of changing throwback or throwout provisions would require a separate analysis and is beyond the scope of this paper. While the empirical analysis does not directly control for throwback or throwout provisions, the synthetic control approach (Section VI) helps mitigate this concern by relying on donor states with broadly similar exposure to such rules.

Appendix Table 1: Throwback/Throwout Rules by State

State	Throwback/Throwout Rule	State	Throwback/Throwout Rule
Alabama	No Throwback Rule	Montana	Throwback Rule
Alaska	Throwback Rule	Nebraska	Throwback Rule
Arizona	Throwback Rule	Nevada	
Arkansas	Throwback Rule	New Hampshire	Throwback Rule
California	Throwback Rule	New Jersey	No throwback rule
Colorado	Throwback Rule	New Mexico	Throwback Rule
Connecticut	No Throwback Rule	New York	No throwback rule
Delaware	No Throwback Rule	North Carolina	No throwback rule
Florida	No Throwback Rule	North Dakota	Throwback Rule
Georgia	No Throwback Rule	Ohio	
Hawaii	Throwback Rule	Oklahoma	Throwback Rule
Idaho	Throwback Rule	Oregon	Throwback Rule
Illinois	Throwback Rule	Pennsylvania	No Throwback rule
Indiana	No Throwback Rule	Rhode Island	Throwback Rule
Iowa	No Throwback Rule	South Carolina	No Throwback rule
Kansas	Throwback Rule	South Dakota	
Kentucky	No Throwback Rule	Tennessee	No Throwback rule
Louisiana	No Throwback Rule	Texas	
Maine	Throwout Rule	Utah	No Throwback rule
Maryland	No Throwback Rule	Vermont	No Throwback rule
Massachusetts	Throwback Rule	Virginia	No Throwback rule
Michigan	No Throwback Rule	Washington	
Minnesota	No Throwback Rule	West Virginia	No Throwback Rule
Mississippi	Throwback Rule	Wisconsin	Throwback rule
Missouri	No Throwback Rule	Wyoming	

Note: This table lists the throwback and throwout rules for each state. In general, states have been repealing these rules over the past twenty years. Any state without a throwback or throwout rule likely increases the amount of non-taxable income that increases under SSFA.

ND CIT Base $82,250 taxed at 4.31%, yields a ND tax liability of $3,545. NE CIT Base $17,750 taxed at 7.25%, yields a NE tax liability of $1,286. This leaves a total state CIT liability under three-factor apportionment of $4,832.

If one expands the above situation to a scenario where all of the sales are purchased online, packaged, and then just delivered in all fifty states, it is straightforward to understand the revenue and total tax liability implications of a state having a throwback rule. Twenty-two states have a throwback rule, one states has a throwout rule, and the rest of states do not have either (Appendix Table 1). In throwout rule states any "nowhere income" is thrown out or subtracted from the denominator, or total sales, if SSFA. Since the only state remaining with this policy is Maine, I will not go through an example scenario.

A.3. Employment, Manufacturing, and When States Switch

Appendix Table 2 presents the probit specification of the discrete-time hazard model for SSFA adoption. Results are consistent with the logit specification presented in the main text (Appendix Table 2).

Appendix Table 2: Probit Discrete-Time Hazard Model of SSFA Adoption

Variable	**Estimate**	**Std. Error**	**z Value**	**p-Value**
CES State Employment (t–1)	0.189	0.0912	2.07	0.039**
State Unemployment (t–1)	0.162	0.0865	1.87	0.061*
Manufacturing (t–1)	0.215	0.0834	2.58	0.010***
Coefficients (95% CI)				
CES State Employment (t–1)	0.189	[0.007,	0.340]	
State Unemployment (t–1)	0.162	[-0.011,	0.339]	
Manufacturing (t–1)	0.215	[0.053,	0.390]	

Note: Discrete-time probit hazard model of SSFA adoption. Predictors are lagged (t–1) logged values of Current Employment Statistics (CES), state unemployment, and manufacturing employment. Standard errors clustered at the state level.
Significance: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Employment comes from the Current Employment Statistics series, unemployment from the Local Area Unemployment Statistics series, and manufacturing employment from the CES manufacturing sector series. Summary statistics are provided in Table 3.

Appendix Table 3: Summary Statistics for Predictors (Raw and Logged Annual Averages)

Predictor	**Observations**	**Raw Annual Average**				**Logged Annual Average**			
		Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
CES State	1969	2469	2760	198	15 461	7.30	1.03	5.29	9.65
LAUS (Unemployment)	1969	2 400 675	2 709 515	152 181	17 107 673	14.20	1.02	11.90	16.70
Manufacturing	1969	276	307	8.74	1968	4.96	1.28	2.17	7.58

Note: Raw columns show annual-average levels; the right panel shows log-transformed annual averages (natural log). All series have the same sample size ($N = 1969$). Current Employment Statistics is CES, and Local Area Unemployment Statistics is LAUS.

B. Background Information

Section B.1 provides a more detailed discussion of the Multistate Tax Commission's recent update to the interpretation of P.L. 86-272, Nexus for Online Sales, and South Dakota v. Wayfair, Inc. Section B.2 presents an example of Nowhere Income in the context of a commercial website available in South Carolina but with no physical presence there. Sections B.3, B.4, and B.5 discuss the background of Moorman v. Bair and why SSFA does not violate the Due Process Clause or Commerce Clause.

B.1. Multistate Tax Commission 2021 Update, Nexus for Online Sales, and South Dakota v. Wayfair, Inc.

In the South Dakota v. Wayfair, Inc.(2018), the Supreme Court held that remote retailers that meet an economic nexus threshold (determined by the dollar amount or number of sales into a state), then they would meet the sales tax nexus threshold. This overturned the previous physical presence standard established in Quill Corp. v. North Dakota (1992). This case did not overrule the standards laid forth in P. L. 86-272 for corporate income tax nexus. Though, the Multistate Tax Commission did issue an updated interpretation of P. L. 86-272 in the wake of this ruling in 2021. This interpretation stated, "As a general rule, when a business interacts with a customer via the business's website or app, the business engages in a business activity within the customer's state." Multistate Tax Commission [2024] It should be noted that this interpretation does not have the force of law and though it has been adopted by some states, the issue has not been taken up by the courts on whether it conflicts with P. L. 86-272 (DeBruin and Smith [2023]).[3]

B.2. Nowhere Income: South Carolina Example

P.L. 86-272 creates situations where income cannot be legally taxed by any state—termed "nowhere income." Consider this example from the South Carolina Department of Revenue: An Ohio-based company maintains a website accessible in South Carolina but has no physical presence there. The mere accessibility of the website or use of email to solicit sales does not create sufficient nexus to allow South Carolina to tax the resulting income [State of South Carolina Department of Revenue, 2008]. Similarly, Ohio cannot tax this income if it lacks property or payroll presence there. This illustrates how P.L. 86-272's protections for remote solicitation directly generate nowhere income.

