The Dynamic Response of Municipal Budgets to Revenue Shocks

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Online Appendix

A Additional Tables and Figures

Table A.1: Spatial Variation in the Census Shock

	Dependent variable: Census Shock			
	Federal State Fixed Effects	Commuting Zone Fixed Effects	District Fixed Effects	Nearest Neighbors
	(1)	(2)	(3)	(4)
R2	0.014	0.163	0.184	0.082
Residual Variation (SD)	0.040	0.037	0.037	0.039
# fixed effects	5	173	265	5
# municipalities	4,373	4,365	4,304	4,373

Notes: The table reports the R2 and residual variation from an unweighted regression of the Census Shock on federal state (column (1)), commuting zone (columns (2) and (4)), or district fixed effects (column (3)). Column (4) includes the population-weighted average Census Shock of the nearest five neighbors as an explanatory variable (in addition to federal state fixed effects). The Census Shock is defined as the percentage difference between the Census count on May 25, 1987 and the population projection on December 31, 1986.

Table A.2: Dynamic Effects of Fiscal Transfers on Local Tax Revenues and Tax Base

	Tax Revenues			Tax Base		
	baseline	w/neighbor	CZ x Year FE	baseline	w/neighbor	CZ x Year FE
	(1)	(2)	(3)	(4)	(5)	(6)
τ = -5	0.05	0.00	-0.07	0.06	0.03	0.01
	(0.17)	(0.12)	(0.12)	(0.06)	(0.03)	(0.03)
τ = -4	0.09	0.11	0.04	0.05	0.04	0.02
	(0.15)	(0.13)	(0.12)	(0.05)	(0.03)	(0.04)
τ = -3	0.07	0.07	0.03	0.04	0.03	0.02
	(0.09)	(0.09)	(0.10)	(0.03)	(0.03)	(0.03)
τ = -2	0.03	0.02	-0.01	0.02	0.02	0.01
	(0.07)	(0.07)	(0.07)	(0.02)	(0.02)	(0.02)
τ = -1	.	.	.	.	.	.
τ = 0	0.08	0.11	0.09	0.02	0.03	0.03
	(0.07)	(0.09)	(0.09)	(0.02)	(0.02)	(0.03)
τ = 1	0.10	0.08	0.09	0.03	0.04	0.04
	(0.08)	(0.08)	(0.08)	(0.03)	(0.03)	(0.03)
τ = 2	0.19**	0.20***	0.22***	0.06	0.08***	0.09***
	(0.08)	(0.08)	(0.07)	(0.04)	(0.02)	(0.03)
τ = 3	0.21*	0.33***	0.36***	0.07	0.13***	0.15***
	(0.13)	(0.10)	(0.10)	(0.06)	(0.03)	(0.03)
τ = 4	0.25*	0.36***	0.39***	0.08	0.14***	0.16***
	(0.14)	(0.11)	(0.11)	(0.06)	(0.04)	(0.04)
τ = 5	0.02	0.23**	0.25**	0.02	0.12***	0.13***
	(0.14)	(0.12)	(0.12)	(0.07)	(0.04)	(0.04)
τ = 6	-0.08	0.07	0.07	-0.01	0.06	0.08*
	(0.15)	(0.12)	(0.12)	(0.07)	(0.04)	(0.04)
τ = 7	0.01	0.10	0.12	0.02	0.08*	0.10**
	(0.15)	(0.12)	(0.12)	(0.07)	(0.04)	(0.04)
τ = 8	0.15	0.16	0.17	0.09	0.11**	0.13***
	(0.14)	(0.12)	(0.12)	(0.06)	(0.05)	(0.05)
τ = 9	0.15	0.25*	0.24*	0.09	0.14***	0.16***
	(0.18)	(0.13)	(0.12)	(0.09)	(0.05)	(0.05)
τ = 10	0.22	0.38**	0.40***	0.11	0.20***	0.22***
	(0.22)	(0.15)	(0.14)	(0.10)	(0.06)	(0.06)
States	all	all	all	all	all	all

Notes: The table reports 2SLS estimates of the effects of fiscal transfers on municipal revenues based on equation (4), instrumenting the change in municipal fiscal transfers per capita with the Census Shock. The dependent variable is the per capita change relative to 1988 in tax revenues (columns 1-3) or a proxy for the tax base (columns 4-6). We control for federal state x year fixed effects ("baseline"), commuting zone x year fixed effects ("CZ x Year FE"), or the average Census Shock in the other municipalities in the district ("w/neighbor"). Observations are heteroscedasticity-weighted based on a modified Breusch-Pagan test. Standard errors are clustered at the commuting zone level. Significance levels: 1% ***, 5% **, 10% *.

Table A.3: Dynamic Effects of Fiscal Transfers on Local Tax Rates

	Baseline		Tax Competition (10% deviation)				Size of Shock				>0 adjustments		Tax Changes (any tax)
	Business Tax	Property Tax (Index)	Business Tax		Property Tax		Business Tax		Property Tax		Business Tax	Property Tax	
			High	Low	High	Low	Small	Large	Small	Large			
	(1.1)	(1.2)	(2.1)		(2.2)		(3.1)		(3.2)		(4.1)	(4.2)	(5)
τ = -5	0.032	-0.024	0.019	0.161	-0.046	0.136	-0.026	0.057	-0.272**	0.083	0.051	-0.035	-0.003
	(0.043)	(0.067)	(0.044)	(0.206)	(0.058)	(0.115)	(0.076)	(0.052)	(0.107)	(0.073)	(0.068)	(0.087)	(0.005)
τ = -4	-0.012	-0.053	-0.017	0.071	-0.073	0.105	-0.103*	0.019	-0.280***	0.049	-0.018	-0.072	-0.005
	(0.041)	(0.060)	(0.042)	(0.184)	(0.049)	(0.110)	(0.057)	(0.056)	(0.096)	(0.070)	(0.065)	(0.080)	(0.004)
τ = -3	-0.018	-0.023	-0.021	-0.044	-0.008	-0.011	-0.047	-0.015	-0.118*	0.012	-0.029	-0.03	-0.003
	(0.026)	(0.034)	(0.025)	(0.069)	(0.042)	(0.049)	(0.052)	(0.026)	(0.067)	(0.033)	(0.041)	(0.047)	(0.003)
τ = -2	-0.005	-0.015	-0.005	-0.032	-0.015	0.008	-0.016	-0.015	-0.113**	0.012	-0.008	-0.021	-0.002
	(0.022)	(0.029)	(0.018)	(0.062)	(0.033)	(0.039)	(0.040)	(0.019)	(0.053)	(0.026)	(0.036)	(0.041)	(0.002)
τ = -1													
τ = 0	-0.002	0.005	0.007	-0.077	0.028	-0.037	-0.011	0.006	-0.024	0.022	-0.005	0.006	-0.001
	(0.015)	(0.024)	(0.015)	(0.063)	(0.024)	(0.046)	(0.032)	(0.020)	(0.041)	(0.029)	(0.024)	(0.033)	(0.002)
τ = 1	-0.045*	-0.053	-0.02	-0.103	-0.016	-0.039	-0.108*	-0.025	-0.096	-0.028	-0.075*	-0.075	-0.003
	(0.026)	(0.042)	(0.026)	(0.093)	(0.036)	(0.078)	(0.061)	(0.028)	(0.067)	(0.051)	(0.043)	(0.058)	(0.003)
τ = 2	-0.083**	-0.128**	-0.031	-0.312*	-0.057	-0.092	-0.168**	-0.063*	-0.170**	-0.097	-0.135**	-0.179**	-0.006
	(0.034)	(0.063)	(0.031)	(0.174)	(0.050)	(0.090)	(0.068)	(0.037)	(0.082)	(0.081)	(0.056)	(0.090)	(0.004)
τ = 3	-0.094**	-0.169**	-0.014	-0.336	-0.09	-0.106	-0.194**	-0.054	-0.256**	-0.106	-0.152**	-0.238**	-0.006
	(0.042)	(0.070)	(0.041)	(0.213)	(0.068)	(0.112)	(0.093)	(0.042)	(0.125)	(0.087)	(0.068)	(0.100)	(0.005)
τ = 4	-0.162***	-0.239***	-0.081	-0.414	-0.082	-0.351**	-0.351***	-0.116**	-0.393**	-0.182*	-0.254***	-0.336***	-0.01
	(0.062)	(0.086)	(0.059)	(0.275)	(0.071)	(0.167)	(0.126)	(0.059)	(0.153)	(0.102)	(0.086)	(0.117)	(0.006)
τ = 5	-0.202***	-0.284***	-0.102	-0.664**	-0.116	-0.411**	-0.379***	-0.133*	-0.549***	-0.155	-0.320***	-0.403***	-0.01
	(0.066)	(0.104)	(0.066)	(0.280)	(0.085)	(0.171)	(0.133)	(0.068)	(0.179)	(0.128)	(0.091)	(0.142)	(0.007)
τ = 6	-0.232***	-0.282**	-0.119	-0.753**	-0.119	-0.469**	-0.391***	-0.150*	-0.467**	-0.186	-0.371***	-0.404**	-0.011
	(0.074)	(0.121)	(0.076)	(0.307)	(0.114)	(0.194)	(0.139)	(0.077)	(0.182)	(0.144)	(0.098)	(0.163)	(0.008)
τ = 7	-0.221***	-0.267**	-0.105	-0.796**	-0.12	-0.376*	-0.380***	-0.155**	-0.426**	-0.19	-0.356***	-0.388**	-0.008
	(0.073)	(0.128)	(0.072)	(0.340)	(0.131)	(0.198)	(0.134)	(0.078)	(0.210)	(0.149)	(0.097)	(0.170)	(0.009)
τ = 8	-0.238***	-0.354**	-0.125*	-0.790**	-0.145	-0.513**	-0.336**	-0.188**	-0.439**	-0.301*	-0.386***	-0.511***	-0.01
	(0.073)	(0.139)	(0.071)	(0.343)	(0.141)	(0.208)	(0.134)	(0.079)	(0.216)	(0.162)	(0.097)	(0.179)	(0.010)
τ = 9	-0.265***	-0.360***	-0.131*	-1.021***	-0.208	-0.416*	-0.415***	-0.208**	-0.480**	-0.303**	-0.427***	-0.517***	-0.009
	(0.074)	(0.131)	(0.075)	(0.356)	(0.128)	(0.227)	(0.139)	(0.080)	(0.224)	(0.152)	(0.099)	(0.163)	(0.011)
τ = 10	-0.266***	-0.436***	-0.123*	-1.012***	-0.231*	-0.575**	-0.415***	-0.217***	-0.489**	-0.413**	-0.429***	-0.621***	-0.011
	(0.074)	(0.141)	(0.071)	(0.363)	(0.128)	(0.237)	(0.137)	(0.080)	(0.227)	(0.166)	(0.103)	(0.173)	(0.011)
Federal States	all	all	all		all		all		all		all	all	all
N	69,504	69,501	68,256		68,253		69,504		69,501		42,928	50,173	69,968

Notes: The table reports estimates of the effects of the Census Shock on local tax multipliers in columns (1) to (4) and on the number of tax changes in column (5) based on the reduced-form equivalent of equation (4). The dependent variables represent the absolute change relative to 1988 of the variables reported in the top row. In columns (2.1) and (2.2), low tax competition municipalities are defined as municipalities whose tax rates deviate by at least 10 percent from the district average. In columns (3.1) and (3.2), large shocks are defined as municipalities with a Census Shock of at least 5 percent. Columns (4.1) and (4.2) restrict the sample to municipalities that adjust tax rates at least once in the analysis period. All columns control for federal state-by-year fixed effects and observations are heteroscedasticity-weighted based on a modified Breusch-Pagan test. Standard errors clustered at the commuting zone level. Significance levels: 1% ***, 5% **, 10% *.

