Online Appendix for "Behavioral Responses to Wealth Taxes: Evidence from Switzerland"

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Appendix A: Cross-canton analysis

A.1. Cross-canton data

Data on aggregate *taxable wealth* by canton are taken from the 'Gesamtschweizerische Vermögensstatistik der natürlichen Personen' (Swiss Federal Tax Administration, 2018a) . These data report the number of taxpayers as well as aggregate taxable wealth per canton and year in 11 different brackets of taxable net wealth (CHF 0, 1 - 50k, 51 - 100k, 101 - 200k, 201k - 500k, 501k - 1,000k, 1,001k - 2,000k, 2,001k - 5,000k, 5,001k - 10,000k, over 10,000k). We use the sum over the 11 wealth brackets as our main dependent variable.

Data for *tax rates* are taken from the publication 'Steuerbelastung in den Gemeinden' (Swiss Federal Tax Administration, 2018b). These data report average tax rates (cantonal, municipal and parish) on wealth and income for 3 types of taxpayers (unmarried taxpayers without children, married couples without children, married couples with 2 children), 20 wealth levels (CHF 20k, 25k, 30k, 40k, 50k, 75k, 80k, 100k, 150k, 200k, 250k, 300k, 400k, 500k, 600k, 800k, 1,000k, 2,000k, 5,000k, 10,000k) or 8 income levels (6k, 10k, 20k, 50k, 100k, 200k, 500k, 1,000k), respectively, for a sample of municipalities. Parchet (2019a,b) has completed these data to cover all municipalities, allowing us to work with the universe of municipalities within each canton. Parish tax rates are taken to be those of the dominant religious denomination in the municipality. We first aggregate the combined municipal average tax rates to the level of the canton by calculating averages of the municipal rates, weighted by the number of taxpayers per municipality. We then approximate marginal tax rates on wealth by calculating finite differences of the implied tax payments at the observed levels of wealth. We proceed analogously for income tax rates. We use the resulting top marginal wealth tax rate as our main explanatory variable. Figure A1 shows a map with the values in 2015 and Figure A2 the evolution over time in all cantons.

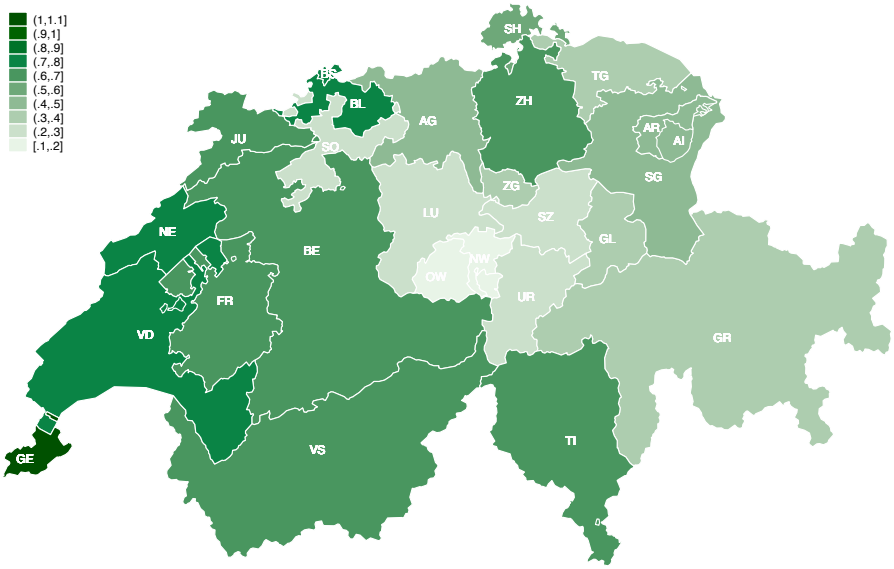
Data for *bequest taxes* are taken from the publication 'Steuerbelastung in den Kantonshauptorten' (Swiss Federal Tax Administration, 2018c). We take statutory rates on an inheritance of CHF 500,000 by a direct descendant. This measure has been found to be highly correlated with a broader weighted average of statutory bequest tax rates across multiple bequest sizes and heir types (Brülhart and Parchet, 2014a,b).

In our estimations, we do not take account of *real estate taxation*, even though three such taxes exist in Switzerland: real estate transfer taxes, real estate capital gains taxes, and annual taxes on the value of real estate and land. However, within our sample period there was minimal panel variation in all three types of taxes at the cantonal level. One significant change was that the real estate transfer tax was abolished in three cantons (Zurich in 2005, Schwyz in 2009, Solothurn in 2011). We have explored the implication of adding a dummy variable for the existence of this tax and found it to have no discernible impact on our results.

Another substantial change occurred in the canton of Schwyz, where the real estate capital gains tax was lowered substantially. Apart from this reform, there were no changes in legislation, and all variation that there may have been was due to cantonal and municipal tax multipliers. We therefore do not control for this tax.

There are annual real estate and land taxes. Seven cantons (Zurich, Schwyz, Glarus, Zug, Solothurn, Basel-Land, Aargau) did not use this tax throughout our sample period. In the

Figure A1: Top marginal wealth tax rates across Swiss cantons, 2015



Notes: Marginal tax rate on wealth > CHF 5m, in percent. Tax rates are consolidated across municipal and cantonal levels, with municipal rates calculated as averages across each canton's municipalities weighted by the number of taxpayers.