B.3. Moorman v. Bair Info

Between 1949-1960, the State Tax Commission "allowed" Moorman to apportion its Iowa income using the three-factor formula. Between 1961-1964, Moorman complied with the State Tax Commission and used SSFA for apportionment. In 1965, Moorman used the three-factor formula "without the consent of the commission."

B.4. Moorman v. Bair- SC's judgment on why SSFA does not violate Due Process Clause

"The Due Process Clause places two restrictions on a State's power to tax income generated by the activities of an interstate Page 437 U. S. 273 business.

First, no tax may be imposed unless there is some minimal connection between those activities and the taxing State. National Bellas Hess, Inc. v. Department of Revenue,386 U. S. 753, 386 U. S. 756. This requirement was plainly satisfied here. Second, the income attributed to the State for tax purposes must be rationally related to"values connected with the taxing State." Norfolk & Western R. Co. v. State Tax Comm'n, 390 U. S. 317, 390 U. S. 325.

[3]Thank you to Soto at Loyola Marymount University Law School for bringing this to my attention.

Since 1934, Iowa has used the formula method of computing taxable income. This method, unlike separate accounting, does not purport to identify the precise geographical source of a corporation's profits; rather, it is employed as a rough approximation of a corporation's income that is reasonably related to the activities conducted within the taxing State. The single factor formula used by Iowa, therefore, generally will not produce a figure that represents the actual profits earned within the State. But the same is true of the Illinois three factor formula. Both will occasionally over-reflect or under-reflect income attributable to the taxing State. Yet despite this imprecision, the Court has refused to impose strict constitutional restraints on a State's selection of a particular formula."

B.5. Moorman Vs Bair- SC's judgment on why SSFA does not violate Commerce Clause

"Nor is Iowa's single factor formula invalid under the Commerce Clause. Pp. 437 U. S. 276-281. Page 437 U. S. 268 (a) On this record, the existence of duplicative taxation as between Iowa and Illinois (which uses the so-called three factor – property, payroll, and sales – formula) is speculative, but even then assuming some overlap, appellant's argument that Iowa, rather than Illinois, was necessarily at fault in a constitutional sense cannot be accepted. Where the record does not reveal the sources of appellant's profits, its Commerce Clause claim cannot rest on the premise that profits earned in Illinois were included in its Iowa taxable income, and therefore the Iowa formula was at fault for whatever overlap may have existed. Pp. 437 U. S. 276-277. (b) The Commerce Clause itself, without implementing legislation by Congress, does not require, as appellant urges, that Iowa compute corporate net income under the Illinois three factor formula. If the Constitution were read to mandate a prohibition against any overlap in the computation of taxable income by the States, the consequences would extend far beyond this particular case and would require extensive judicial lawmaking. Pp. 437 U. S. 277-281."

B.6. Formal Definitions of Market-Intensive and Production-Intensive States

The Multistate Tax Commission defines property to include "The property factor includes all real and tangible personal property owned or used during the tax period to produce business income. The term 'real and tangible personal property' includes land, buildings, machinery, stocks of goods (inventory), equipment, and other real and tangible personal property used in connection with the production of business income but does not include coin or currency."

States with a larger share of in-state sales relative to productive factors, such as payroll or property, may see short-term increases in apportioned taxable corporate income from adopting SSFA. The state is a "Market-intensive" state if

$$\frac{S_j}{S} > \frac{(R_j/R) + (P_j/P)}{2}. \tag{OA.1}$$

In contrast, states with significant production but fewer in-state sales may not benefit from this transition. The states can either choose ϕ_j^S, which weights the sales factor more, or ϕ_j^P, which weights the productive factors more. The state is a "Production-intensive" state if:

$$\frac{S_j}{S} < \frac{(R_j/R) + (P_j/P)}{2}. \tag{OA.2}$$

This distinction between sales-intensive and production-intensive states provides a formal framework for understanding how apportionment changes affect taxable corporate income based on a state's economic structure.

C. Results Information

Section C.1 presents the formulas used for transformations of the logarithm of taxable corporate income results. Section C.2. presents the table of Comparative Yearly Changes in logarithm of Taxable Corporate Income.

C.1. Taxable Corporate Income Results

The following formulas were used for transformations of the logarithm of taxable corporate income results.

In section VII.A, this formula was used to calculate the average of the log difference across all states and compute the geometric of the original values for the logarithm of differences. It is as follows

$$\text{Average Log Difference} = \frac{1}{n}\sum_{i=1}^{n}\left(\log(\text{Year}(0)_i) - \log(\text{Year}(-1)_i)\right). \tag{C.1}$$

In order to convert the logarithm of geometric mean into a percentage change, I exponentiate the average log difference and subtract 1. This is expressed as

$$\text{Percentage Change} = (\exp\{\text{Average Log Difference}\} - 1) \times 100. \tag{C.2}$$

This gives the geometric mean percentage change in non-logged taxable corporate income.

C.2. Comparative Yearly Changes in logarithm of Taxable Corporate Income

[write an intro for this: Appendix Table 4]

Appendix Table 4: Yearly Differences for Ln(taxable corporate income) (Year -1, Year 0, and Year +1)

State	Year(-1)	Year(0)	Year(1)	Y(0) - Y(-1)	Y(1) - Y(-1)	Year Effective
Iowa	14.2319	14.3290	14.3986	0.0972	0.1668	1978
Nebraska	13.7018	13.7514	13.7930	0.0496	0.0912	1988
Michigan	17.8949	17.7230	17.7755	-0.1719	-0.1194	1991
Illinois	17.0372	17.0854	17.1245	0.0482	0.0873	1999
Oregon	14.4344	14.7583	14.8573	0.3239	0.4229	2004
Georgia	15.6203	15.8121	15.9168	0.1918	0.2965	2006
Wisconsin	15.4395	15.4398	15.5449	0.0003	0.1054	2006
Arizona	15.6614	15.7359	15.4695	0.0745	-0.1919	2007
Indiana	15.6224	15.5384	15.4189	-0.0840	-0.2036	2007
Maine	13.8589	13.8084	13.7744	-0.0505	-0.0846	2007
Minnesota	15.5066	15.5778	15.4111	0.0712	-0.0955	2007
Pennsylvania	16.1680	16.2169	16.1368	0.0490	-0.0312	2007
South Carolina	14.8953	14.9170	14.8815	0.0217	-0.0137	2007
Colorado	15.4439	15.0148	15.0869	-0.4292	-0.3570	2009
California	17.6717	17.6939	17.4833	0.0222	-0.1884	2011
Utah	14.6292	14.6049	14.6275	-0.0243	-0.0016	2011
New Jersey	16.2087	16.0494	16.2028	-0.1593	-0.0058	2012
New York	17.1802	17.2238	17.1041	0.0436	-0.0761	2015
Rhode Island	13.3778	13.8764	13.6632	0.4987	0.2854	2015
Connecticut	14.9297	15.0807	15.2185	0.1510	0.2887	2016
Louisiana	14.1065	13.7030	14.2113	-0.4034	0.1049	2016
North Carolina	16.2336	16.2233	16.1472	-0.0103	-0.0865	2016
North Dakota	14.3652	13.8119	13.2642	-0.5533	-1.1010	2016
Delaware	14.2366	13.9591	13.9694	-0.2776	-0.2673	2017
Kentucky	14.9529	15.4199	15.6017	0.4670	0.6488	2018
Maryland	15.4158	15.4224	15.6350	0.0066	0.2192	2018
Missouri	14.6525	15.0741	15.6619	0.4216	1.0094	2020
Alabama	15.3159	15.6780	15.8560	0.3621	0.5400	2021
Arkansas	14.8409	15.1188	15.3816	0.2779	0.5407	2021
Ln(Geometric Mean)	-	-	-	0.03498	0.0684	-
Transformed Δ %	-	-	-	3.56%	7.08%	-