Table A.5: Asymmetric Effects - Expenditures

	Total		Administrative Budget							
			Total (Admin)		Public Employees		Material		Other Expenditures	
	(1.1) Positive	(1.2) Negative	(2.1) Positive	(2.2) Negative	(3.1) Positive	(3.2) Negative	(4.1) Positive	(4.2) Negative	(5.1) Positive	(5.2) Negative
τ = -5/-4	-0.22	0.47	0.14	0.22	-0.10**	0.06	-0.01	0.16**	0.47**	-0.01
	(0.70)	(0.52)	(0.22)	(0.22)	(0.05)	(0.04)	(0.11)	(0.07)	(0.23)	(0.21)
τ = -3/-2	0.20	0.02	0.31	0.07	-0.02	0.02	0.01	0.07	0.42*	-0.06
	(0.58)	(0.48)	(0.21)	(0.18)	(0.02)	(0.02)	(0.07)	(0.06)	(0.24)	(0.16)
τ = -1	.	.	.	.	.	.	.	.	.	.
τ = 0/1	0.99	1.57***	0.86***	1.11***	-0.05	0.02	0.15*	0.06	0.78***	0.70***
	(0.70)	(0.44)	(0.17)	(0.22)	(0.03)	(0.03)	(0.09)	(0.06)	(0.16)	(0.15)
τ = 2/3	1.33*	3.20***	0.98***	1.43***	-0.10	0.08	0.24**	0.21**	0.99***	0.89***
	(0.76)	(0.56)	(0.23)	(0.31)	(0.06)	(0.06)	(0.11)	(0.10)	(0.19)	(0.23)
τ = 4/5	2.06**	3.43***	1.16***	1.55***	-0.14	0.10	0.27*	0.23	1.10***	0.86***
	(0.93)	(0.60)	(0.35)	(0.31)	(0.09)	(0.09)	(0.15)	(0.14)	(0.24)	(0.23)
τ = 6/7	1.46	2.06***	1.10***	1.40***	-0.22**	0.15	0.35**	0.18	1.10***	0.78***
	(0.98)	(0.68)	(0.37)	(0.34)	(0.10)	(0.09)	(0.18)	(0.18)	(0.25)	(0.26)
τ = 8/9	2.15**	2.88***	0.89**	1.53***	-0.36***	0.22**	0.33	0.19	1.06***	0.88***
	(0.88)	(0.68)	(0.39)	(0.41)	(0.13)	(0.10)	(0.21)	(0.22)	(0.27)	(0.29)
τ = 10	2.73**	3.00***	1.28***	1.94***	-0.36***	0.27**	0.42*	0.18	1.34***	1.21***
	(1.06)	(0.75)	(0.43)	(0.48)	(0.14)	(0.12)	(0.24)	(0.23)	(0.31)	(0.35)
States	all		all		all		no HE		no HE	
N	69,968		69,968		69,968		63,152		63,152	

	Capital Budget									
	Total (Capital)		Debt Repayment		Acquisition of Assets		Other Expenditures (incl. Infrastructure)		Infrastructure Investments	
	(6.1) Positive	(6.2) Negative	(7.1) Positive	(7.2) Negative	(8.1) Positive	(8.2) Negative	(9.1) Positive	(9.2) Negative	(10.1) Positive	(10.2) Negative
τ = -5/-4	-0.35	0.45	0.08	-0.17	-0.04	-0.01	0.17	0.45	-0.14	0.66*
	(0.58)	(0.47)	(0.15)	(0.13)	(0.35)	(0.23)	(0.43)	(0.33)	(0.49)	(0.38)
τ = -3/-2	-0.09	-0.04	0.00	-0.03	0.05	0.10	0.13	-0.21	0.03	-0.14
	(0.45)	(0.41)	(0.11)	(0.10)	(0.26)	(0.20)	(0.34)	(0.33)	(0.33)	(0.28)
τ = -1	.	.	.	.	.	.	.	.	.	.
τ = 0/1	0.02	0.55	0.06	-0.08	0.27	0.22	0.23	0.47	-0.04	0.63**
	(0.62)	(0.38)	(0.10)	(0.11)	(0.25)	(0.29)	(0.48)	(0.31)	(0.50)	(0.29)
τ = 2/3	0.30	1.69***	-0.01	0.17	0.17	0.79**	0.83	0.76**	0.26	1.23***
	(0.67)	(0.47)	(0.12)	(0.11)	(0.33)	(0.32)	(0.52)	(0.34)	(0.62)	(0.40)
τ = 4/5	0.84	1.84***	0.31**	-0.01	0.44	1.31***	0.61	0.76**	0.36	1.06***
	(0.74)	(0.52)	(0.15)	(0.13)	(0.38)	(0.38)	(0.61)	(0.35)	(0.65)	(0.38)
τ = 6/7	0.39	0.61	0.26*	-0.03	0.08	0.87**	0.48	0.00	0.16	0.44
	(0.77)	(0.56)	(0.15)	(0.14)	(0.40)	(0.38)	(0.58)	(0.40)	(0.64)	(0.40)
τ = 8/9	1.15*	1.16**	0.27**	-0.06	0.30	0.93***	0.69	0.35	0.39	0.61
	(0.68)	(0.54)	(0.13)	(0.13)	(0.35)	(0.34)	(0.54)	(0.43)	(0.54)	(0.37)
τ = 10	1.37	1.20**	0.40**	0.24**	0.59	0.59*	0.70	0.21	0.22	0.62
	(0.83)	(0.52)	(0.17)	(0.12)	(0.38)	(0.36)	(0.65)	(0.51)	(0.62)	(0.45)
States	all		all		no HE		no HE		no BY	
N	69,968		69,968		63,152		63,152		37,344	

Notes: The table reports 2SLS estimates of the effects of fiscal transfers on growth in the respective expenditure category based on variants of equation (4). The dependent variable is the per capita change in the variable reported in the top row relative to 1988. All columns control for federal state-by-year fixed effects. Regressions are heteroscedasticity-weighted based on a modified Breusch-Pagan test. Standard errors are clustered at the commuting zone level. Significance levels: 1% ***, 5% **, 10% *.

Table A.4: Asymmetric Effects - Revenues

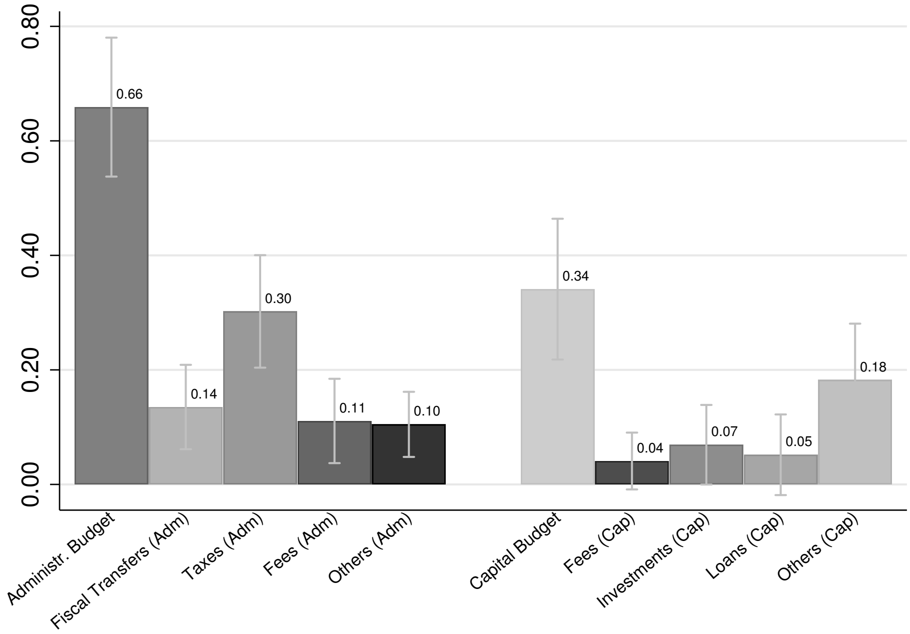
	Total		Administrative Budget							
			Total (Admin)		Taxes		Fees and Charges		Other Revenues	
	(1.1) Positive	(1.2) Negative	(2.1) Positive	(2.2) Negative	(3.1) Positive	(3.2) Negative	(4.1) Positive	(4.2) Negative	(5.1) Positive	(5.2) Negative
τ = -5/-4	0.38	0.36	0.36*	0.18	0.35**	-0.09	0.05	0.05	-0.11	0.11
	(0.59)	(0.52)	(0.20)	(0.18)	(0.15)	(0.22)	(0.07)	(0.08)	(0.09)	(0.07)
τ = -3/-2	0.55	-0.30	0.52***	-0.01	0.37**	-0.13	-0.01	0.03	0.01	0.11*
	(0.60)	(0.40)	(0.19)	(0.15)	(0.15)	(0.10)	(0.07)	(0.06)	(0.05)	(0.06)
τ = -1	.	.	.	.	.	.	.	.	.	.
τ = 0/1	1.38**	1.84***	1.13***	1.28***	0.09	0.16	0.06	-0.02	-0.07	-0.15
	(0.59)	(0.42)	(0.15)	(0.16)	(0.11)	(0.11)	(0.06)	(0.05)	(0.07)	(0.12)
τ = 2/3	1.81***	3.18***	1.12***	1.45***	0.05	0.38***	0.02	-0.05	-0.05	-0.05
	(0.65)	(0.49)	(0.23)	(0.25)	(0.15)	(0.12)	(0.09)	(0.09)	(0.11)	(0.13)
τ = 4/5	2.12**	3.09***	1.15***	1.41***	-0.11	0.31*	0.12	-0.03	-0.02	0.03
	(0.82)	(0.57)	(0.32)	(0.33)	(0.22)	(0.17)	(0.11)	(0.14)	(0.14)	(0.16)
τ = 6/7	1.25	1.82**	0.78**	1.25***	-0.28	0.1	0.18	-0.11	-0.01	-0.07
	(0.87)	(0.73)	(0.38)	(0.38)	(0.24)	(0.20)	(0.14)	(0.18)	(0.16)	(0.16)
τ = 8/9	2.37***	2.75***	0.90**	1.46***	-0.05	0.29	0.1	-0.04	0.00	-0.08
	(0.78)	(0.74)	(0.37)	(0.45)	(0.24)	(0.20)	(0.13)	(0.21)	(0.20)	(0.19)
τ = 10	2.29**	2.98***	1.09**	1.77***	-0.1	0.47	0.31*	-0.07	0.12	0.08
	(0.97)	(0.82)	(0.45)	(0.52)	(0.24)	(0.29)	(0.16)	(0.23)	(0.20)	(0.19)
States	all		all		all		no HE		no HE	
N	69,968		69,968		69,968		63,152		63,152	