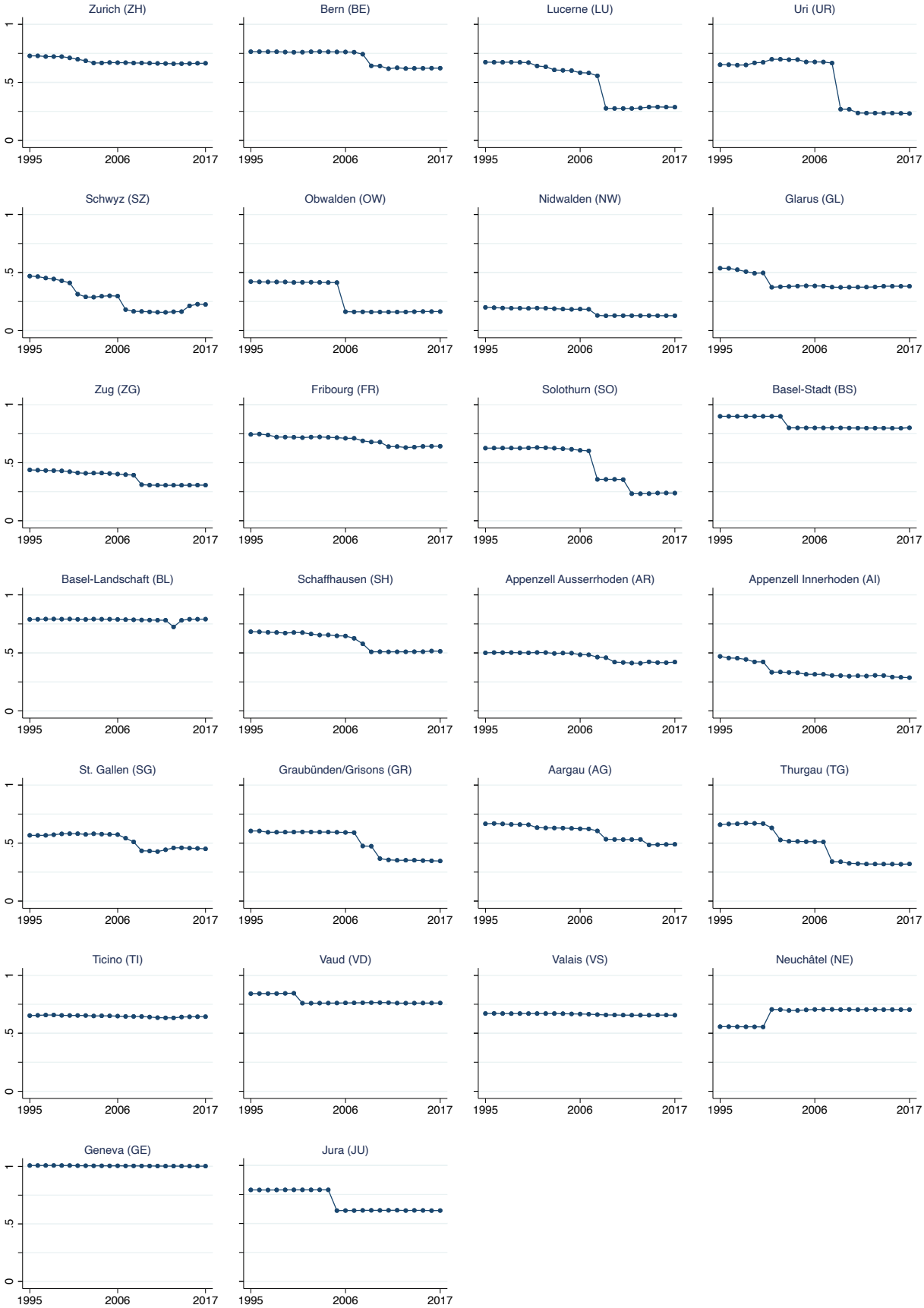
other cantons, the tax is levied either by the canton or by the municipalities. In the cantons with municipal property taxes, these can be either compulsory or optional up to an upper limit set by the canton. We observe little variation in cantonal legislation with respect to this tax during our sample period. The canton of Graubünden raised the upper limit of the range allowed for municipal property taxes from 0.1% to 0.2%, but the overall uptake of this change is not reported. Similarly, the canton of St. Gallen changed the admissible range for the municipality property tax rates from 0.03-0.1% to 0.02-0.08%. Obwalden and Nidwalden abolished compulsory minimum regular real estate and land taxes at both canton and municipality levels in 2013. Lucerne abolished optional taxes at municipality level, too, but only in 2015. Other than that, there were no changes.

Note that real estate taxes are likely less relevant for individual behavioral responses in Switzerland than in other countries because the major share of property taxes in Switzerland is paid by corporations and other legal entities, such as pension funds.

Data on wealth tax revenue for the cantons including its municipalities used in Section VI are taken from Swiss Federal Finance Administration (2020).

Finally, shape files with geo data of cantonal boundaries used for maps are take from Swiss Federal Statistical Office (2013).

Figure A2: Top marginal wealth tax rates across cantons, 2001-2017



Notes: Top marginal wealth tax rates (canton + municipality) across cantons over years 2001-2017. Cantons are listed in the standard order used for official purposes as established by the Swiss constitution.

A.2. Cross-canton analysis: event study model and additional tables

As a complement to the distributed-lag analysis reported in Section IV, we report estimates of a standard event study model of the form

$$\ln W_{it} = \sum_{j=-\infty}^{\infty} \beta_j d_{i,t-j} + \mu_i + \theta_t + \varepsilon_{it}, \tag{1}$$

where W_{it} is aggregate taxable wealth in canton i and year t, μ_i is a canton fixed effect, θ_t is a year fixed effect, and d_{it} is a dummy variable that indicates whether a tax reform (event) occurred in year t. For the purpose of this analysis, we define events as, respectively, the 10 and 20 largest canton-level wealth tax reforms between 2000 and 2016. It turns out that all these reforms involved wealth tax cuts (see Figure 3). The parameters β_j are the dynamic effects of the event j years after or prior to the event for positive and negative values of j, respectively. These dynamic effects are only identified up to a constant. We therefore standardize $\beta_{-1} = 0$, which implies that the dynamic effects are expressed relative to the year prior to the reform. We assume that the effect of a tax reform fully builds up over 6 years after the event, hence $\beta_j = \beta_6$ for all $j > 6$. We also assume that pre-trends remain constant 3 and more years before the event, hence $\beta_j = \beta_{-3}$ for all $j < -3$. These two assumption are typically called 'binning of the endpoints'.[1]