Note: This table presents the logarithm of taxable corporate income for each state in the effective year (Year 0), the year prior (Year -1), and the year after the switch (Year +1). The columns "Y(0) - Y(-1)" and "Y(1) - Y(-1)" show the differences in the logarithm of taxable corporate income between these years. The Ln(Geometric Mean) of the differences across states is exponentiated, $\exp\{0.03498\}$ and $\exp\{0.0684\}$, to obtain geometric means, resulting in values of 1.0624 and 1.1360, representing percentage increases of 3.56% and 7.08%, respectively (Table 4).

While SSFA adoption reduced taxable corporate income collections in several states, broader economic conditions and industry-specific factors offer context for the observed year-to-year patterns.[4] Indiana, Maine, and Colorado adopted SSFA during the Great Recession, and the year-to-year declines during this period can likely be attributed to that broader economic downturn. It is not surprising that North Dakota would experience a decline after adoption because the state's corporate income tax base is largely composed of oil and gas corporations [Kroshus, 2022]. This finding is in line with the severance tax logistic regression results presented in Section II.D. Delaware's outcomes, discussed in Section VII.C., stem from its distinct tax base, while Michigan's volatility

[4]Contrary to those average increases, Michigan, Indiana, Maine, Colorado, Utah, New Jersey, North Carolina, North Dakota, and Delaware do not increase taxable corporate income in the first or second year.

in the auto industry during this period likely overshadowed any effects from SSFA adoption. Given the auto industry's heavy investment in labor and capital within Michigan, but comparatively lower in-state sales, SSFA would tend to shift taxable income away from the state.

These observed year-to-year changes show that many states experienced increases immediately following adoption, which is consistent with the story that in the short-run, state officials and legislators might perceive the switch to SSFA as beneficial, or at least not detrimental. However, these simple year-to-year differences lack an appropriate counterfactual and cannot isolate the effect of SSFA from other economic trends. These immediate patterns provide descriptive context for the two-way fixed effect regression and synthetic DID results in Section VII.B. Although there is no counterfactual state or formal statistical test in this section, examining these immediate effects contextualizes the regression analysis that follows. Section VII.B addresses this limitation using regression specifications with appropriate control groups, and the decomposition in Section VII.B.2 reveals that when controlling for state-specific baselines, the within-state effect of SSFA adoption is negative. These findings are consistent with the "nowhere income" hypothesis that corporations adjust their strategies to minimize tax liabilities following the policy change.

References

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Appendix Table 5: State Fixed Effects from 2007 TWFE Regression

State	Estimate	Std. Error	t-Statistic	p-value
CT	-0.05968	0.08756	-0.682	0.496
DE	-1.03695	0.08756	-11.843	< 0.001
IN	0.92138	0.08483	10.862	< 0.001
KY	-0.20472	0.08756	-2.338	0.020
LA	-0.48376	0.08756	-5.525	< 0.001
MD	0.01942	0.08756	0.222	0.825
ME	-1.50916	0.08483	-17.790	< 0.001
MN	0.25215	0.08483	2.972	0.003
NC	0.70373	0.08756	8.037	< 0.001
ND	-1.86020	0.08756	-21.245	< 0.001
NY	1.78584	0.08756	20.396	< 0.001
PA	0.99009	0.08483	11.671	< 0.001
RI	-1.91083	0.08756	-21.824	< 0.001
SC	-0.28789	0.08483	-3.394	< 0.001

Note: Coefficients reflect state fixed effects relative to the omitted base state in the 2007 TWFE regression for the truncated Sample in 7.2.

Appendix Table 6: Year Fixed Effects from 2007 TWFE Regression

Year	Estimate	Std. Error	t-Statistic	p-value
1991	-0.12613	0.10952	-1.152	0.250
1992	-0.09955	0.10952	-0.909	0.364
1993	-0.02349	0.10952	-0.214	0.830
1994	0.08281	0.10952	0.756	0.450
1995	0.16732	0.10952	1.528	0.128
1996	0.13448	0.10952	1.228	0.220
1997	0.17620	0.10952	1.609	0.109
1998	0.17483	0.10952	1.596	0.111
1999	0.18014	0.10952	1.645	0.101
2000	0.14624	0.10952	1.335	0.183
2001	0.04395	0.10952	0.401	0.688
2002	-0.25086	0.10952	-2.291	0.023
2003	-0.11949	0.10952	-1.091	0.276
2004	-0.10733	0.10952	-0.980	0.328
2005	0.18736	0.10952	1.711	0.088
2006	0.43437	0.10952	3.966	< 0.001
2007	0.64863	0.11282	5.749	< 0.001
2008	0.48820	0.11282	4.327	< 0.001
2009	0.26269	0.11282	2.328	0.020
2010	0.13333	0.11282	1.182	0.238
2011	0.27990	0.11282	2.481	0.014
2012	0.35422	0.11282	3.140	0.002
2013	0.39821	0.11282	3.530	< 0.001
2014	0.46456	0.11282	4.118	< 0.001

Note: Coefficients reflect year fixed effects relative to the omitted base year in the 2007 TWFE regression for the truncated Sample in 7.2.