	Capital Budget									
	Total (Capital)		Fees and Contributions		Investments		Loans		Other Revenues	
	(6.1) Positive	(6.2) Negative	(7.1) Positive	(7.2) Negative	(8.1) Positive	(8.2) Negative	(9.1) Positive	(9.2) Negative	(10.1) Positive	(10.2) Negative
τ = -5/-4	-0.10	0.35	0.03	0.03	-0.27	-0.07	-0.49*	0.06	0.59*	0.11
	(0.50)	(0.43)	(0.15)	(0.10)	(0.24)	(0.22)	(0.27)	(0.21)	(0.34)	(0.31)
τ = -3/-2	0.00	-0.08	0.03	-0.15	-0.20	-0.20	-0.48**	0.09	0.56	-0.09
	(0.44)	(0.38)	(0.11)	(0.10)	(0.19)	(0.13)	(0.22)	(0.21)	(0.38)	(0.30)
τ = -1	.	.	.	.	.	.	.	.	.	.
τ = 0/1	0.44	0.55	0.11	0.04	-0.20	-0.03	-0.18	-0.10	0.54*	0.57*
	(0.51)	(0.37)	(0.13)	(0.10)	(0.22)	(0.17)	(0.20)	(0.19)	(0.29)	(0.31)
τ = 2/3	0.61	1.95***	0.27	0.21	-0.02	0.02	-0.30	0.32	0.89**	1.27***
	(0.56)	(0.49)	(0.18)	(0.14)	(0.25)	(0.24)	(0.23)	(0.22)	(0.37)	(0.37)
τ = 4/5	1.01	2.07***	0.37**	0.53***	-0.21	0.10	0.23	0.31	0.69*	1.05***
	(0.65)	(0.48)	(0.17)	(0.17)	(0.29)	(0.23)	(0.31)	(0.23)	(0.37)	(0.29)
τ = 6/7	0.40	0.98*	0.33*	0.38**	-0.21	-0.16	0.15	-0.03	0.27	0.57
	(0.67)	(0.52)	(0.17)	(0.15)	(0.28)	(0.26)	(0.33)	(0.23)	(0.37)	(0.35)
τ = 8/9	1.39**	1.42***	0.55***	0.28*	-0.12	-0.17	0.24	0.21	0.51	0.98***
	(0.61)	(0.52)	(0.16)	(0.16)	(0.28)	(0.33)	(0.26)	(0.23)	(0.34)	(0.37)
τ = 10	1.10	1.33**	0.58***	0.15	0.05	-0.13	-0.29	0.56**	0.56	0.70*
	(0.70)	(0.53)	(0.19)	(0.18)	(0.38)	(0.31)	(0.31)	(0.26)	(0.35)	(0.40)
States	all		no HE		no HE		all		no HE	
N	69,968		63,152		63,152		69,968		63,152	

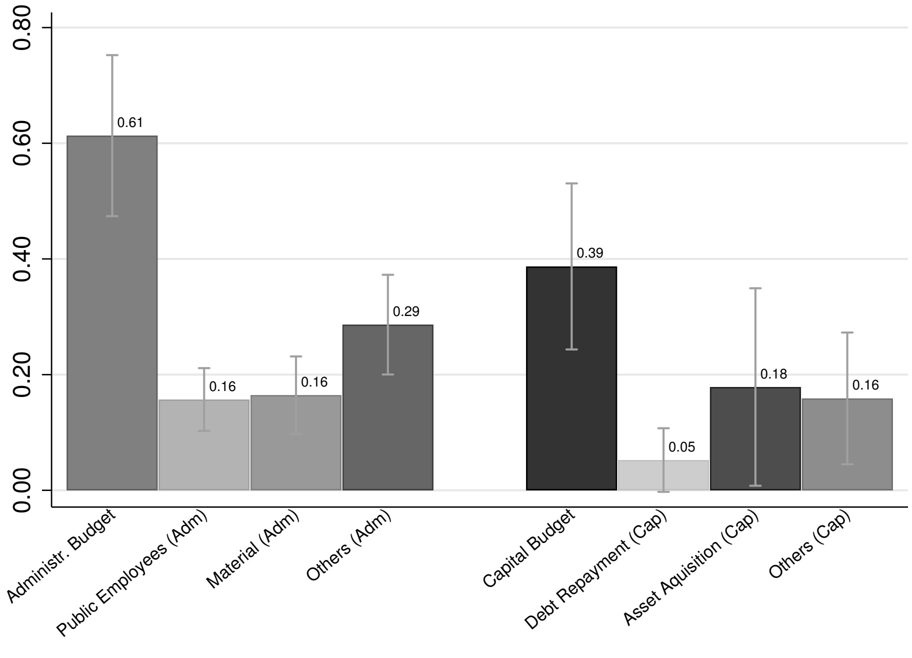
Notes: The table reports 2SLS estimates of the effects of fiscal transfers on the respective revenue category based on variants of equation (4). The dependent variable is the per capita change in the variable reported in the top row relative to 1988. All columns control for federal state-by-year fixed effects. Regressions are heteroscedasticity-weighted based on a modified Breusch-Pagan test. Standard errors are clustered at the commuting zone level. Significance levels: 1% ***, 5% **, 10% *.

Figure A.1: Municipal Budget Shares

A. Revenue Categories

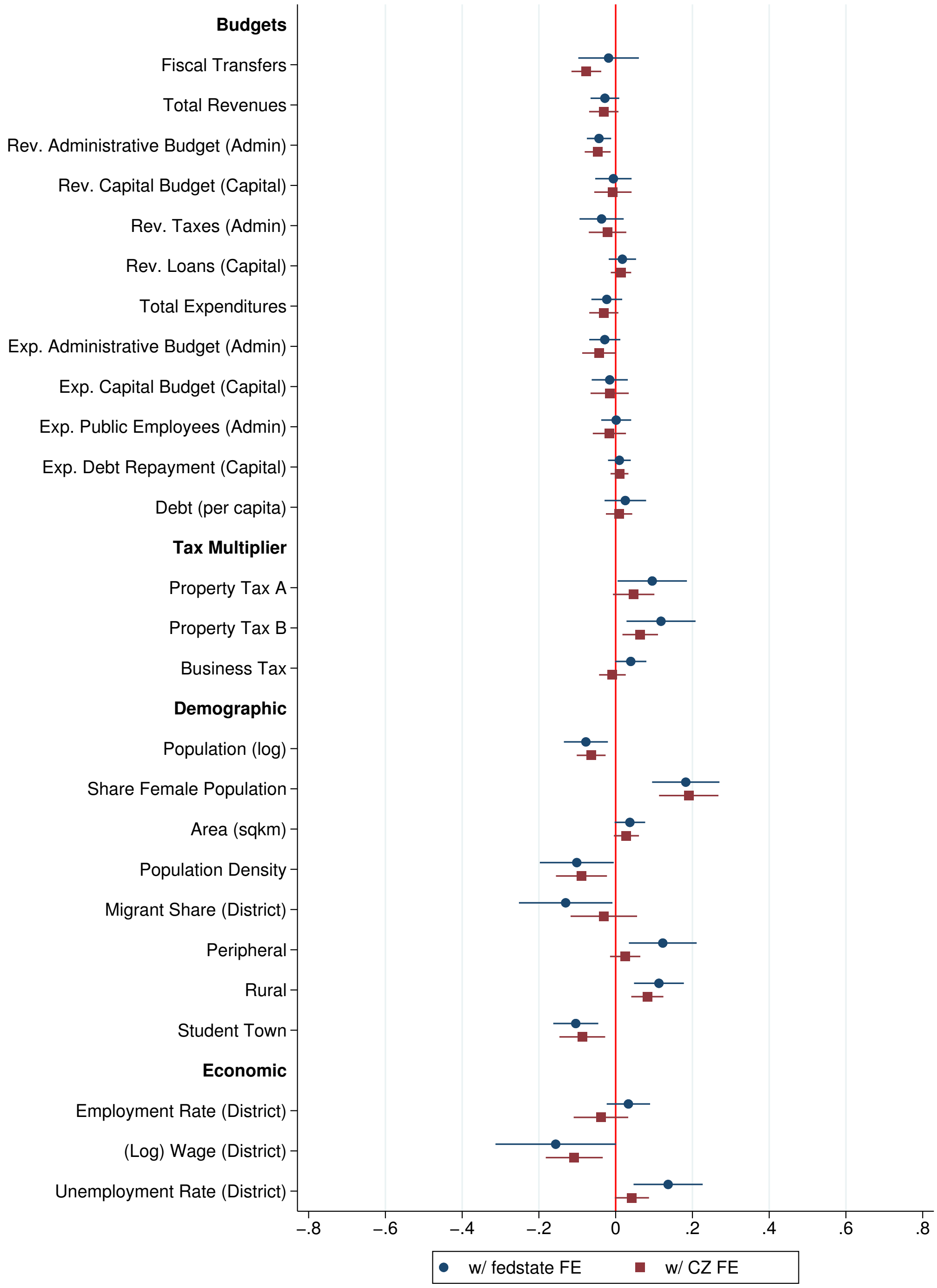


B. Expenditure Categories



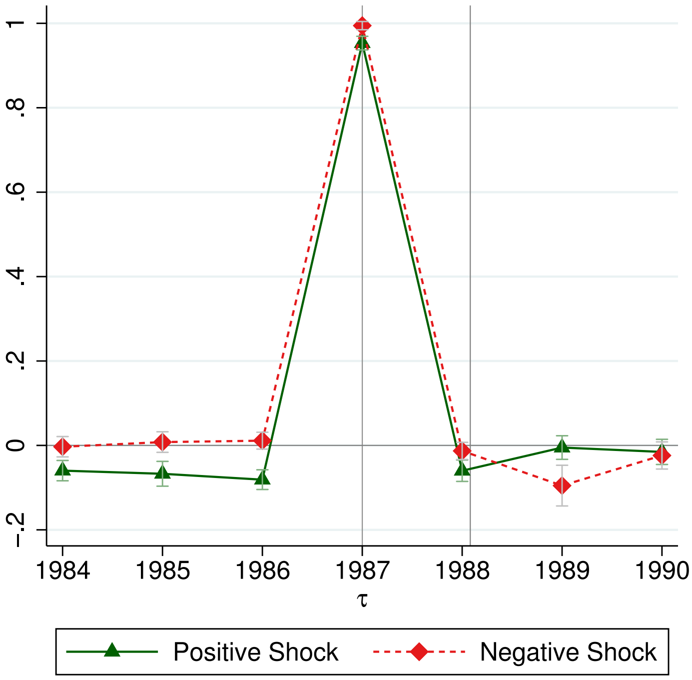
Notes: The figure plots municipal mean budget shares and standard deviations for the main sample in 1986. Panel A reports shares of the various municipal revenue budget categories, separately for the administrative budget and the capital budget, Panel B reports shares of the various municipal expenditure budget categories, separately for the administrative and the capital budget. Mean shares are weighted by municipal population in 1986.