Two of the ten largest tax reductions took place in the same canton (Solothurn). In our baseline event-study estimations, we therefore drop this canton from the sample. However, Schmidheiny and Siegloch (2019) show that the standard event-study model generalizes naturally to multiple events if the binned treatment dummies are generated correctly, and we therefore also estimate regressions with all large tax cuts including the two in Solothurn.[2]

Table A1 shows our estimation results.[3] We consider an event-study model for the top-8 single events (columns 1 and 2), the top-10 single and multiple events (columns 3 and 4), and the top-20 single and multiple events (columns 5 and 6). In all three cases we alternatively estimate models without and with interaction terms of initial-year millionaire shares and year fixed effects. These interaction terms allow for differential responses of canton-level wealth to aggregate annual shocks. For instance, a global financial crisis is likely to affect cantons with large shares of high-net-worth individuals particularly strongly.

These estimates are informed by large tax reforms. As shown at the bottom of Table A1, the average top-10 event size was -0.20 percentage points, and the average top-20 event size was -0.15 percentage points. Given that the sample average wealth tax rate was 0.53% (see

[1] Binning of the endpoints leads to a regression on binned treatment dummies b_{it}^j for $j = -3, ..., 6$ which can be generated either as

$$b_{it}^j = \begin{cases} \sum_{s=-\infty}^{-3} d_{i,t-s} & \text{if} \quad j = -3 \\ d_{i,t-j} & \text{if} \quad -3 < j < 6 \\ \sum_{s=6}^{\infty} d_{i,t-s} & \text{if} \quad j = 6, \end{cases} \quad \text{or as} \quad b_{it}^j = \begin{cases} \mathbb{1}[t \leq e_i + j] & \text{if} \quad j = -3 \\ \mathbb{1}[t = e_i + j] & \text{if} \quad -3 < j < 6 \\ \mathbb{1}[t \geq e_i + j] & \text{if} \quad j = 6 \end{cases}, \tag{2}$$

where e_i is the year of the event for canton i. Standardization implies that b_{it}^{-1} is dropped.

[2] In that case, the binned treatment dummies have to be formed according to the first of the two versions described in footnote 1.

[3] We dropped five observation from the balanced panel described in Table 3 (Lucerne, 2003-2005, and Vaud 2003-2004). According to a government report, the values reported by the cantons in those years were incorrect (Swiss Federal Council, 2010).

Table A1: Cross-canton event study model for total wealth

	Few Single Events		Few Multiple Events		Many Multiple Events	
	[1]	[2]	[3]	[4]	[5]	[6]
Wealth tax						
3 and more years before event	-0.022	-0.044	0.064	0.050	0.045	0.041
	(0.059)	(0.042)	(0.058)	(0.058)	(0.038)	(0.035)
2 years before event	-0.034	-0.040	-0.015	-0.021	-0.013	-0.018
	(0.024)	(0.024)	(0.023)	(0.025)	(0.019)	(0.019)
1 year before event	0	0	0	0	0	0
at event	0.078	0.083 **	0.059	0.062 *	0.049 *	0.060 **
	(0.051)	(0.039)	(0.042)	(0.035)	(0.025)	(0.028)
1 year after event	0.070	0.087 **	0.046	0.059	0.043	0.059 **
	(0.042)	(0.036)	(0.037)	(0.037)	(0.026)	(0.028)
2 years after event	0.178 **	0.196 ***	0.132 *	0.144 **	0.075 *	0.090 **
	(0.069)	(0.055)	(0.067)	(0.061)	(0.039)	(0.035)
3 years after event	0.195 ***	0.214 ***	0.147 **	0.158 **	0.080 **	0.094 **
	(0.069)	(0.056)	(0.065)	(0.062)	(0.037)	(0.034)
4 years after event	0.194 **	0.221 ***	0.164 **	0.187 ***	0.080 *	0.090 **
	(0.076)	(0.060)	(0.068)	(0.060)	(0.039)	(0.036)
5 years after event	0.196 **	0.225 ***	0.167 **	0.191 ***	0.082 *	0.092 **
	(0.075)	(0.060)	(0.068)	(0.061)	(0.044)	(0.041)
6 and more years after event	0.212 *	0.253 **	0.170	0.204 **	0.135 *	0.135 *
	(0.108)	(0.092)	(0.101)	(0.094)	(0.078)	(0.070)
Canton fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Initial share of millionaires x year f.e.		yes		yes		yes
Effect w.r.t. a 1 percentage point (p.p.) decrease in the wealth tax rate						
5 years after event	0.958 **	1.103 ***	0.836 **	0.956 ***	0.563 *	0.635 **
	(0.528)	(0.452)	(0.503)	(0.472)	(0.536)	(0.478)
Average tax change of events in p.p.	-0.204	-0.204	-0.200	-0.200	-0.146	-0.146
Number of events	8	8	10	10	20	20
Number of observations	320	320	333	333	333	333
Number of cantons	25	25	26	26	26	26

Notes: Regression of aggregate taxable cantonal wealth (in logs) on lags and leads of event dummies. Events are defined as the 10 and 20, respectively, largest p.p. reductions of wealth tax rates in our sample (see Figure 3). In the 'Few Single Event' regressions, the canton of Solothurn was dropped because it experienced two top-10 events, leading to a total of 8 sample events. In 'multiple events' regressions, cantons with more than one event are also included. Lags and leads 3 years before and 6 years after the event are binned. Data observed from 2003 to 2015 for dependent variable and from 1996 to 2017 for tax changes. The effect one year prior to the event is standardized to one. Effect $\times$ 100% means the %-effect of the event on aggregate wealth before and after the event. Standard errors clustered for cantons in parentheses. Significance * p<0.10, ** p<0.05, *** p<0.01.