Appendix Table 7: Event Study Regression: Interaction Terms with Treated

Year $\times$ Treated	**Estimate, β_k**	**Std. Error**	**t-Statistic**	**p-value**
1990	-0.02242	0.29145	-0.077	0.940
1991	0.06372	0.23801	0.268	0.793
1992	0.27766	0.33207	0.836	0.417
1993	0.24043	0.30581	0.786	0.445
1994	0.27741	0.30062	0.923	0.372
1995	0.29199	0.29692	0.983	0.342
1996	0.35250	0.28874	1.221	0.242
1997	0.41495	0.25095	1.654	0.120
1998	0.37680	0.25305	1.489	0.159
1999	0.48994	0.25058	1.955	0.071$^{\cdot}$
2000	0.46672	0.25230	1.850	0.086$^{\cdot}$
2001	0.38799	0.22314	1.739	0.104
2002	0.44669	0.28774	1.552	0.143
2003	0.32819	0.23376	1.404	0.182
2004	0.26280	0.12699	2.070	0.057$^{\cdot}$
2005	0.09324	0.09889	0.943	0.362
2007	-0.10572	0.06472	-1.634	0.125
2008	-0.03346	0.10671	-0.314	0.758
2009	-0.03018	0.12121	-0.249	0.807
2010	-0.15966	0.15015	-1.063	0.306
2011	-0.03937	0.16676	-0.236	0.817
2012	-0.04532	0.16438	-0.276	0.787
2013	-0.00049	0.18030	-0.003	0.998
2014	-0.09452	0.18223	-0.519	0.612

Note: This table reports interaction terms for each year with the treated group. Standard errors are clustered at the state level. $^{\cdot}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Appendix Table 8: Point Estimates and Percentage Changes for Ln(taxable corporate income) in Short and Long Run

State	SR-Estimate	SR-Δ %	LR-Estimate	LR-Δ %
Nebraska	-0.02006	-1.98600	0.20545	22.82335
Michigan	0.00235	0.23527	-1.23669	-71.36002
Illinois	0.11044	11.67553	-0.42876	-34.79002
Oregon	0.13269	14.16973	-0.03523	-3.46390
Georgia	-0.19895	-18.03052	-0.11582	-10.96326
Wisconsin	-0.23157	-20.68685	-0.25653	-22.62306
Arizona	0.01839	1.85136	0.22247	24.93023
Indiana	-0.64005	-47.29962	-0.89009	-59.03582
Maine	-0.12706	-11.93463	-0.15517	-14.37008
Minnesota	-0.11005	-10.42970	0.00603	0.60426
Pennsylvania	-0.13771	-12.85684	-0.35021	-29.57493
South Carolina	-0.16959	-15.57252	-0.22706	-20.31198
Colorado	0.01649	1.65885	0.33616	40.00621
California	-0.27212	-23.78794	-0.22460	-20.08194
Utah	-0.02009	-2.00184	0.51401	67.10751
New Jersey	-0.07816	-7.51693	-0.47215	-37.64281
New York	-0.00107	-0.10692	-0.17026	-15.65047
Rhode Island	0.15385	16.63952	0.01007	1.00958
Connecticut	0.25011	28.42323	0.69759	100.85756
Louisiana	0.01134	1.13647	0.23426	26.41792
North Carolina	0.04613	4.71783	0.07774	8.08868
North Dakota	-0.34899	-29.47462	-0.36645	-30.70235
Delaware	-0.32311	-27.64086	-0.43166	-35.05177
Kentucky	0.23977	27.13079	0.16644	18.11745
Maryland	-0.01078	-1.07395	-0.03685	-3.61524
Missouri	0.52804	69.48171	0.49325	63.64099
Ln(Geometric Mean)	-0.04523		-0.09350	
Transformed Δ %		-4.42		-8.92

Note: This table presents the Synthetic Difference-in-Differences (SDID) point estimates and percentage changes for logarithm of taxable corporate income in both the short and long run. The columns "SR-Estimate" and "LR-Estimate" represent the point estimates for the short-run and long run, respectively. The "SR-Δ%" and "LR-Δ%" columns show the corresponding percentage changes in taxable corporate income, derived from the point estimates. The geometric means of the short-run and long-run estimates are provided at the bottom of the table. The transformed Δ% rows represent the exponentiated log geometric means, converted to percentage changes, indicating an overall decrease of 4.42% in the short-run and 8.92% in the long run (Table 8).

VII.C.2. Summary Statistics and Control Group Composition

The summary statistics and control group composition provide further context for interpreting the synthetic DID estimates. Appendix Tables 9 and 10 provide the summary statistics for both the treatment and control groups in the short run across all states. For the treated group, the observations consist of the logarithm of taxable corporate income before the policy switch and for the first three years following SSFA adoption. The control group includes states that had not yet switched or never switched to SSFA during this same period. I exclude states that adopted SSFA within three years after the policy was enacted from the control group. The number of observations in the control group increases steadily until 2011, then it begins to decrease as more states adopt the SSFA, which reduces the size of the control group. Appendix Tables 11 and 12 provide the summary statistics for both the treatment and control groups in the long run. The observations for treated states include the logarithm of taxable corporate income over an extended time frame, while the control group consists of states that either had not yet switched or never switched to SSFA. States that adopted SSFA after 2022 were included in the control group.

Tables

Appendix Table 9: Summary Statistics for Treatment and Control Groups - Ln(CI) Short-Run