Figure A.2: Census Shock and Pre-Treatment Levels



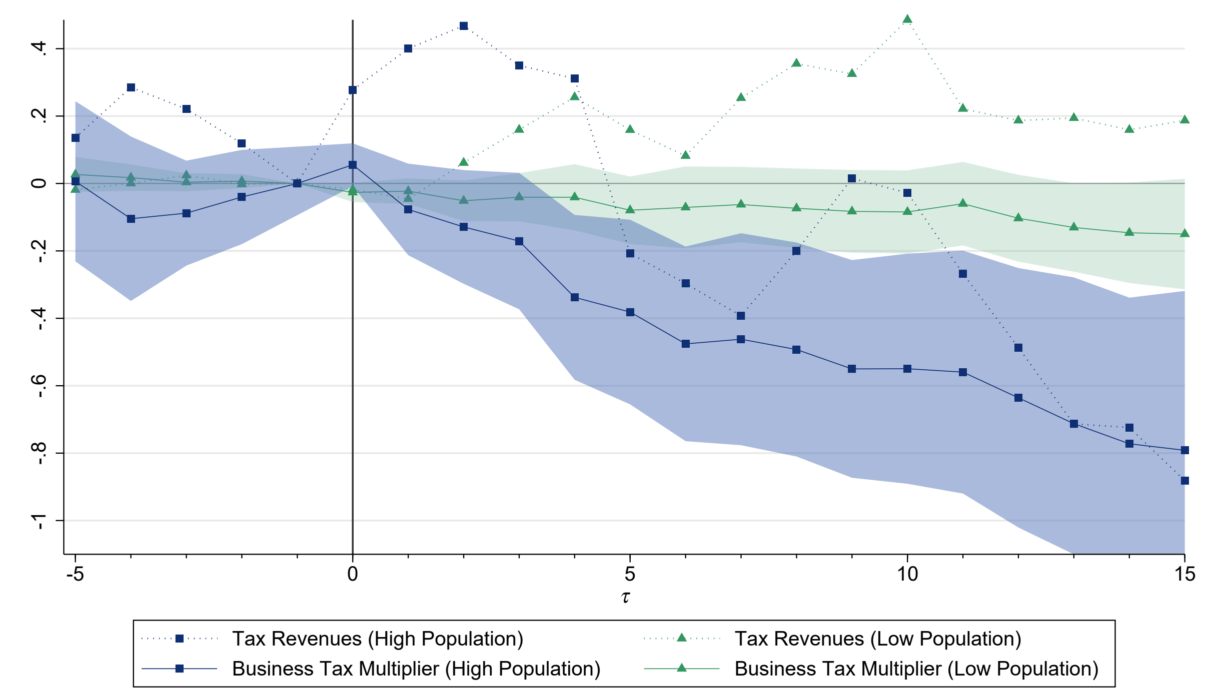
Notes: The Figure reports weighted correlation coefficients between the Census Shock in official population counts and 1986 levels in municipal fiscal, economic and demographic characteristics. Correlations are net of federal state fixed effects (blue dots) or net of commuting zone fixed effects (red dots). The horizontal bars show the 95% confidence interval based on standard errors clustered at the commuting zone level.

Figure A.3: Census Shock and Population Growth



Notes: The figure reports coefficient estimates and 95-percent confidence intervals of the relationship between the Census Shock and population growth based on variants of equation (3). Regressions are heteroscedasticity-weighted.

Figure A.4: Tax Multipliers and Tax Revenue - By Population Level



Notes: The figure plots the estimated effects of the Census Shock on tax revenues (dotted lines) and local tax multipliers (solid lines) for municipalities in the top third of population levels in 1986 (squares) versus the bottom two thirds (triangles). The effects on tax revenues are estimated by two-stage least squares, the effects on local tax multipliers are reduced-form estimates. Regressions are heteroscedasticity-weighted and the areas represent the 90% confidence intervals.

B Robustness

B.1 Demographic and Economic Controls.

In Section 5.3, we showed that the Census Shock does not correlate with fiscal pre-trends, and that its correlations with demographic and economic pre-trends are small. We report five robustness checks to verify that these correlations are indeed negligible for our purposes. First, we control for pre-treatment levels and (three-year) growth rates in (log) population and economic variables (employment rate, unemployment rate and log wage).[68] Second, we control for the Census-induced change in young, middle-aged and old-aged population shares, as one may worry that systematic shifts in the composition affect municipal planning and investments (over and above the Census effect on fiscal transfers, which operates through the population *level*).[69] Third, we add control variables that classify a municipality as urban or rural. In each case, control variables are interacted with year fixed effects to flexibly allow for a differential impact of these variables over time. Fourth, we exclude student towns from the

[68] The data on employment and wages is provided by the institute for employment research, data on the unemployment rate comes from the German federal employment agency.

[69] This specification is estimated excluding observations from BY, for which we do not have population by age group in the relevant time period. Differences in the first stage estimates are driven by this difference in samples.

regression. Lastly, we control for commuting zone x year fixed effects in order to account for potential differential trends at the local labor market level.[70]

Panel A of Figure B.1 presents these robustness tests for our three main outcomes *fiscal transfers*, *total revenues*, and *total expenditures*. For comparison, the figure also includes our baseline estimates, which only control for state-by-year fixed effects (thick black line). All estimates are robust to the inclusion of additional control variables or finer fixed effects. None of the specifications presents a pre-trend, and the post-treatment estimates are very similar to, and not statistically different from, the baseline results. Appendix Figure B.2 presents the effects for all other outcome variables (for brevity, only for event period $\tau = 10$). Again, the estimated coefficients are largely similar to the baseline estimates (dashed grey line). The estimates tend to be more precise when controlling for commuting zone-by-year fixed effects, thus confirming the small positive effects on tax revenues from the main specification.

To further mitigate concerns about selection-on-observables, we complement our baseline approach by presenting inverse-probability weighting (IPW) and regression-adjusted IPW (IPWRA) treatment effects estimators, which necessitates replacing the continuous Census Shock with a binary treatment indicator (above or below median).[71] We first reestimate the baseline specification using this approach, controlling only for federal state fixed effects (by event year). We then consecutively add pre-treatment trends in population, economic outcomes (employment rate, unemployment rate and log wage) and fiscal outcomes. The corresponding results are presented in Panel B of Figure B.1. Our results are robust to these alternative estimators.

B.2 Functional Form and Definition of the Census Shock.

We provide additional robustness checks with respect to the definition of the Census Shock and the functional form of our estimating equation. First, as one may be worried that our Census Shock measure picks up population growth in the first five months of 1987, we create an alternative measure that imputes the January to May population growth. Second, we construct an alternative measure that accounts for non-linearities and discontinuities in the relationship between the Census Shock and fiscal transfers, since the assumed linear relationship in our baseline model represents a simplification of the true function (see Appendix E.1). Third, we include the average Census Shock in the other municipalities in the district, to control for

[70] This specification accounts for any shocks that affect some local labor markets more than others, such as population movements or spatial changes in economic activity.

[71] We estimate first stage and reduced-form regressions of the respective outcome variable on the treatment indicator, separately for each event period. We then use these estimates to infer the implied effects of an increase in fiscal transfers on the respective outcome.

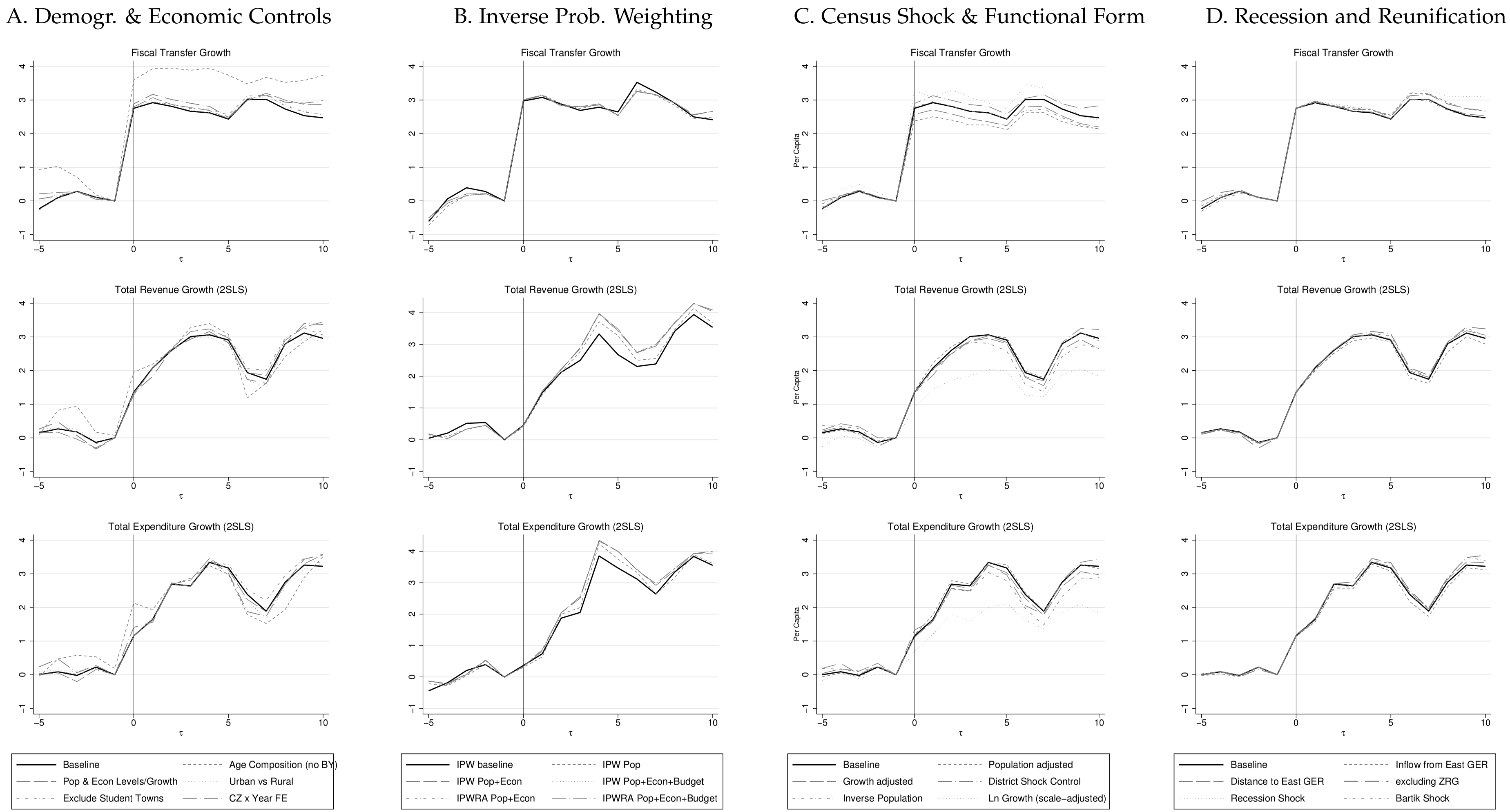
potential spillovers and for fiscal transfers at the next higher level of government.[72] As shown in Figure B.1C and Appendix Figure B.3, the results are robust to these alternative definitions (Appendix E.2 provides further details). Fourth, to address potential bias from using a common denominator, we include its reciprocal $1/Pop_{m,1986}$ interacted with the federal state-by-year fixed effects as a control variable. The results remain very similar. Finally, we estimate a variant of equation (4) in which $\Delta Y_{m,t}$, $\Delta Trans_{m,1989}$ and the Census Shock are defined as log rather than per-capita growth. While the log form misrepresents the true functional relationship (see Appendix E.1) the resulting coefficients, normalized by baseline means, remain similar (see Figure B.1C).

B.3 Reunification and Post-Reunification Recession.

Our analysis period coincides with German reunification in 1990 and the subsequent recession of 1993. To rule out that these events affect the internal validity of our estimates (see Section 5.3), we provide five additional checks. First, to account for the sizable migration flows from East Germany in the wake of German reunification, we control for (municipality-level) distance to the inner-German border or for the actual (district-level) migration flows from East Germany between 1991 and 1994.[73] Second, we exclude so called *Zonenrandgebiete* – municipalities close to the Eastern German border during German division, who benefited from additional transfers until 1994 (Ehrlich and Seidel, 2018). Third, to account for potential correlations with the 1993 recession shock, we control for the 1991 to 1993 change in local unemployment at the district level or for Bartik shocks as a proxy for industry-related local demand shocks. As shown in Figure B.1D, our results are robust to these additional control variables, reflecting that neither local consequences from reunification, nor local recession shocks are correlated with the Census Shock.