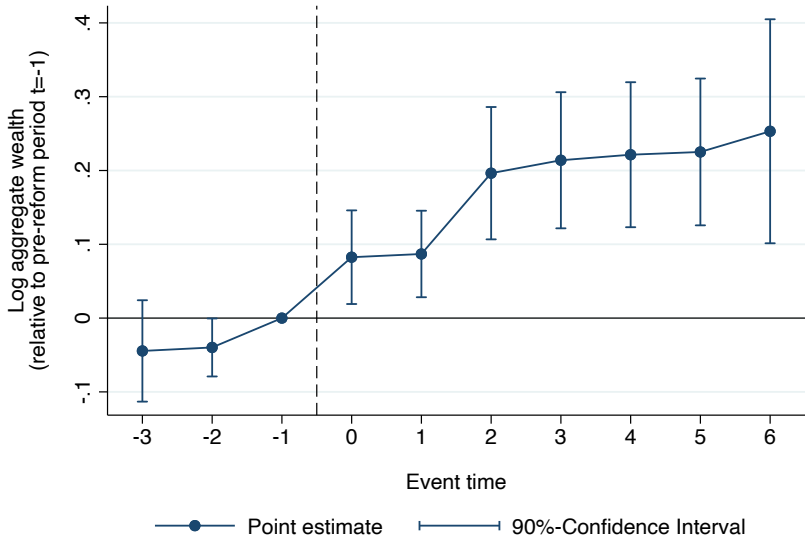
Table 3), these events represent significant changes.

Our event-study results show that tax cuts triggered strong tax-base responses. While we see no statistically significant trends in wealth accumulation prior to the tax cuts, all six specifications shown in Table A1 imply statistically significant increases in taxable wealth subsequent to the events.

This is most easily seen in a graph of the sequencing of implied average effects. Figure A3 presents such an illustration, based on the top-8 single events (column 2 of Table A1). The graph shows a strong response that plateaus out after some four years.

The magnitude of the estimated effects is substantial as well. The event study graph of Figure A3 implies that the average top-8 tax cut led to an increase in reported wealth of some 0.22 log points after 4-5 years. The implied semi-elasticities with respect to a 1 percentage point decrease in the wealth tax rate are reported at the bottom of Table A1. We find semi-

Figure A3: Event study graph: Top-8 single events



Notes: Baseline empirical model (2) with nonparametric controls (initial share of millionaires × year dummy) for the 8 largest single wealth tax cuts in 25 cantons (estimates of column 2 of Table A1). One canton (Solothurn) with two of the 10 largest events was dropped.

elasticities between 0.84 and 1.10 for the top-10 events, and between 0.56 and 0.64 for the top-20 events. These responses are larger than all estimates reported elsewhere (see Table 2). The significant drop in the estimated responses as one moves from the top-10 sample to the top-20 sample suggests that tax-base elasticities increase in the magnitude of the tax change.

In Table A2, we use our event-study model to explore differential responses across wealth categories. Our data allow us to consider separately wealth by taxpayers declaring more than CHF 0.5m, CHF 1m and CHF 5m, respectively. These estimates imply that wealth declared by the very wealthy responds more strongly to tax cuts than wealth declared by the moderately wealthy. The implied semi-elasticity of the top wealth category (CHF 5m and over) is 1.90, and thus almost double the corresponding estimate for wealth by all taxpayers (of 1.10). However, the estimates are not statistically significantly different from each other, and we therefore cannot reject the hypothesis that the moderately wealthy react as strongly as the very wealthy.

In Table A3, we show the responses across wealth categories as estimated with a distributed-lag model described in Section IV. The estimates of columns 1, 3 and 4 of this table are shown in Figure 5.

Finally, Table A4 shows detailed distributed-lag estimates of the revenue regression models described in Section VI.

Table A2: Cross-canton event study model for top wealth brackets

	All wealth	Wealth over CHF 0.5m	Wealth over CHF 1m	Wealth over CHF 5m
	[1]	[2]	[3]	[4]
Wealth tax				
3 and more years before event	-0.044	-0.042	-0.061	-0.117 *
	(0.042)	(0.050)	(0.050)	(0.068)
2 years before event	-0.040	-0.042	-0.047	-0.039
	(0.024)	(0.027)	(0.029)	(0.034)
1 year before event	0	0	0	0
at event	0.083 **	0.098 **	0.101 **	0.129 **
	(0.039)	(0.044)	(0.046)	(0.058)
1 year after event	0.087 **	0.109 **	0.117 ***	0.140 **
	(0.036)	(0.040)	(0.041)	(0.051)
2 years after event	0.196 ***	0.247 ***	0.268 ***	0.336 ***
	(0.055)	(0.065)	(0.066)	(0.079)
3 years after event	0.214 ***	0.270 ***	0.299 ***	0.389 ***
	(0.056)	(0.065)	(0.066)	(0.081)
4 years after event	0.221 ***	0.274 ***	0.297 ***	0.365 ***
	(0.060)	(0.070)	(0.072)	(0.089)
5 years after event	0.225 ***	0.280 ***	0.306 ***	0.387 ***
	(0.060)	(0.071)	(0.073)	(0.085)
6 and more years after event	0.253 **	0.312 ***	0.342 ***	0.404 ***
	(0.092)	(0.109)	(0.115)	(0.141)
Canton fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Initial share of millionaires x year f.e.	yes	yes	yes	yes
Effect w.r.t. a 1 percentage point (p.p.) decrease in the wealth tax rate				
5 years after event	1.103 ***	1.373 ***	1.499 ***	1.895 ***
	(0.452)	(0.532)	(0.562)	(0.690)
Average tax change of events in p.p.	-0.204	-0.204	-0.204	-0.204
Number of events	8	8	8	8
Number of observations	320	320	320	320
Number of cantons	25	25	25	25

Notes: Regression of aggregate taxable cantonal wealth (in logs) on lags and leads of event dummies. Events are defined as the 10 largest p.p. reductions of wealth tax rates in our sample (see Figure 3). Data observed from 2003 to 2015 for dependent variable and from 1996 to 2017 for tax rates. Lags and leads 3 years before and 6 years after the event are binned. The effect one year prior to the event is standardized to one. Effect $\times$ 100% means the %-effect of the event on aggregate wealth before and after the event. Cantons with more than 1 event are dropped from the sample. Standard errors clustered for cantons in parentheses. Significance * p<0.10, ** p<0.05, *** p<0.01.