Group	Observations	Mean	SD	Median	Min	Max	IQR (25th, 75th)
Treated (Nebraska)	15	13.8938	0.3127	13.7930	13.4360	14.3319	(13.6642, 14.1989)
Control (for Nebraska)	645	14.8420	1.1560	14.8911	12.4355	18.0167	(13.9200, 15.5260)
Treated (Michigan)	18	17.7525	0.2208	17.8167	17.0350	18.0167	(17.6805, 17.8736)
Control (for Michigan)	756	14.7617	1.0793	14.8507	12.4038	17.5975	(13.9182, 15.4458)
Treated (Illinois)	26	16.7252	0.2444	16.7204	16.2410	17.1245	(16.5354, 16.9333)
Control (for Illinois)	1066	14.7709	1.0554	14.8437	12.4038	17.6013	(14.0114, 15.4164)
Treated (Oregon)	31	14.6447	0.2532	14.5809	14.3122	15.1036	(14.4219, 14.8638)
Control (for Oregon)	1178	14.7452	1.0903	14.7998	12.0704	17.8740	(13.9534, 15.4164)
Treated (Georgia)	33	15.5771	0.2172	15.6203	15.1734	15.9168	(15.3942, 15.7695)
Control (for Georgia)	1056	14.7334	1.1117	14.7821	12.0704	17.9468	(13.9313, 15.3709)
Treated (Wisconsin)	33	15.3455	0.1469	15.3805	14.9569	15.5575	(15.2592, 15.4398)
Control (for Wisconsin)	1056	14.7334	1.1117	14.7821	12.0704	17.9468	(13.9313, 15.3709)
Treated (Arizona)	34	14.6290	0.5869	14.4520	13.6137	15.7359	(14.1877, 15.1042)
Control (for Arizona)	1020	14.7117	1.1350	14.7461	12.0704	17.9468	(13.8840, 15.3235)
Treated (Indiana)	34	15.8858	0.5105	15.7011	15.2057	16.6761	(15.4511, 16.4266)
Control (for Indiana)	1020	14.7117	1.1350	14.7461	12.0704	17.9468	(13.8840, 15.3235)
Treated (Maine)	34	13.4224	0.2534	13.4235	12.8253	13.8589	(13.2310, 13.6036)
Control (for Maine)	1020	14.7117	1.1350	14.7461	12.0704	17.9468	(13.8840, 15.3235)
Treated (Minnesota)	34	15.1341	0.2296	15.1429	14.5692	15.5778	(14.9571, 15.3095)
Control (for Minnesota)	1020	14.7117	1.1350	14.7461	12.0704	17.9468	(13.8840, 15.3235)
Treated (Pennsylvania)	34	16.0455	0.1669	16.0824	15.6181	16.2638	(15.9406, 16.1655)
Control (for Pennsylvania)	1020	14.7117	1.1350	14.7461	12.0704	17.9468	(13.8840, 15.3235)
Treated (South Carolina)	34	14.7865	0.1744	14.8440	14.3904	15.0837	(14.6540, 14.9148)
Control (for South Carolina)	1020	14.7117	1.1350	14.7461	12.0704	17.9468	(13.8840, 15.3235)
Treated (Colorado)	36	14.7731	0.3568	14.7576	13.9361	15.4440	(14.4841, 15.0297)
Control (for Colorado)	1008	14.6380	1.0411	14.7434	12.0704	17.3660	(13.8478, 15.2716)
Treated (California)	38	17.4786	0.2088	17.4783	17.0374	17.9468	(17.3633, 17.5913)
Control (for California)	1026	14.5989	1.0211	14.7154	12.0704	17.3660	(13.8271, 15.2159)

Note: Summary statistics for the treatment and control groups in the short run. The statistics include the logarithm of taxable corporate income observations from the year prior to SSFA adoption and the first three years post-adoption. Control group observations span the same period but exclude states that switched within the first three years of SSFA implementation. The table shows the number of observations, mean, standard deviation, median, minimum, maximum, and interquartile range (25th and 75th percentiles) for each group. Discussed in Section 7.3 (Table 9).

Appendix Table 10: Summary Statistics for Treatment and Control Groups - Ln(CI) Short-Run (Continued)

Group	Observations	Mean	SD	Median	Min	Max	IQR (25th, 75th)
Treated (Utah)	38	14.2403	0.4693	14.2283	13.4330	15.1630	(13.9073, 14.6219)
Control (for Utah)	1026	14.5989	1.0211	14.7154	12.0704	17.3660	(13.8271, 15.2159)
Treated (New Jersey)	39	16.0461	0.2407	15.9990	15.4955	16.5545	(15.8997, 16.2156)
Control (for New Jersey)	1053	14.6051	1.0203	14.7181	12.0704	17.3660	(13.8484, 15.2226)
Treated (New York)	42	16.8430	0.2471	16.8282	16.4140	17.3660	(16.6462, 17.0406)
Control (for New York)	840	14.5839	0.9170	14.7185	12.2676	16.8927	(13.9246, 15.1493)
Treated (Rhode Island)	42	13.3567	0.3373	13.3888	12.0704	13.8764	(13.2052, 13.6004)
Control (for Rhode Island)	840	14.5839	0.9170	14.7185	12.2676	16.8927	(13.9246, 15.1493)
Treated (Connecticut)	43	15.0959	0.3018	15.0931	13.9178	15.6798	(14.9263, 15.2543)
Control (for Connecticut)	774	14.5385	0.9516	14.6262	12.2676	16.8927	(13.8399, 15.1299)
Treated (Louisiana)	43	14.7133	0.4068	14.7480	13.7030	15.3281	(14.4269, 15.0899)
Control (for Louisiana)	774	14.5385	0.9516	14.6262	12.2676	16.8927	(13.8399, 15.1299)
Treated (North Carolina)	43	15.7942	0.2463	15.8429	15.3391	16.2336	(15.5926, 15.9592)
Control (for North Carolina)	774	14.5385	0.9516	14.6262	12.2676	16.8927	(13.8399, 15.1299)
Treated (North Dakota)	43	13.2447	0.5700	13.1831	12.4337	14.6636	(12.7842, 13.5894)
Control (for North Dakota)	774	14.5385	0.9516	14.6262	12.2676	16.8927	(13.8399, 15.1299)
Treated (Delaware)	44	13.8839	0.4241	13.9847	12.7478	14.4800	(13.6800, 14.1950)
Control (for Delaware)	792	14.5463	0.9528	14.6310	12.2676	16.9134	(13.8549, 15.1390)
Treated (Kentucky)	45	14.9972	0.3185	14.9081	14.5263	15.7753	(14.7243, 15.2226)
Control (for Kentucky)	765	14.5337	0.9813	14.5668	12.2676	16.9134	(13.7797, 15.1660)
Treated (Maryland)	45	15.1076	0.3023	15.0477	14.5711	15.6413	(14.8679, 15.4157)
Control (for Maryland)	765	14.5337	0.9813	14.5668	12.2676	16.9134	(13.7797, 15.1660)
Treated (Missouri)	47	14.8508	0.3016	14.8179	14.2332	15.6755	(14.6508, 15.0575)
Control (for Missouri)	564	14.6597	1.1047	14.7623	12.2676	17.4399	(13.7311, 15.4771)

Note: Summary statistics for the treatment and control groups in the short run. The statistics include the logarithm of taxable corporate income observations from the year prior to SSFA adoption and the first three years post-adoption. Control group observations span the same period but exclude states that switched within the first three years of SSFA implementation. The table shows the number of observations, mean, standard deviation, median, minimum, maximum, and interquartile range (25th and 75th percentiles) for each group. Discussed in Section 7.3 (Table 10).