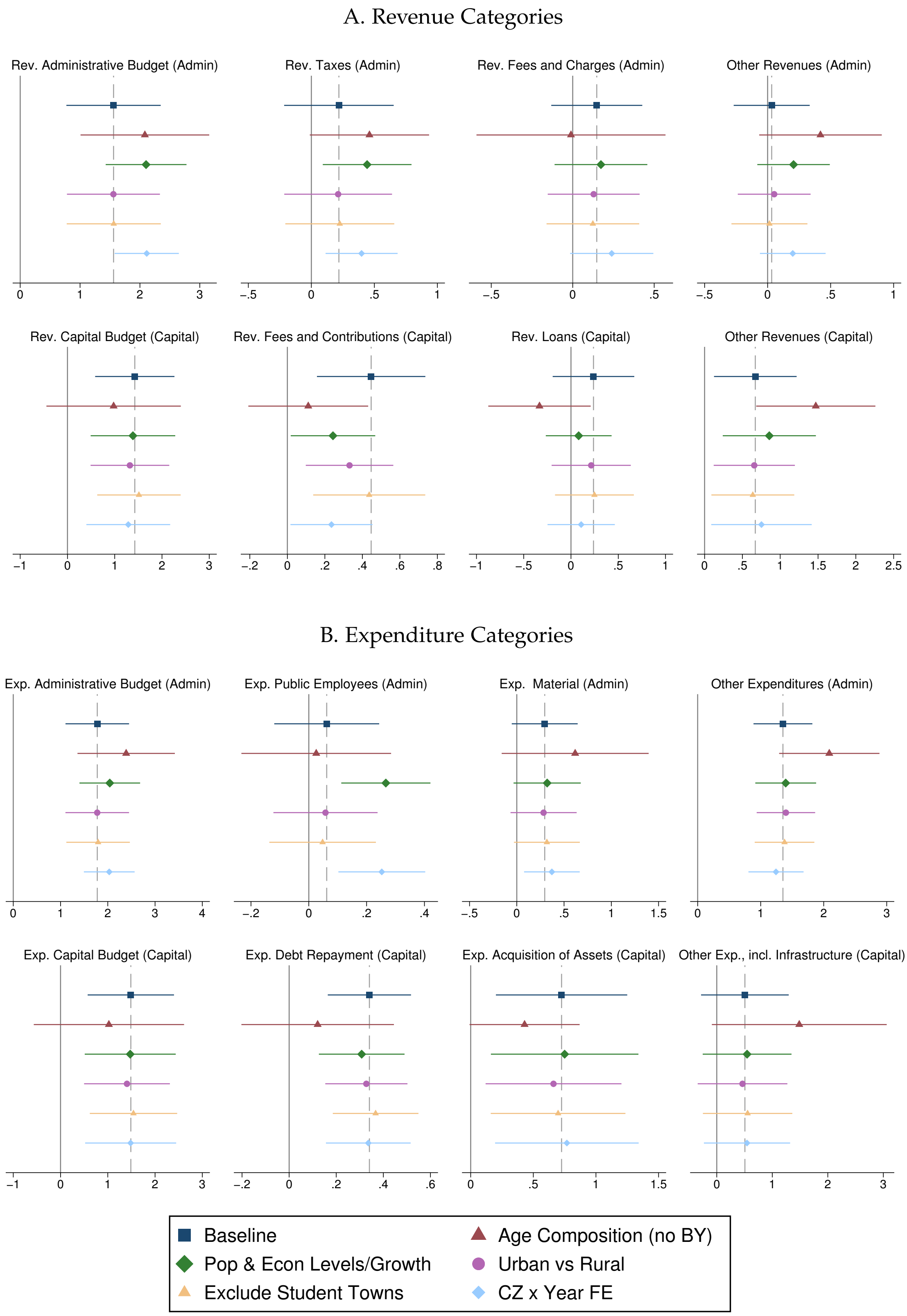
[72] Transfers at the district level do not directly affect municipal budgets, since districts have their own budgets.
[73] We take the 1991 to 1994 shock, as we first observe migration flows in 1991 and as the bulk of the reunification migration shock takes place before 1994.

Figure B.1: Robustness



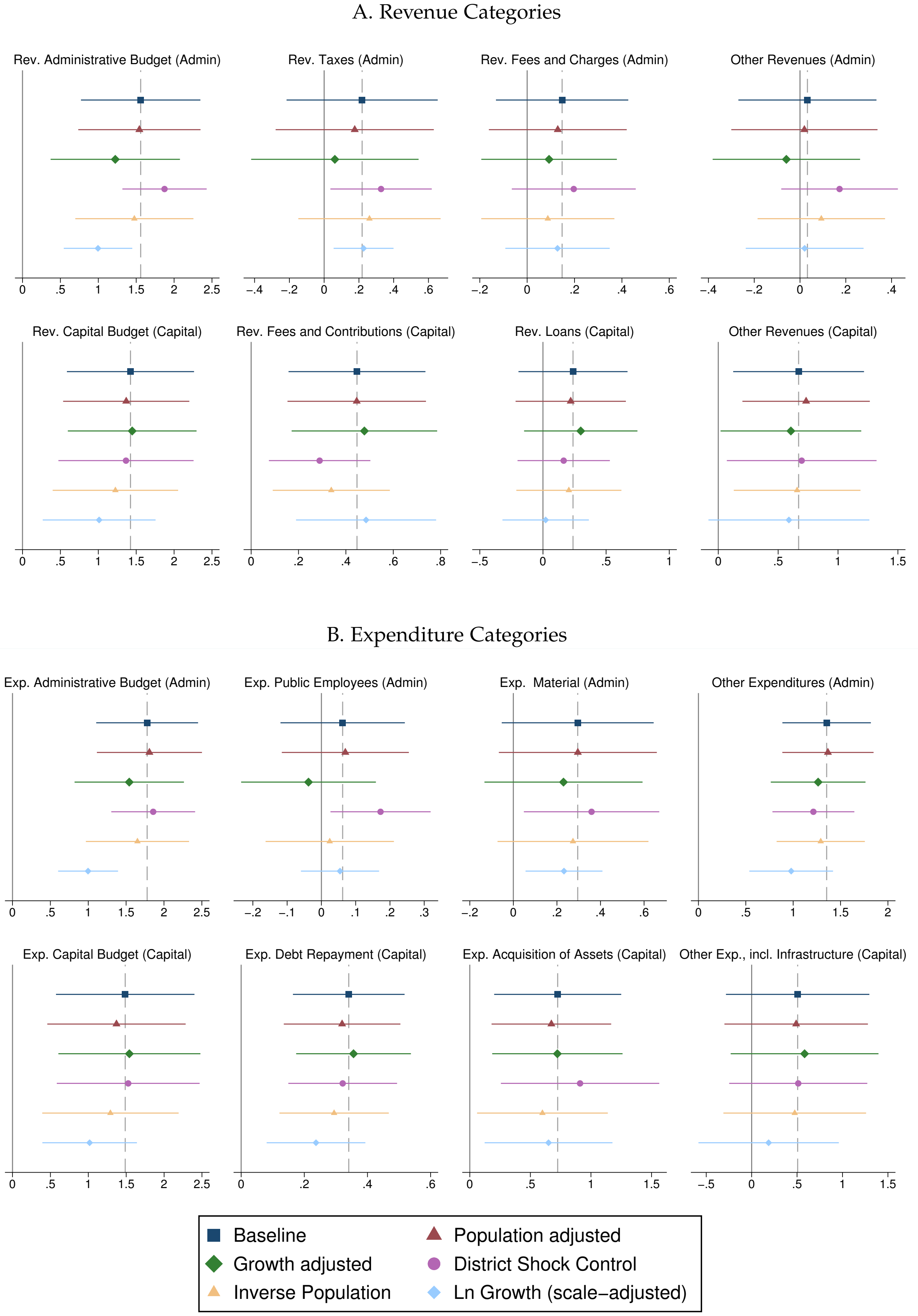
Notes: The figure reports estimates of the effects of the Census Shock on municipal fiscal transfers, revenues and expenditures, and illustrates their robustness to the inclusion of demographic and other controls in Panel A, to using IPW and IPWRA estimators in Panel B, to alternative definitions of the Census Shock in Panel C and to recession and reunification controls in Panel D. The top panels show reduced-form estimates based on variants of equation (3) while the other panels show two-stage least square estimates based on variants of equation (4). Control variables are interacted with event year. The "Age Composition" specification in Panel A does not include observations from BY. In Panel B, treatment is binary (above vs below median) and coefficients represent the 2SLS effects implied from the respective first-stage and reduced-form IPW and IPWRA regressions. To simplify comparisons, the first-stage coefficients are normalized by the average difference in the Census Shock between the two groups. All regressions are heteroscedasticity-weighted.

Figure B.2: Robustness I - Demographic and Economic Control Variables



Notes: The figure reports two-stage least squares estimates and 95% confidence intervals of the effects of an increase in municipal fiscal transfers on revenue and expenditure growth in event period $\tau = 10$ based on variants of equation (4). Regressions are heteroscedasticity-weighted.

Figure B.3: Robustness II - Census Shock Definition



Notes: The figure reports two-stage least squares estimates and 95% confidence intervals of the effects of an increase in municipal fiscal transfers on revenue and expenditure growth in event period $\tau = 10$ based on variants of equation (4). Regressions are heteroscedasticity-weighted.

C Supplemental Empirical Analysis

C.1 Fiscal Transfers and Local Conditions: Additional Evidence

In this section, we provide additional evidence on how the response to fiscal transfers varies with local demographic, economic and fiscal conditions. We allow for a non-linear effect by estimating a variant of equation (4) in which we interact the change in fiscal transfers with a restricted cubic spline with four knots of the respective variable (located at the 5th, 35th, 65th and 95th percentile). Specifically we estimate the following specification separately for two two-year periods representing the short ($\tau = 0, 1$) and the long-run response ($\tau = 9, 10$),

$$\Delta Y_{m,t} = \alpha_{s,t} + \gamma_t \Delta Trans_{m,1989} + \sum_{j=1}^{3} \gamma_t^j \Delta Trans_{m,1989} \times Spline_m^j + \sum_{j=1}^{3} \omega_t^j Spline_m^j + \epsilon_{m,t}, \quad \text{(C.1)}$$

where $Spline_m^j$ represents the restricted cubic spline variables and we instrument $\Delta Trans_{m,1989} \times Spline_m^j$ with the interaction between the Census Shock and the splines. This method allows the response of municipal budgets to vary smoothly with baseline characteristics while taking heterogeneities in the first stage into account.

We focus on heterogeneities along three dimensions: population unemployment and debt levels. The complete set of results are presented in Figures C.1 to C.3. In each of the figures we overlay the effect (and confidence interval) in period $\tau = 0, 1$ (orange) with the effect in $\tau = 9, 10$ (blue). This allows us to focus on the long-run effects while still being able to detect stark differences between the short- and long-run response.

We first analyze whether the fiscal response varies with respect to local population levels (measured in 1986). Figure C.1A shows that the Census Shock impacts transfers more in large municipalities. This result is expected, as Germany's fiscal equalization scheme assumes a higher per-capita "fiscal need" – and puts a higher weighting factor – on each inhabitant in larger municipalities (see Appendix E.1).[74] The long-run multiplier in revenues and expenditures is however smaller in larger municipalities. This is partially driven by lower investments into infrastructure (Figure C.1D, fourth panel), which in turn leads to lower revenues from fees and contributions (Figure C.1C, third panel). More importantly, it is driven by the stronger reduction in tax multipliers in larger municipalities (Figure C.1D). As a consequence, large municipalities experience declining tax revenues after a positive transfer shock (Figure C.1B, first panel).