Table A3: Cross-canton distributed-lag model in first differences for top wealth brackets

	All wealth	Wealth over 500,000	Wealth over 1 million	Wealth over 5 million
	[1]	[2]	[3]	[4]
Wealth tax rate effect				
3 and more years before event	0.042	0.066	0.047	0.056
	(0.081)	(0.122)	(0.146)	(0.224)
2 years before event	-0.042	-0.028	-0.025	0.045
	(0.061)	(0.074)	(0.086)	(0.127)
1 year before event	0	0	0	0
at event	0.214 **	0.251 **	0.252 **	0.380 **
	(0.090)	(0.105)	(0.110)	(0.185)
1 year after event	0.205 *	0.265 **	0.289 **	0.394 *
	(0.105)	(0.124)	(0.132)	(0.218)
2 years after event	0.486 ***	0.607 ***	0.639 ***	0.709 **
	(0.176)	(0.224)	(0.234)	(0.316)
3 years after event	0.495 ***	0.605 ***	0.642 ***	0.762 **
	(0.181)	(0.229)	(0.242)	(0.332)
4 years after event	0.463 ***	0.546 **	0.555 **	0.562
	(0.175)	(0.226)	(0.244)	(0.343)
5 years after event	0.511 **	0.607 **	0.627 **	0.666 *
	(0.199)	(0.251)	(0.269)	(0.357)
6 and more years after event	0.517 **	0.608 *	0.641 *	0.656
	(0.254)	(0.316)	(0.342)	(0.447)
Year fixed effects	yes	yes	yes	yes
Initial share of millionaires x year f.e.	yes	yes	yes	yes
Number of observations	307	307	307	307
Number of cantons	26	26	26	26

Notes: Regression of aggregate taxable cantonal wealth (in first differences of logs) on 6 lags and 2 leads of net-of-wealth-tax rate (in first differences of logs) with nonparametric controls (initial share of millionaires $\times$ year dummy). Data observed from 2003 to 2015 for dependent variable and from 1996 to 2017 for tax rates. Canton fixed effects are implied by first differencing. Reported is the cumulative log difference in wealth w.r.t. a 1 percent increase in the net-of-tax rate. The reported effects w.r.t. a 1 percent increase in the net-of- tax rate can be interpreted as the effect w.r.t. a 1 percentage-point decrease in the tax rate. Standard errors clustered for cantons in parentheses. Significance * p<0.10, ** p<0.05, *** p<0.01.

Table A4: Cross-canton distributed-lag model in first differences for wealth tax revenue

	[1]	[2]	[3]	[4]
Wealth tax effect				
3 and more years before event	0.008	-0.001	0.058	0.090 *
	(0.052)	(0.057)	(0.048)	(0.053)
2 years before event	-0.024	-0.020	-0.007	0.013
	(0.056)	(0.052)	(0.067)	(0.065)
1 year before event	0	0	0	0
at event	-0.296 ***	-0.279 ***	-0.243 ***	-0.254 ***
	(0.088)	(0.079)	(0.081)	(0.077)
1 year after event	-0.455 ***	-0.425 ***	-0.452 ***	-0.480 ***
	(0.126)	(0.111)	(0.132)	(0.137)
2 years after event	-0.811 ***	-0.808 ***	-0.752 ***	-0.772 ***
	(0.214)	(0.231)	(0.209)	(0.217)
3 years after event	-0.643 ***	-0.657 ***	-0.571 ***	-0.615 ***
	(0.246)	(0.245)	(0.206)	(0.216)
4 years after event	-0.432 ***	-0.425 ***	-0.447 *	-0.459 **
	(0.150)	(0.155)	(0.233)	(0.230)
5 years after event	-0.434 ***	-0.417 ***	-0.349 **	-0.372 **
	(0.125)	(0.136)	(0.152)	(0.152)
6 and more years after event	-0.361 ***	-0.345 ***	-0.273 **	-0.286 **
	(0.110)	(0.127)	(0.137)	(0.134)
Income tax effect				
5 years after event			0.894	0.331
			(1.272)	(1.404)
Bequest tax effect				
5 years after event				-0.622
				(1.872)
Year fixed effects	yes	yes	yes	yes
Initial share of millionaires x year f.e.		yes	yes	yes
Number of observations	312	312	312	312
Number of cantons	26	26	26	26

Notes: Regression of wealth tax revenue (canton+municipalities, in first differences of logs) on 6 lags and 2 leads of wealth-tax rate (in first differences of logs) and control variables. If included as control variables, the net-of-income-tax and net-of-bequest-tax rate and are also included in first differences of logs with 6 lags and 2 leads. Data observed from 2003 to 2015 for dependent variable and from 1996 to 2017 for tax rates. Canton fixed effects are implied by first differencing. Reported is the cumulative log difference in wealth w.r.t. a *decrease* in the wealth tax rate by 1 log point. In the case of bequest taxes, the reported effects w.r.t. a 1 percent increase in the net-of- tax rate can be approximately interpreted as the effect w.r.t. a 1 percentage-point decrease in the tax rate. Standard errors clustered for cantons in parentheses. Significance * p<0.10, ** p<0.05, *** p<0.01.