Appendix Table 11: Summary Statistics for Treatment and Control Groups - Ln(CI) Long-Run

Group	Observations	Mean	SD	Median	Min	Max	IQR (25th, 75th)
Treated (Nebraska)	47	14.0007	0.3462	13.9420	13.4360	14.9967	(13.7417, 14.2470)
Control (for Nebraska)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Michigan)	47	17.1701	0.9600	17.7531	15.4708	18.0167	(15.9857, 17.8966)
Control (for Michigan)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Illinois)	47	16.6674	0.2662	16.6130	16.0425	17.3604	(16.4918, 16.8317)
Control (for Illinois)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Oregon)	47	14.7699	0.3495	14.7698	14.1789	15.7168	(14.4664, 14.9775)
Control (for Oregon)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Georgia)	47	15.6238	0.2615	15.6653	15.1734	16.5178	(15.4414, 15.7680)
Control (for Georgia)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Wisconsin)	47	15.4189	0.2484	15.4135	14.9569	16.3540	(15.2774, 15.4730)
Control (for Wisconsin)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Arizona)	47	14.7964	0.5890	14.9286	13.6137	15.9090	(14.2929, 15.2243)
Control (for Arizona)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Indiana)	47	15.7779	0.5013	15.6224	14.9858	16.6760	(15.4098, 16.2277)
Control (for Indiana)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Maine)	47	13.5163	0.2890	13.5658	12.8253	14.2799	(13.2956, 13.6933)
Control (for Maine)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Minnesota)	47	15.2702	0.3536	15.2365	14.5692	16.6184	(15.0503, 15.4287)
Control (for Minnesota)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Pennsylvania)	47	16.0737	0.1884	16.0909	15.6181	16.6561	(15.9670, 16.1684)
Control (for Pennsylvania)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (South Carolina)	47	14.8361	0.2828	14.8710	14.1245	15.9232	(14.6555, 14.9544)
Control (for South Carolina)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Colorado)	47	14.9881	0.5184	14.8432	13.9361	16.2428	(14.6058, 15.3797)
Control (for Colorado)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (California)	47	17.5637	0.3316	17.5268	17.0374	18.9963	(17.3789, 17.6586)
Control (for California)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)

Note: Summary statistics for the treatment and control groups in the long run. The statistics include the logarithm of taxable corporate income observations between 1976-2022. The control group consists of states that either had not yet switched or never switched to SSFA. The table shows the number of observations, mean, standard deviation, median, minimum, maximum, and interquartile range (25th and 75th percentiles) for each group. Discussed in Section 7.3 (Table 11).

Appendix Table 12: Summary Statistics for Treatment and Control Groups - Ln(CI) Long-Run (Continued)

Group	Observations	Mean	SD	Median	Min	Max	IQR (25th, 75th)
Treated (Utah)	47	14.4025	0.5573	14.4751	13.4330	15.7012	(13.9862, 14.7836)
Control (for Utah)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (New Jersey)	47	16.1076	0.2914	16.0718	15.4955	17.0632	(15.9122, 16.2529)
Control (for New Jersey)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (New York)	47	16.8717	0.2578	16.8369	16.4140	17.4175	(16.6673, 17.0818)
Control (for New York)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Rhode Island)	47	13.4142	0.3712	13.4304	12.0704	14.1658	(13.2593, 13.6369)
Control (for Rhode Island)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Connecticut)	47	15.2009	0.4545	15.1296	13.9178	16.5811	(14.9320, 15.3547)
Control (for Connecticut)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Louisiana)	47	14.7265	0.4011	14.7480	13.7030	15.3711	(14.4860, 15.0899)
Control (for Louisiana)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (North Carolina)	47	15.8621	0.3409	15.8529	15.3391	16.9234	(15.5941, 16.0585)
Control (for North Carolina)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (North Dakota)	47	13.3114	0.5959	13.1901	12.4337	14.6636	(12.8433, 13.7477)
Control (for North Dakota)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Delaware)	47	13.9031	0.4213	14.0001	12.7478	14.4882	(13.7022, 14.1957)
Control (for Delaware)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Kentucky)	47	15.0320	0.3538	14.9231	14.5263	15.8930	(14.7681, 15.2393)
Control (for Kentucky)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Maryland)	47	15.1439	0.3432	15.0604	14.5711	15.9984	(14.8698, 15.4159)
Control (for Maryland)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)
Treated (Missouri)	47	14.8508	0.3016	14.8179	14.2332	15.6755	(14.6508, 15.0575)
Control (for Missouri)	705	14.5383	1.0491	14.4708	12.2676	17.4399	(13.6790, 15.2676)

Note: Summary statistics for the treatment and control groups in the long run. The statistics include the logarithm of taxable corporate income observations between 1976-2022. The control group consists of states that either had not yet switched or never switched to SSFA. The table shows the number of observations, mean, standard deviation, median, minimum, maximum, and interquartile range (25th and 75th percentiles) for each group. Discussed in Section 7.3 (Table 12).

Appendix Table 13: Summary Statistics for Non-Corporate Tax Revenue per Capita by State

State	Mean	Median	IQR	Min	Max
Alabama	742.0	765.0	145.0	544.0	1001.0
Alaska	1836.0	1571.0	1706.0	465.0	5023.0
Arizona	838.0	844.0	73.6	625.0	1076.0
Arkansas	928.0	991.0	487.0	530.0	1354.0
California	1181.0	1154.0	423.0	759.0	2134.0
Colorado	781.0	783.0	213.0	496.0	1182.0
Connecticut	1349.0	1501.0	733.0	621.0	2012.0
Delaware	1306.0	1330.0	286.0	956.0	1948.0
Florida	744.0	746.0	133.0	512.0	1030.0
Georgia	756.0	776.0	170.0	528.0	984.0
Hawaii	1593.0	1588.0	340.0	1067.0	2366.0
Idaho	864.0	900.0	283.0	555.0	1186.0
Illinois	918.0	905.0	282.0	600.0	1448.0
Indiana	883.0	857.0	275.0	533.0	1386.0
Iowa	938.0	961.0	219.0	643.0	1287.0
Kansas	909.0	975.0	347.0	552.0	1368.0
Kentucky	926.0	997.0	261.0	632.0	1165.0
Louisiana	799.0	813.0	203.0	617.0	1127.0
Maine	1026.0	1094.0	304.0	617.0	1481.0
Maryland	1070.0	1054.0	293.0	723.0	1509.0
Massachusetts	1206.0	1232.0	342.0	717.0	1903.0
Michigan	958.0	1039.0	332.0	610.0	1211.0
Minnesota	1344.0	1405.0	453.0	814.0	1896.0
Mississippi	828.0	891.0	342.0	574.0	1101.0
Missouri	725.0	759.0	166.0	449.0	910.0
Montana	859.0	861.0	353.0	570.0	1318.0
Nebraska	861.0	920.0	371.0	522.0	1201.0
New Hampshire	476.0	552.0	269.0	248.0	666.0
New Jersey	1100.0	1108.0	382.0	494.0	1628.0
New Mexico	1038.0	1032.0	201.0	771.0	1346.0
New York	1232.0	1138.0	378.0	776.0	1914.0
North Carolina	901.0	965.0	230.0	582.0	1176.0
North Dakota	1286.0	958.0	987.0	622.0	3356.0
Ohio	799.0	834.0	232.0	477.0	1050.0
Oklahoma	870.0	871.0	134.0	589.0	1052.0
Oregon	844.0	841.0	278.0	555.0	1436.0
Pennsylvania	929.0	966.0	303.0	629.0	1293.0
Rhode Island	999.0	1084.0	293.0	636.0	1407.0
South Carolina	769.0	788.0	115.0	575.0	960.0
Tennessee	672.0	694.0	142.0	419.0	953.0
Utah	852.0	860.0	244.0	587.0	1314.0
Vermont	1304.0	1334.0	991.0	578.0	2245.0
Virginia	879.0	912.0	235.0	575.0	1369.0
West Virginia	974.0	1004.0	277.0	697.0	1290.0
Wisconsin	1071.0	1129.0	202.0	785.0	1296.0

Note: This table presents summary statistics for non-corporate tax revenue per capita across various states, including the mean, median, interquartile range (IQR), minimum, and maximum values.