We next study whether the fiscal response varies with respect to the local unemployment

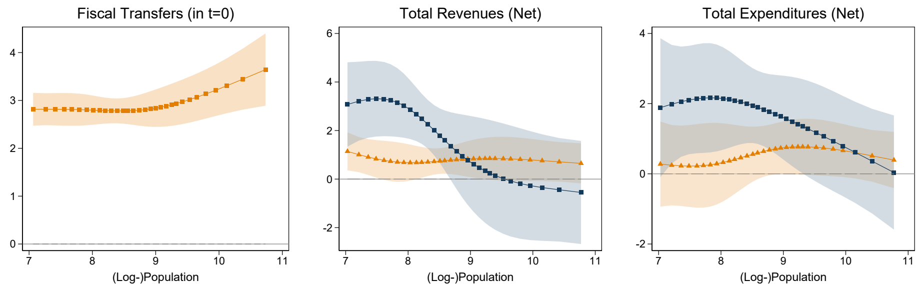
[74] Note that our 2SLS estimates take such non-linearities into account, as also the Census Shock is allowed to vary with population.

rate. As illustrated in Figure C.2A, the Census Shock has a stronger effect on fiscal transfers in municipalities with high unemployment (measured as the average rate at the district level between 1986 and 1988). This is expected, as the equalization formulas depend on the local unemployment rate in some states. We observe more pronounced non-linearities in total revenues and expenditures: fiscal transfers increase total revenues and expenditures in municipalities with low unemployment, but do not expand spending much in municipalities with high unemployment. This contrast is driven by differences in how municipalities use the additional transfers. Municipalities with favorable economic conditions invest most of the additional funds into assets or infrastructure (see Figure C.2C, fourth panel) – amplified by an increase in the take-up of loans (Figure C.2B, fourth panel). Municipalities with high unemployment instead reduce the tax multipliers, in particular the business tax multiplier (see Figure C.2D). Given that local capital taxation has strong effects on the tax base (Buettner, 2003), this reduction of the business tax may reflect an attempt to attract business, to increase labor demand and reduce unemployment.

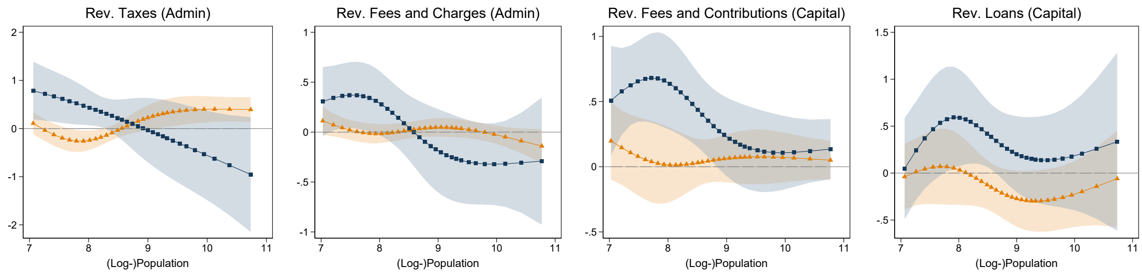
Figure C.3 presents variation in the fiscal response with respect to the pre-treatment local debt level, expressed as a share of total revenues. Because standard errors are very large below a debt share of 20 percent, we focus on the estimated effects above that level. We do not observe strong heterogeneities in the effects of the Census Shock on fiscal transfers. The short-run effect on total revenues is similar, but the long-run multiplier is larger among municipalities with low debt levels. Again, municipalities with higher debt level seem to invest less into infrastructure (Figure C.3C, right panel) and instead reduce their tax multipliers (Figure C.3D). This response seems intuitive given that tax multipliers and debt levels are positively correlated across municipalities —- municipalities may have to raise local taxes to serve the debt, but the receipt of additional transfers would alleviate that constraint.

Figure C.1: Response Heterogeneity by Population

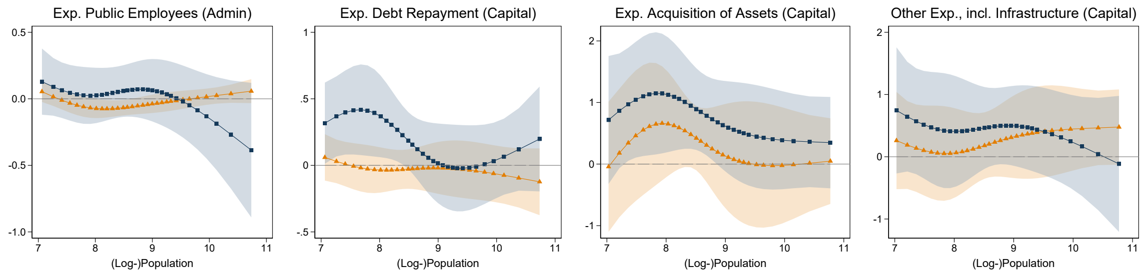
A. Transfers, Total Revenues and Expenditures



B. Other Revenue Categories



C. Other Expenditure Categories

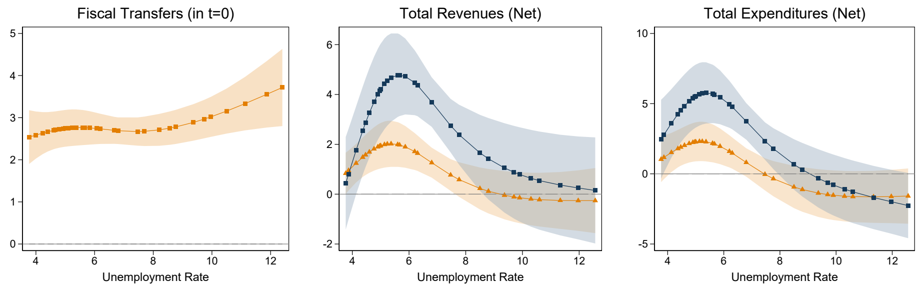


D. Tax Multipliers

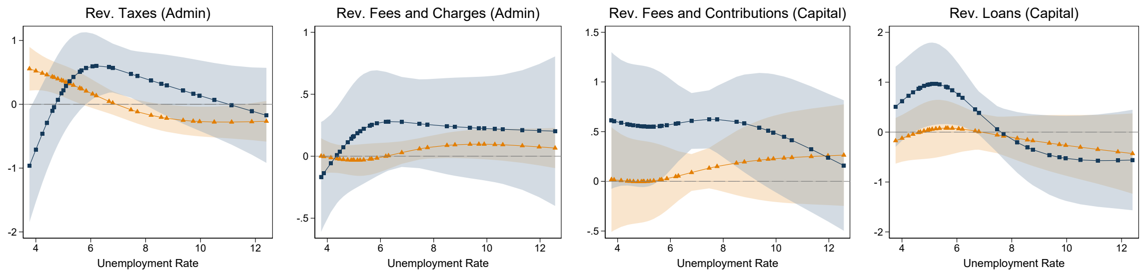
Notes: Variation in the estimated municipal response with respect to the population level (measured as share of total revenues). All estimates except the ones in Panel A, first panel, are from two-stage least squares regressions based on equation (C.1) in which the change in fiscal transfers in 1989 is interacted with a restricted cubic spline with 4 knots in the local population level (at the 5th, 35th, 65th and 95th percentile). The estimates in Panel A, first panel, report the corresponding first-stage estimates. The local population level is measured pre-Census in 1986. In each of the figures we overlay the effect in period $\tau = 0, 1$ (orange triangles) with the effect in $\tau = 9, 10$ (blue squares). The triangles and squares represent marginal effects measured at each 3rd percentile between the 5th and the 95th percentile of the distribution. The orange and blue area represent 90% confidence intervals clustered at the commuting zone level.

Figure C.2: Response Heterogeneity by Unemployment Rate

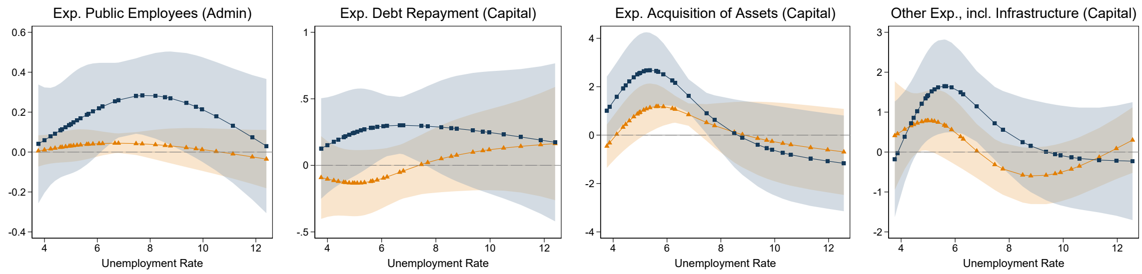
A. Transfers, Total Revenues and Expenditures