Appendix B: The Lucerne wealth tax cut

B.1. Lucerne and Bern micro data

B.1.1. General description

We obtained confidential anonymized individual records for the universe of taxpayers in the canton of Lucerne from the Statistical Services of the canton of Lucerne (LUSTAT Statistik Luzern, 2019). In Switzerland, taxpayers are single individuals, married couples or couples in civil partnerships. The Lucerne data include 2,366,928 taxpayer-year observations, or 215,175 taxpayers per year, over the period 2005 to 2015. We exclude all taxpayers with 'non-dom' status ('Pauschalbesteuerte'), because they are not required to declare their complete domestic and foreign wealth holdings. We also exclude repeated taxpayer-year observations which we found in the original data. We are thus left with 2,365,848 taxpayer-year observations for Lucerne, or 215,077 taxpayers per year.

We obtained confidential anonymized individual records for the universe of taxpayers in the canton of Bern from the tax administration of the canton of Bern (Steuerverwaltung des Kantons Bern, 2018). The data from the canton of Bern contain information on all tax returns filed over the period 2001 to 2015. The data include 9,495,240 entries, i.e. on average 633,033 entries per year. Entries do not necessarily cover the whole calendar year in the Bern data.[4] There are multiple entries per taxpayer in case of event such as changes in family status (marriage, divorce, death of spouse), birth of children or children leaving the household, relocations to and from other countries, relocations to and from other cantons within Switzerland, relocations across municipalities within the canton of Bern, and own death. Each entry has a starting date, which can be either January 1 or the day following an event that is relevant for the taxpayer's marginal tax rate, and an end date, which can be either a tax-relevant event or December 31. Only the stock of wealth on December 31 of each year is relevant for the purpose of our analysis, so we drop all entries that end with dates other than December 31 of any given year. In addition, we again exclude taxpayers with 'non-dom' status. After this procedure, we are left with 9,308,171 taxpayer-year observations, i.e. 620,545 taxpayers per year. We use all these taxpayer-year observations in the bunching analysis of Section V.C. We only use the period 2005-15 when we compare the canton of Lucerne to the canton of Bern in the main analysis of Section V. We are thus left with 6,602,269 taxpayer-year observations in the main analysis, or 600,206 taxpayers per year.

We use household net wealth ('Reinvermögen'), i.e. gross assets net of debt, to construct our canton-year wealth measures. In the Bern data, net wealth is reported as negative in cases where debt exceeds gross assets. In the Lucerne data, however, net wealth is truncated at zero. We therefore truncate net wealth at zero in the Bern data as well. Net wealth is strictly positive for 1,882,802 of the 2,365,848 taxpayer-year observations in Lucerne (= 79.6%) and for 5,003,754 of the 6,602,269 taxpayer-year observations in Bern (= 75.8%).

[4] We exploit this feature of the Bern data to identify movers and other exits from our data, i.e. we use all entries that do not end with December 31 to identify people who left the data for some reason – because they moved away or they died or married and only the partner's identifier was maintained, etc. In the Lucerne data, we have to rely on entries that do not appear at all in a given year but in the previous one. For more detail on this procedure, see Section B.1.2.

Only households with net wealth above an exemption threshold are subject to wealth taxation. Exemption thresholds differ across cantons and years. In Lucerne, the minimum taxable wealth threshold was CHF 50,000 for singles and CHF 100,000 for married couples. In Bern, the threshold has been CHF 97,000 for singles and CHF 115,000 for married couples since 2011, and somewhat lower in preceding years. We observe 931,193 taxpayer-year observations above the exemption thresholds in Lucerne and 2,129,486 in Bern. This corresponds to 39.4% of the 2,365,848 households in Lucerne and 32.3% of the 6,602,269 households in Bern, or 34.1% in the pooled data. In the canton of Lucerne, 96.4% of all wealth belonged to households whose wealth exceeded the taxable wealth threshold (75,000 for singles and 150,000 for couples). If we subtract the part of their wealth that is below the threshold, we find that 81.5% of all wealth in Lucerne was subject to the wealth tax. In Bern, 94.1% of all wealth belonged to households whose wealth exceeded the taxable wealth threshold. In Bern, wealth below the threshold was subject to the tax as well.

Real estate located in other cantons or abroad is considered for determining marginal tax rates, but it is is taxed in the canton where it is located and not in the canton of residence. In the case of Lucerne, we do not have information about real estate in other cantons or abroad. In the case of Bern, we observe the value of real estate outside of the canton for each taxpayer for the years 2005-2014. We subtract this value from total net wealth. As we were not provided extra-cantonal real estate for Bern taxpayers in 2015, we use the information for 2014 as a proxy for extra-cantonal real estate in 2015. Of the 31,600 taxpayers in Bern with real estate outside the canton in 2014, we were able to match 30,100 to tax records for the year 2015. We have no information on taxable real estate holdings in Lucerne for taxpayers with residence outside of Lucerne. We therefore cannot include these taxable assets in our wealth measures for Lucerne. Consequently, we also do not consider real estate located in Bern and owned by taxpayers who reside outside of Bern.

Wealth includes everything a taxpayer owns except for tax-exempt private retirement savings (mandatory pension plans and voluntary savings up to an annual cap, CHF 6,768 in 2015) and non-luxury durable household goods such as washing machines and electronic devices (but not cars). Assets are in principle valued at market prices. Real estate values are officially established by cantonal appraising officers. These appraisals are made at the moment of transactions and after extensions or major renovations. In the absence of such events, new appraisals usually take place at least every 15 years.

The data for both cantons separately report gross assets, financial assets ('Wertschriftenvermögen'), and debt. We construct non-financial assets as gross wealth minus financial assets. More detail on the wealth composition is available for Lucerne.

The Lucerne tax data are top-coded at wealth of CHF 40m. Unlike in other settings with censored data, however, we know the average value of the top-coded cases. This average is reported for each censored variable, i.e. total wealth and all wealth components. For example, in 2009, average taxable wealth of the 69 Lucerne-based taxpayers with wealth above 40m CHF was 108.6m CHF. The censored observations account for 0.04% of taxpayers but 12.4% of taxable wealth. Swiss tax data contain too few other individual characteristics (age, marital status, residence municipality, and censored income) to allow a plausible estimation of heterogeneous conditional imputed values. We know nothing, for example, of those indi-

viduals' family background, occupation or education. Such information would be essential for individual-level imputations, considering that in Switzerland about half of private wealth originates from inheritance (Brülhart, Dupertuis and Moreau, 2018).