Appendix Table 14: Aggregated Summary Statistics for Treatment and Control Groups - Ln(CI)

Period	Group	Observations	Mean	SD	Min	Max
Panel A: Short-Run Analysis						
	Treatment (All States)	948	15.1048	1.1609	12.0704	18.0167
	Control (All States)	1,178	14.7452	1.0903	12.0704	17.8740
Panel B: Long-Run Analysis						
	Treatment (All States)	1,222	15.2038	1.1735	12.0704	18.9963
	Control (All States)	705	14.5383	1.0491	12.2676	17.4399

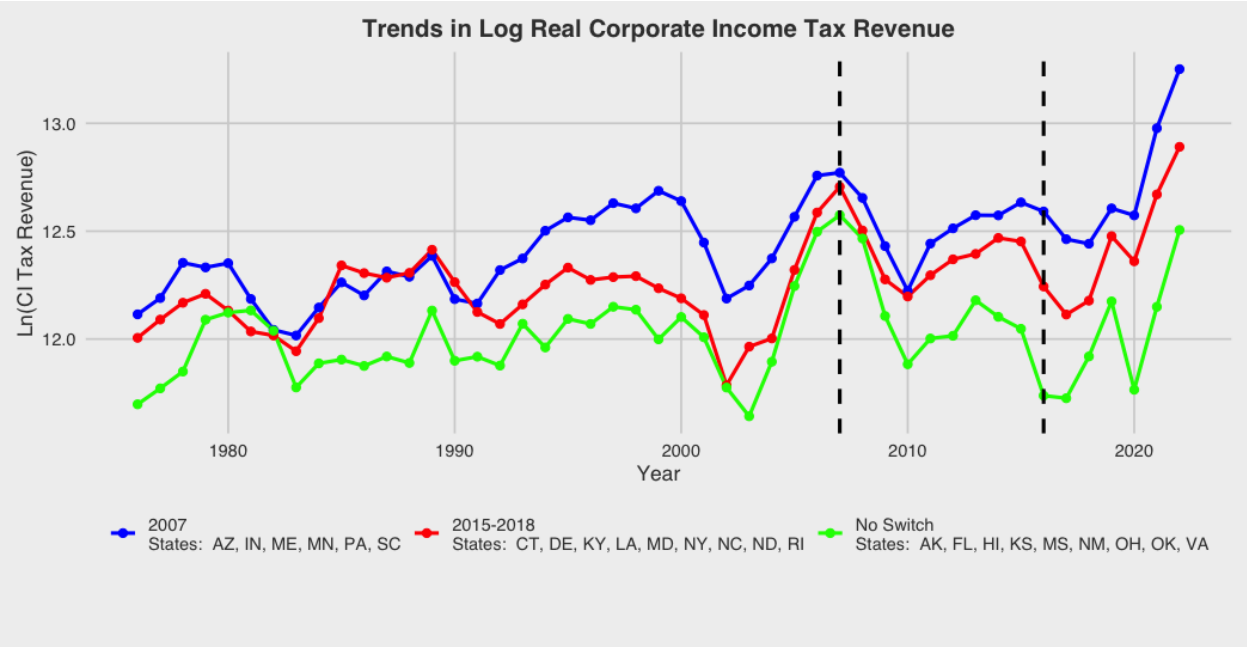
Note: This table presents pooled summary statistics for all treatment and control groups across short-run and long-run analyses. Panel A (Short Run) includes observations from the year prior to SSFA adoption through the first three years post-adoption for all 26 treated states, with control group observations from states that did not adopt SSFA during the short-run analysis window. Panel B (Long Run) spans the full panel period of 1976-2022, with the Treatment group aggregating all observations from states that adopted SSFA and the Control group including observations from states that either had not yet switched or never switched to SSFA. Statistics shown are the logarithm of taxable corporate income and include total observations, weighted mean, pooled standard deviation, and overall minimum and maximum values across all state-year observations. The pooled means are calculated as weighted averages across all states' means, weighted by the number of observations per state. The pooled standard deviations account for both within-state and between-state variation using the formula for combined sample variance. State-by-state summary statistics are available in Online Appendix; Discussed in Section 7.3.

Appendix Table 15: Aggregated Summary Statistics: Non-Corporate Tax Revenue per Capita