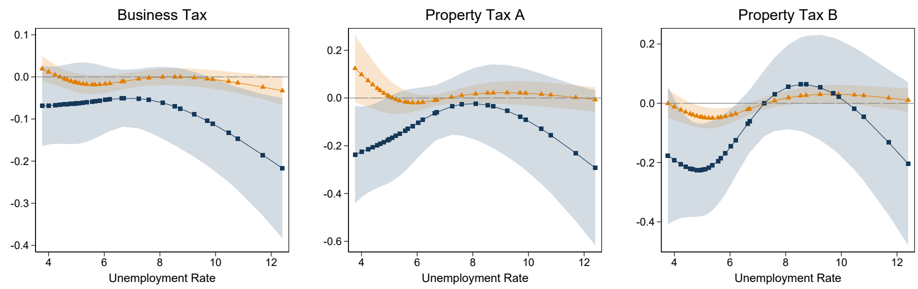
B. Other Revenue Categories



C. Other Expenditure Categories

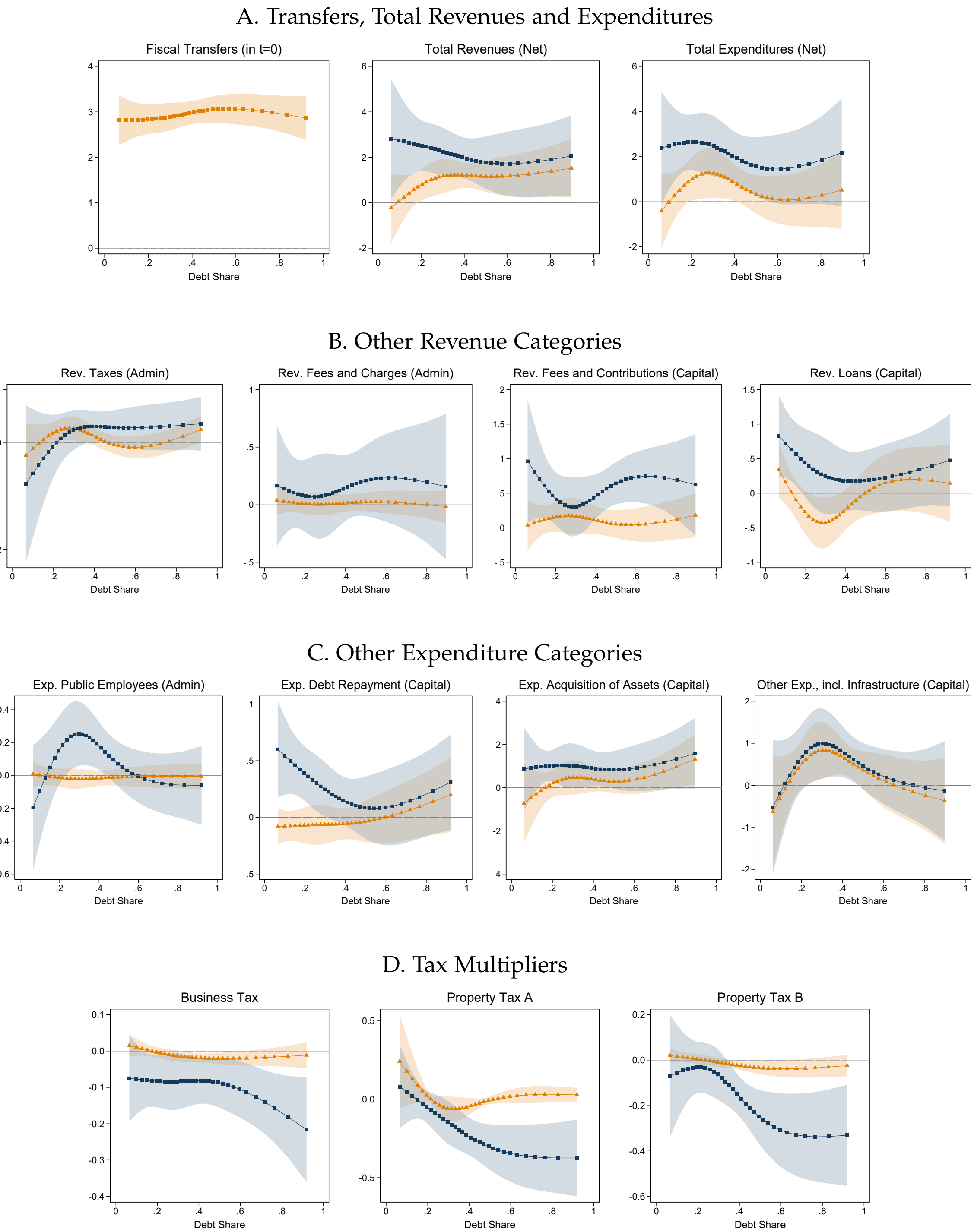


D. Tax Multipliers



Notes: Variation in the estimated municipal response with respect to the unemployment rate (measured at the district level). All estimates except the ones in Panel A, first panel, are from two-stage least squares regressions based on equation (C.1) in which the change in fiscal transfers in 1989 is interacted with a restricted cubic spline with 4 knots in the local unemployment rate (at the 5th, 35th, 65th and 95th percentile). The estimates in Panel A, first panel, report the corresponding first-stage estimates. The local unemployment rate is measured as the pre-treatment average between 1986 and 1988. In each of the figures we overlay the effect in period $\tau = 0, 1$ (orange triangles) with the effect in $\tau = 9, 10$ (blue squares). The triangles and squares represent marginal effects between the 5th and the 95th percentile of the distribution. The orange and blue area represent 90% confidence intervals clustered at the commuting zone level.

Figure C.3: Response Heterogeneity by Debt Share



Notes: Variation in the estimated municipal response with respect to the debt level (as share of total revenues). All estimates except the ones in Panel A, first panel, are from two-stage least squares regressions based on equation (C.1) in which the change in fiscal transfers in 1989 is interacted with a restricted cubic spline with 4 knots in the local debt level (at the 5th, 35th, 65th and 95th percentile). The estimates in Panel A, first panel, report the corresponding first-stage estimates. The local debt level is measured as the pre-treatment average between 1986 and 1988. In each of the figures we overlay the effect in period $\tau = 0, 1$ (orange triangles) with the effect in $\tau = 9, 10$ (blue squares). The triangles and squares represent marginal effects between the 5th and the 95th percentile of the distribution. The orange and blue area represent 90% confidence intervals clustered at the commuting zone level.

D Recession and Municipal Budgets

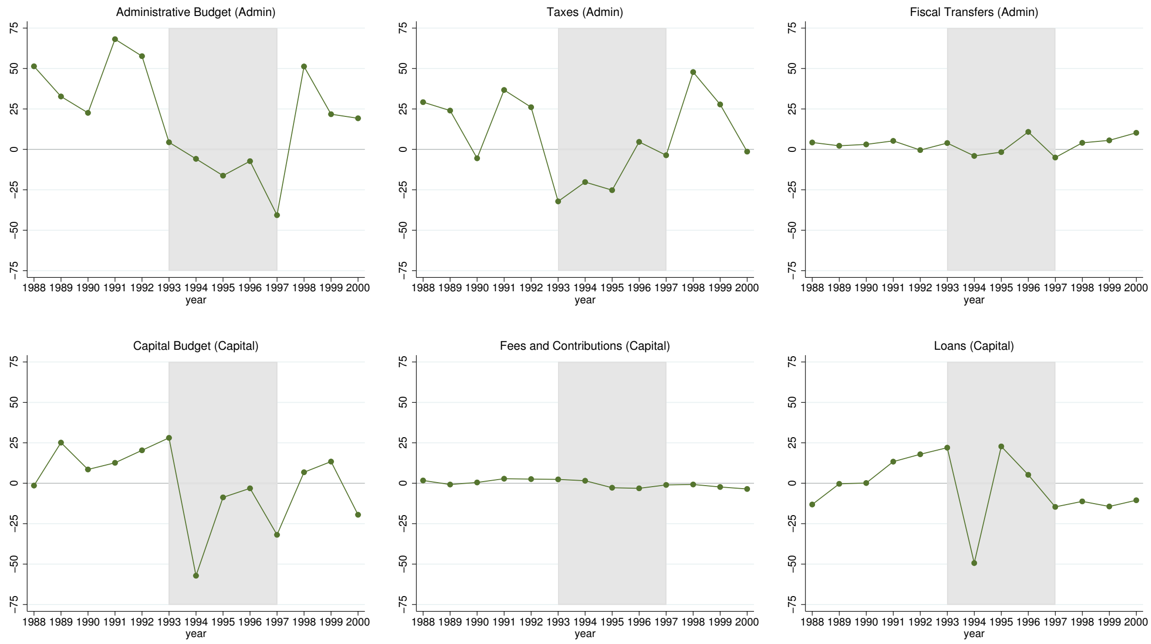
Municipal revenues are more sensitive to cyclical fluctuations than revenues from higher levels of government (Broer 2003). For the interpretation of our results it is therefore important to understand the staggered impact of Germany's post-reunification recession, which started in 1993. Because the Census Shock is as good as random with respect to local characteristics (see Section 5.3), it is unlikely to be correlated with the local severity of the recession. While the recession is thus not a plausible threat for the internal validity of our estimates, it will affect their interpretation. First, the recession will mechanically reduce fiscal revenues and expenditures per inhabitant, thereby also reducing the effect of a Census Shock in population counts on revenues and expenditures. Second, the recession may not only reduce the level but also the distribution of expenditures. For example, municipalities might decide to scale back investments. Such reallocations might also apply to those parts of municipal revenues that originate from the Census Shock and thus affect the multiplier.

To illustrate the timing of these effects, Panel A of Figure D.1 plots the average absolute growth rate of per-capita revenues in our sampled federal states over time. After a steady period of growth, revenues in the administrative and capital budgets stall in 1993, and decline in the following years. The response is staggered because different components decline at different times. Tax revenues drop already in 1993, the year of the recession and continue to decline for several years thereafter, while the take-up of loans continues to grow in 1993, before falling strongly in 1994. The reactions in fiscal transfers and revenues from fees and contributions are only small and do not contribute substantially to the overall drop in revenues. Other sources of revenues decline only from 1994 onwards.

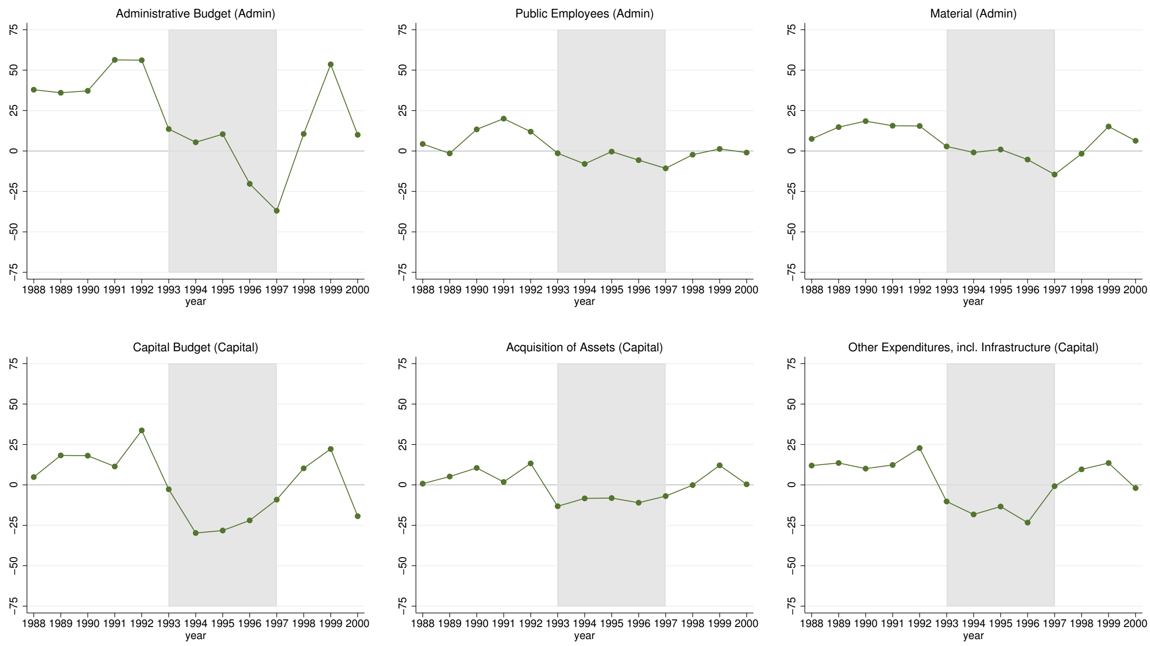
Panel B of Figure D.1 plots the average absolute growth rate of per-capita spending and its sub-categories over time. In line with revenues, the adjustment in expenditures is staggered over multiple years. Administrative budget expenditures only react delayed, with expenditures for personal stalling at pre-recession levels and expenditures for material only declining in the recession aftermath in 1996 and 1997. Instead, the capital budget reacts strongly, with investments into assets and infrastructure dropping considerably over a five-year period between 1993 and 1997. While economic growth recovers more quickly, municipal revenue and spending continue to fall, improving only from 1998 onwards. The impact of the recession on municipal budgets is therefore felt from 1993 to at least 1997, corresponding to event periods $\tau = \{4, 5, 6, 7, 8\}$.

Figure D.1: The Effect of the 1993 Recession on Municipal Budgets

A. Revenues



B. Expenditures



Notes: The figure plots the average absolute growth rate of per-capita revenues and expenditures over the years 1988 to 2000. *Acquistion of Asssets* and *Other Expenditures* missing for HE.

E Fiscal Transfers and Census Shock Definition

E.1 Determinants of Municipal Fiscal Transfers

In this section, we describe in more detail how fiscal transfers within the municipal fiscal equalization scheme are distributed. As mentioned in Section 4.3, the bulk of transfers is distributed according to a fixed spending formula (*Schlï¿œsselzuweisung*). The calculation of these transfers depends on four main factors: The amount of revenues to be distributed (*Schlï¿œsselmasse*), the compensation rate (a_s), the municipality's fiscal need ($Need_{m,t}$), and the municipality's fiscal capacity ($Capacity_{m,t}$). The amount of revenues to be distributed, and therefore the compensation rate a_s, varies across federal states. For example, in 1988, the compensation rate was 0.55 in BY, while it was 1 in NRW.

A municipality receives transfers according to the fixed spending formula if the municipality's fiscal need is larger than its fiscal capacity. If a municipality's fiscal capacity instead is higher than its fiscal need, the municipality will not receive any transfers, but does not have to make payments either. This implies that

$$Transfers_{m,t} = max\left\{a_s \cdot (Need_{m,t} - Capacity_{m,t}), 0\right\}. \tag{E.1}$$

Fiscal capacity is determined by the tax base of the local business tax (calculated by applying a hypothetical statewide tax rate) and other revenue sources (mainly the local share of the statewide income tax revenue). In contrast, the main determinant of fiscal need is the official population count.