We therefore impute the censored observations with the known average value. When we aggregate variables with those imputed amounts, we obtain the true aggregates, and no information is lost. This is an important reason why we prefer working with aggregates, as it allows us not to impute individual wealth values for censored cases, based on parametric estimators. When we need to work with individual records in the decomposition analyses, we replace wealth greater than CHF 40m with conditional means in the Bern data, too. While this procedure reduces information in the Bern data, it makes the data for the two cantons comparable and limits the influence of outliers.

B.1.2. Movers

We generate an indicator for new entrants in the tax data, which equals one if we observe a taxpayer in a given year from 2006 onward, but not in the previous year. Similarly, we generate an indicator for exits, which equals one if we observe a taxpayer in a given year up to 2014 but not in the subsequent year. We observe 123,000 entrants and 92,000 exits in Lucerne, and 265,000 entrants and 218,000 exits in Bern. The size of flows is quite stable across years. 92% of the individuals in the Lucerne data and 93% in Bern are thus 'stayers' in the sense that their status does not change.

Entrants can be people coming of age, women who file their taxes separately but were married in the previous year, or inmovers, either from abroad or from other Swiss cantons. Exits can result from death, marriage or outmoves, again either abroad or to other cantons. We obtained register data with taxpayer identifiers for both cantons that record events such as deaths, changes in marital status or moves to identify these individual-level changes. We match the register events to the taxpayer-year observations in the tax data to identify the

Table B1: Register events by canton

	Lucerne		Bern	
	Number	%	Number	%
(a) Entrants				
Unknown	12,993	10.56	25,030	9.44
Coming-of-age	43,793	35.59	103,154	38.89
Inmove Switzerland	43,846	35.63	72,643	27.38
Inmove abroad	8,217	6.68	19,383	7.31
Widowed woman	7,507	6.10	22,363	8.43
Separated woman	6,692	5.44	22,701	8.56
Total	123,048	100.00	265,274	100.00
(b) Exits				
Unknown	5,345	5.82	3,931	1.80
Death	24,898	27.09	79,534	36.51
Outmove Switzerland	37,835	41.17	71,728	32.92
Outmove abroad	8,426	9.17	22,366	10.27
Marriage woman	15,389	16.75	40,305	18.50
Total	91,893	100.00	217,864	100.00

reasons for observing entries and exits.

In cases where we cannot match a register event to an observed entry or exit in the tax data, we match register events of previous and subsequent years. For example, there are cases where we observe the exit of a taxpayer in a given year but we do not observe a register event in that year. If we observe an outmove in the register data for the previous year, we consider the exit in the tax data as an outmove.

Table B1 shows the distributions of register events in the two cantons. We managed to match more than 90% of entries and exits in the tax data to events in the register data, but some unexplained entries and exits remained. Table B1 shows that the shares of unexplained events is slightly higher in the Lucerne data. Much of our analysis in Section V focuses on stayers, defined as being present in both t and $t-1$.

Note that we do not have different conditional means depending on mover status to impute values for top-coded observations. If, for example, there is an exceptionally wealthy inmover in a given year, that will also increase conditional mean wealth of all stayers with wealth greater than CHF 40m in that year. In fact, there is such a case in the Bern data in the year 2007, in which there were three billionaire inmovers. Since we distribute the additional wealth that entered the canton with those three evenly over all taxpayers with wealth greater than CHF 40m, the evolutions for stayers display variation that in those years is largely artificial.

B.1.3. Top wealth percentiles

The simplest way to to determine the threshold we use to assign taxpayers in Lucerne and in Bern to the top 1% and the top 10% of taxpayers would be to just look them up in the combined individual data for the two cantons. A more elegant method that also minimizes endogeneity in movements of these thresholds over the years, however, is to rely on the nationwide data described in Section A.1. To do so, we assume that wealth follows a Pareto distribution

$$F(y) = 1 - \left(\frac{y}{\kappa}\right)^{-\alpha},$$

where $\alpha > 0$ is a shape parameter and $0 < \kappa \leq y$ is a scale parameter. Since we have information on total wealth and the number of taxpayers per bracket and year for the brackets specified in Appendix A.1 including the years 2005-15 that we use for the Lucerne-Bern comparison, we apply the Pareto interpolation method of Piketty and Saez (2003) to compute the thresholds for top-1% and top-10% taxpayers ('P99' and 'P90', respectively).

Pareto interpolation methods rely on the property that, if the distribution actually were of a Pareto type, the Pareto coefficient β, which equals mean wealth of all individuals with wealth above a certain threshold divided by this threshold itself remains constant no matter where the threshold is placed. In real data, β does vary, and this property only holds approximately. As it turns out, CHF 500,000 is the threshold in our data that is closest to P90. Hence, we use this threshold s to compute P90. In fact, the share p of taxpayers that have wealth above CHF 500,000 grows from 8.7% in 2005 to 12.4% in 2015. We add up total wealth and the number of taxpayers across all brackets above CHF s =500,000 and divide the former by the latter to obtain average wealth of taxpayers with wealth of more than CHF 500,000. Dividing average wealth of taxpayers above CHF 500,000 by the threshold value itself yields the Pareto

coefficient β. From this, we obtain $\alpha = \beta/(\beta - 1)$. This, finally, allows us to calculate the remaining parameter of the Pareto distribution $\kappa = s \times p^{1/\alpha}$. The threshold, above which we assign households to the top 10% will then be P90=$\kappa/(0.1^{1/\alpha})$. The resulting P90 increased over the years from CHF 455,000 in 2005 to CHF 592,000 in 2015.