States	Mean	Median	IQR	Min	Max
All States (45)	981.4	961.0	342.9	248.0	5,023.0

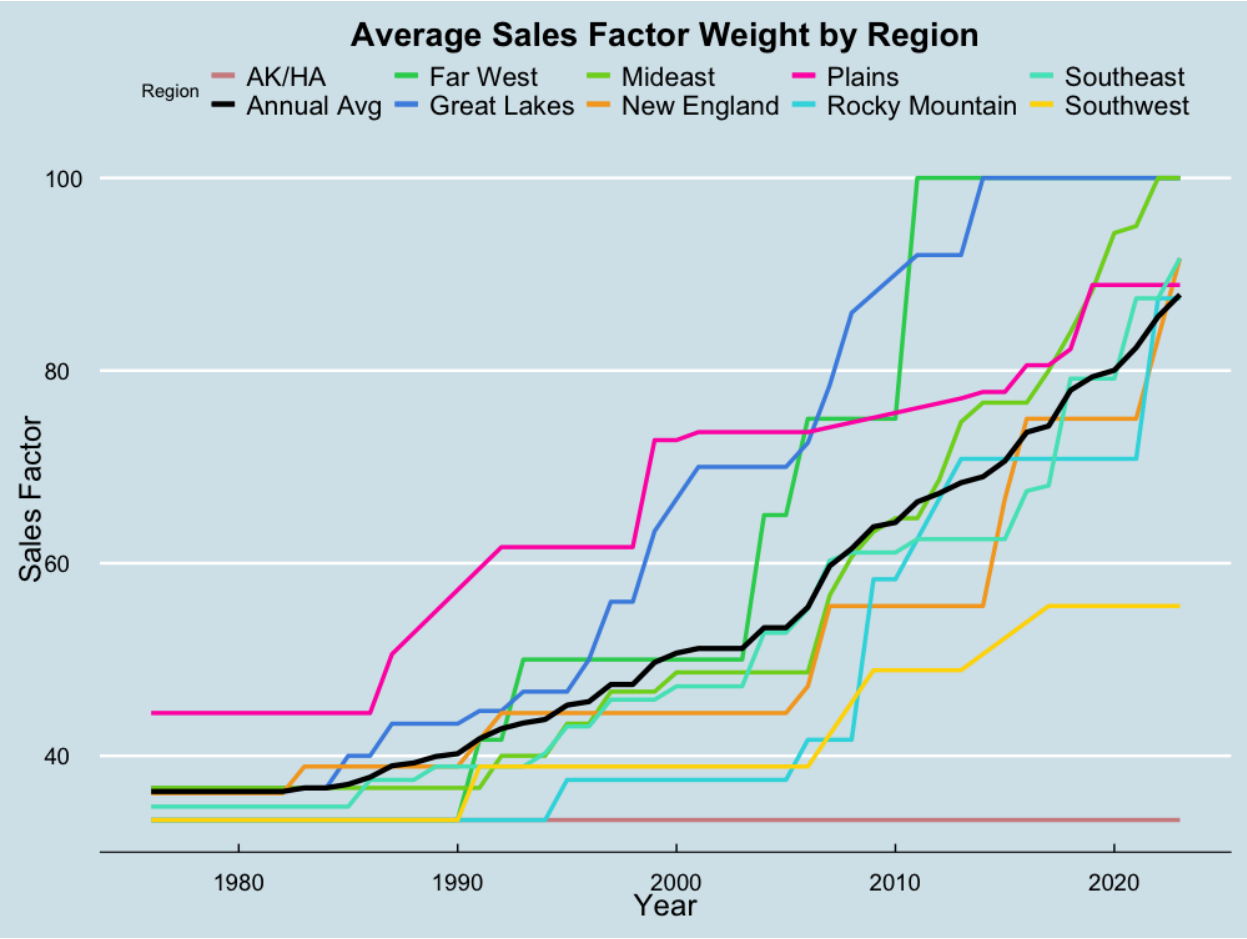
Note: This table presents pooled summary statistics for non-corporate tax revenue per capita across all 45 states in the analysis. Mean and median values represent simple averages across all states. The IQR (interquartile range) shown is the average of individual state IQRs, representing the typical spread between the 25th and 75th percentiles. The minimum and maximum values represent the overall range across all states and time periods. All values are in dollars. State-by-state summary statistics are available in Online Appendix. Discussed in Section 7.3.

Figures



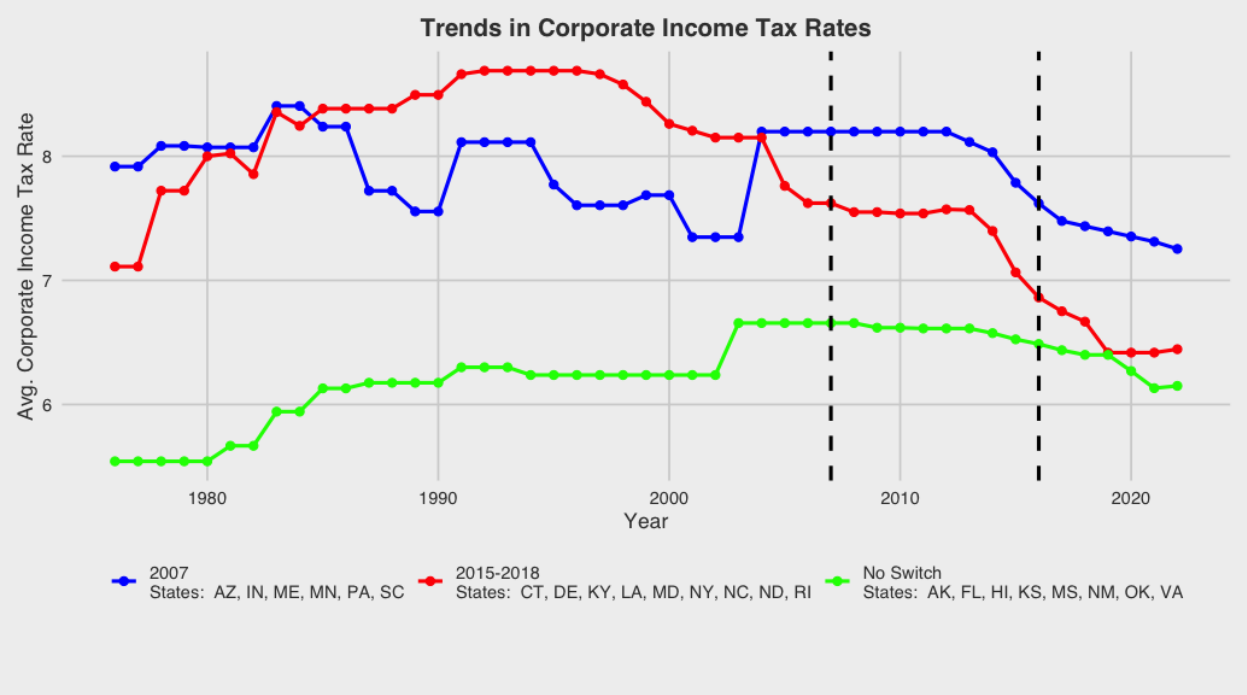
Appendix Figure 1: Log Corporate Tax Revenue by Group

Note: Average log Corporate Tax Revenue from 1978 to 2022 for early adopters (2007), late adopters (2015–2018), and non-adopters. The first dashed line indicates the 2007 treatment year for early adopters, and the second dashed line indicates the 2014 cutoff.



Appendix Figure 2: Regional Trends in Sales Factor Weight and National Average Over Time

Note: This figure depicts the overall trend of states increasing the sales factor weight in corporate income tax apportionment formulas, broken down by region. The figure highlights that, beginning in the late 1980s, several regions started shifting toward a heavier reliance on sales as a key factor for apportioning corporate income. This figure captures the cumulative effect of states gradually transitioning from the traditional three-factor formula (property, payroll, sales) to formulas that place more weight on sales.



Appendix Figure 3: Corporate Income Tax Rates by Group

Note: Average statutory corporate income tax rates from 1978 to 2014 by group for truncated sample in V.A. The first dashed vertical line shows 2007, the adoption year for early adopters. The second dashed line shows the beginning of adoption for the later adopters.

Appendix Figure 4: Treated vs. Control: Ln(Corporate Income)

Note: This figure shows trends in logged Corporate Income, which is created from the Average of the treatment (2007 Switchers) and control (Late Switchers) groups for Regression results of VII.B.

Appendix D: Works Cited for Table 4

This appendix lists the legal and legislative sources corresponding to the adoption of Single Sales Factor Apportionment policies by U.S. states.

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