More specifically, fiscal need is calculated as the product of a base amount $Base_{s,t}$ and weights $w_{s,t} = w_{s,t}(Pop_{m,t-2})$, which themselves depend on population size, such that:[75]

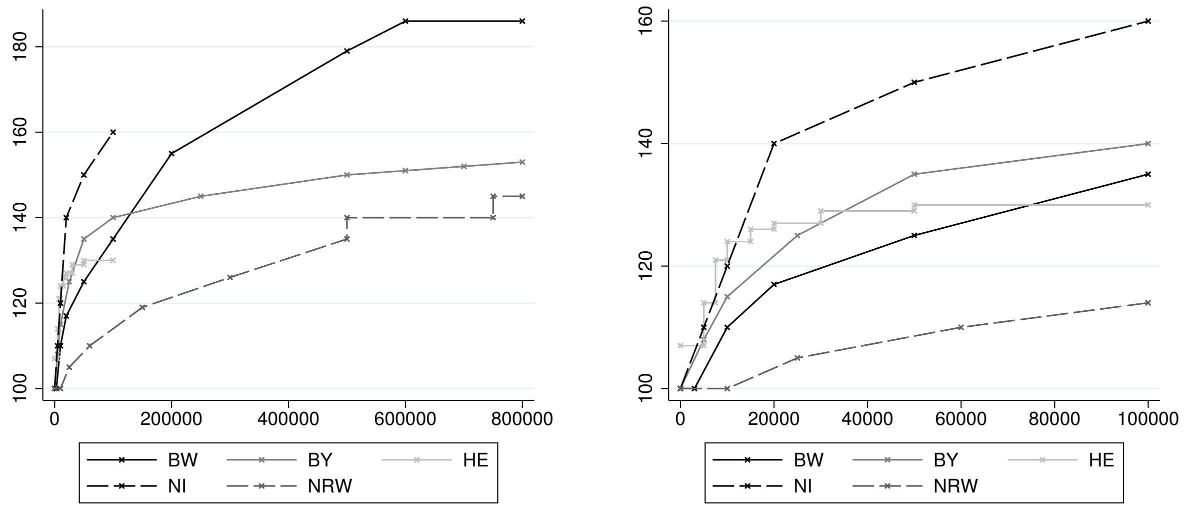
$$Need_{m,t} = Base_{s,t} \cdot w_{s,t}(Pop_{m,t-2}) \cdot Pop_{m,t-2}. \tag{E.2}$$

The base amount $Base_{s,t}$ is endogenously set such that the full *Schlï¿œsselmasse* will be spent amongst the municipalities. Population size enters with a 2-year lag in the calculation of fiscal needs. The weights $w_{s,t}$ increase in population as larger municipalities are assumed to have a higher per-capita fiscal need than smaller municipalities, partly because they may function as

[75] The formula in (E.2) is a simplification of the actual formula, which takes other factors into account. For example, municipalities in BY that were close to the former East German or Czechoslovakian border received a weight that was 10 percentage points higher (until 1999), while transfers in NRW also depend on the number of school pupils and unemployed. Further, in most federal states independent cities receive additional transfers. Population size is however by far the most important determinant of fiscal needs, and these other factors will not be affected by the Census Shock, as they do not depend on official population counts (e.g. the number of school pupils is taken from school registers).

Figure E1: Population Weights

A. All Thresholds B. Thresholds ≤ 100000



Notes: The figure plots the population weights used to calculate a municipality's fiscal need within the municipal fiscal equalization scheme for the year 1986.

a center for surrounding communities. For example, in Bavaria the weight for a municipality with 5,000 inhabitants is 108%, while for a municipality with 25,000 inhabitants each person is weighted at 125%. The specific weighting function varies across federal states, as shown in Figure E1, and contains discontinuities Hessia and Lower Saxony (see also Baskaran, 2016).

The Census Shock has therefore a direct and linear effect on fiscal transfers via the change in official population counts $\Delta Pop_{m,t-2}$, and an additional non-linear effect via the implied change in weights $\Delta w_{s,t}(Pop_{m,t-2})$. Given (E.1) and (E.2), and ignoring the zero lower bound in equation (E.1), the per-capita change in fiscal transfers triggered by a change in official population counts equals therefore

$$\frac{\Delta Transfers_{m,t}}{Pop_{m,t-2}} = a_s Base_{s,t}\left[w_{s,t}\frac{\Delta Pop_{m,t-2}}{Pop_{m,t-2}} + \Delta w_{s,t} + \Delta w_{s,t}\frac{\Delta Pop_{m,t-2}}{Pop_{m,t-2}} \right]. \tag{E.3}$$

Because the weighting functions are known, both the linear and non-linear components in square brackets can be calculated. However, the weighting function $w_{s,t}$ has only a minor effect on the overall impact of the Census. First, while the effect of the percentage change in population in the first term in the square brackets is scaled by $w_{s,t}$, this matters little in practice. The mean absolute value of the scaled and unscaled population growth is nearly the same, and the correlation between the two variables is greater than 0.99. Second, the indirect effect from the change in weights $\Delta w_{s,t} = \Delta w_{s,t}(Pop_{m,t-2})$ in the second term in square brackets is negligible. For the federal states included in our analysis, this term contributes less than five percent to the size of the overall shock in transfers – the mean absolute value of $\frac{\Delta Pop_{m,t-2}}{Pop_{m,t-2}}$ is 2.78 percent compared to 0.16 percent for $\Delta w_{s,t}$. Because the weights $w_{s,t}$ play such a negligible role, we simplify equation (E.3) to the definition of the Census Shock given in our main text in equation (1). We confirm in Appendix B that this has very little consequences for our coefficient estimates.

E.2 Definition of the Census Shock

As described in Section 4.2, we define the Census Shock as the percentage difference between population counts on Census day (May 21, 1987) and the last observed register based counts (December 31, 1986). In this section, we provide two alternative Census Shock definitions and test whether our results are robust to these definitions.

First, while our Census Shock definition accounts for population growth from June to December of 1987, one may still be worried that our Census Shock measure picks up population growth in the first 5 months (January to May). To account for this, we impute population growth from January to May of 1987 based on the assumption that average monthly population growth in this period is the same as average monthly population growth from June to December 1987. We then create an alternative Census Shock measure that abstracts from population growth in the first 5 months by deducting the imputed population growth from the original measure.

Second, as described in Appendix E.1, the assumed linear relation between the Census Shock and fiscal transfers in our baseline model represents a simplification of the actual functional relationship. In particular, the weight of each additional person in the fixed spending formula to determine fiscal transfers tends to increase with population size (see Figure E1). We construct an alternative measure of the Census Shock that accounts for this non-linearity by incorporating the state-specific functions that determine the population weights used to calculate *fiscal needs*. We then reweight both the population counts on Census day and the last observed register based counts according to these weights w_s, i.e.,

$$\begin{aligned} CensShock_{m,s} &= log\left[w_s(Pop_{i,1987,census}) \cdot Pop_{m,1987,census}\right] - \\ &\quad\; log\left[w_s(Pop_{i,1986,register}) \cdot Pop_{m,1986,register}\right]. \end{aligned}$$

Third, there are also fiscal transfers at the next higher level of government (the district level) that depend on local population counts and are consequently affected by the Census Shock. In principle, these transfers at the district level should not directly affect municipal budgets, as districts have their own budgets. One may worry however, that there are nevertheless spillovers across municipalities within a district. For that reason we provide an additional robustness check estimating a specification where we control for the weighted average Census Shock in the other municipalities in the district. That is, we control for

$$CensShock_m^{district} = \sum_{j \in District \setminus m} w_j^{pop} CensShock_j,$$

where $CensShock_j$ is defined as in equation (1) and $w_j^{pop} = \frac{Pop_{j,1986}}{\sum_{k \in District \setminus m} Pop_{k,1986}}$ are population weights.

For our main outcome variables we present again estimates over the whole analysis period (see Figure B.1D-F), while we only report the effect in $\tau = 10$ for the other revenue and expenditure categories (Figure B.3). The estimated coefficients adjusting for population growth from January to May (long dashed line) are slightly smaller than the baseline results (thick black line), but largely similar and not statistically different. When accounting for non-linearities in the relationship between the Census Shock and fiscal transfers (EWR, short dashed line), the first stage becomes slightly smaller. As we describe in Appendix E.1, that result is expected because the weight of each person in the "fiscal needs" formula tends to increase in population size. As such, our original Census Shock measure understates the population weighted Census Shock, which implies that the former should yield a larger first-stage coefficient than the latter. However, the 2SLS estimates in Figure B.1e and B.1f remain virtually unchanged, suggesting that our decision to estimate a linear relationship does not introduce any bias. Intuitively, the population weights can be explicitly integrated into the definition of the Census Shock or picked up implicitly by the first-stage coefficients (our baseline choice). Lastly, the results are also largely robust to controlling for the average Census Shock in the other municipalities in the district. If at all, this specification slightly increases precision. Interestingly, these results largely mirror the estimated effects from the specification controlling for CZ x Year FE (see Figure B.2), confirming the indicative evidence for small positive effects on tax revenues, public employment and material expenses from the main specification.

F A Model of Tax Competition

We consider a standard model of tax competition in which the government in municipality i maximizes the quasi-linear utility of a representative household,

$$u_i = c_i + \alpha_i v(z_i), \ v' > 0, v'' < 0,$$

where c_i is private and z_i public consumption. Municipal revenues depend on the tax rate t_i, the tax base k_i and fiscal grants g_i, such that $z_i = t_i k_i + g_i$. As shown by Buettner (2006), the optimal tax rate in such a model is determined by a familiar first order condition that equates the marginal benefit from public consumption with the marginal cost of raising public funds,

$$\alpha_i v' (t_i k_i + g_i) = \frac{1}{1 + \frac{\partial k_i / k_i}{\partial t_i} t_i}, \tag{F.1}$$

where $\frac{\partial k_i / k_i}{\partial t_i}$ represents the semi-elasticity of the tax base with respect to the tax rate. The marginal costs thus consist of direct costs from shifting private to public consumption, and indirect costs related to the negative effect of taxes on the tax base ($\frac{\partial k_i / k_i}{\partial t_i} \leq 0$).[76]

How do fiscal transfers affect tax setting? Given the concavity of v, fiscal transfers g_i decrease the marginal benefit from public consumption $v'(z_i)$. To restore optimality, the tax rate t_i must decrease ($\frac{\partial t_i}{\partial g} < 0$). The intuition is that the representative household trades off private and public consumption, so shocks in municipal revenues increase private consumption via a reduction in taxes (see Section **??**). However, the optimal reduction in t_i is greater when tax changes trigger only small adjustments in the tax base ($\frac{\partial k_i / k_i}{\partial t_i} \to 0$) as compared to when competition for the tax base is strong ($\frac{\partial k_i / k_i}{\partial t_i} \ll 0$). When tax competition becomes more severe, a municipality becomes more concerned about retaining its tax base (indirect costs of raising public funds) and less concerned about the trade-off between private and public consumption (direct costs). The tax response to fiscal grants should therefore be weaker if tax competition is more severe.

[76] As noted in Section 4.3, a municipality's tax base (*fiscal capacity*) in turn affects transfers within Germany's equalization scheme. The negative effect of tax hikes on the tax base is therefore partially offset by an increase in fiscal transfers (Buettner 2006, Egger et al. 2010).