We apply the same procedure to estimate the threshold P99. Here, the relevant observed value s in our data that was closest to P99 increased over the years from CHF 3m (in 2005, 0.8% of households in Switzerland had taxable wealth above CHF 3m) to CHF 5m (in 2015, 0.7% of households in Switzerland had taxable wealth above CHF 5m). P99=$\kappa/(0.01^{1/\alpha})$ increased from CHF 2,539,000 in 2005 to CHF 3,853,000 in 2015.

B.2. Lucerne and Bern tax reforms

The large event that we exploit in the Lucerne-Bern analysis relates to a reform of the basic tax schedule in Lucerne, which in 2009 introduced a single marginal wealth tax rate of 0.075% above the taxable wealth threshold (see left-hand side of Figure B1). Until 2008, the following progressive schedule had been applied: 0.13% for the first CHF 200,000 above the taxabe wealth threshold, 0.14% for the next CHF 200,000, and then increased to 0.15%, 0.16% and 0.17%, again for each subsequent bracket of CHF 200,000. The marginal tax rate for wealth more than CHF 1,000,000 above the taxable wealth threshold was 0.15%.[5]

Lucerne, moreover, lowered its cantonal multiplier applied to the basic schedule from 1.7 to 1.6 in 2006 and to 1.5 in 2008. In 2014, Lucerne's cantonal multiplier was raised again to 1.6. These changes are visible in Figures 6 and B2. All other minor movements in Lucerne's wealth tax rate during that period are related to changes in municipal multipliers. For example for a taxpayer of the Catholic majority religious denomination in the city of Lucerne in 2015, all multipliers added up to 3.7 (1.6 canton, 1.85 municipality, 0.25 church), which means that their marginal tax rate on wealth above the threshold was $3.7 \times 0.075\% = 0.278\%$. In our sample, population-weighted municipal multipliers are on average 1.94, i.e. somewhat higher than in the city of Lucerne, as are church tax multipliers at 0.29. Hence, we obtain average marginal top wealth tax rates in the canton of Lucerne in 2015 of nearly 0.29%, as shown in Figure B2.

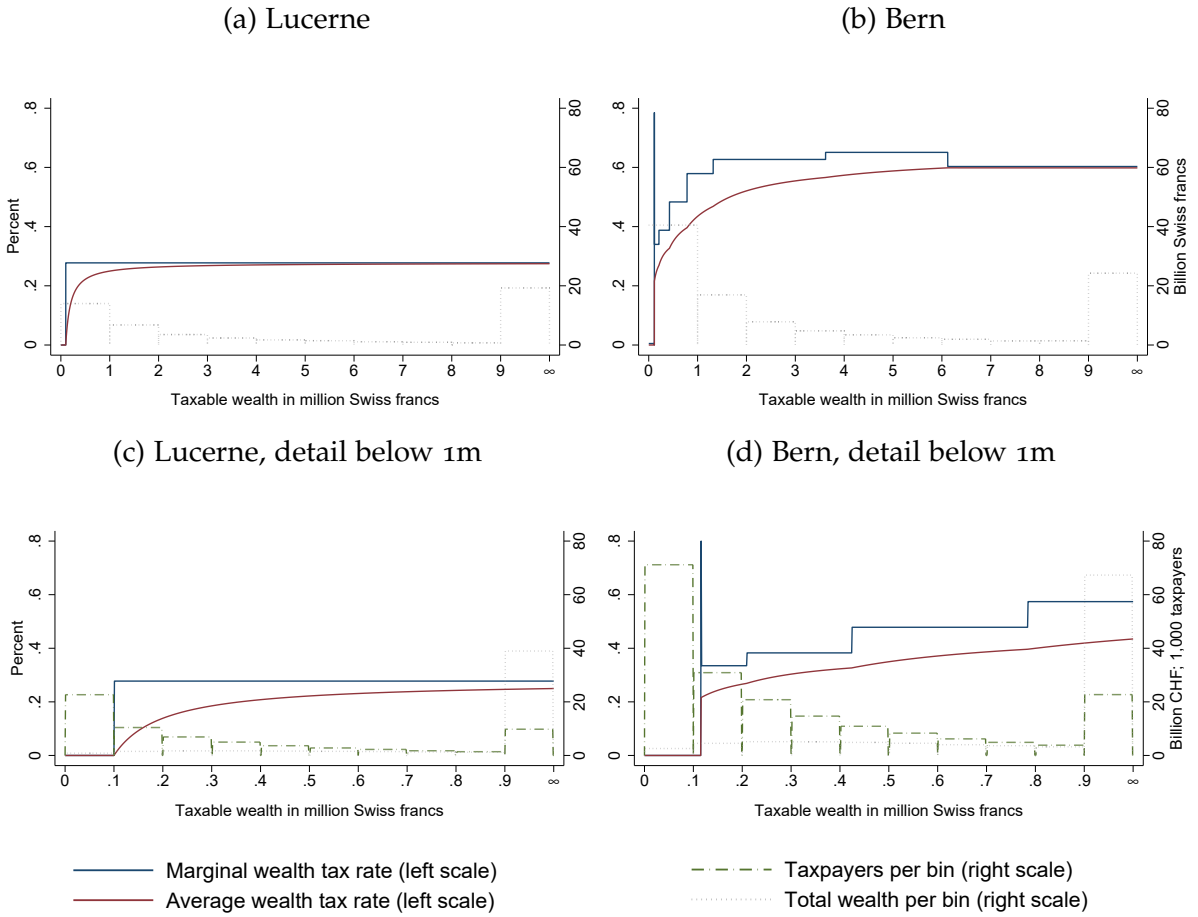
In Bern, there are one basic schedule for wealth tax rates and two basic schedules for income tax rates, one for married couples and one for singles. During our period of interest, the basic income and wealth tax schedules changed twice, in 2009 and 2011.[6] Like in Lucerne, actual tax rates are obtained by multiplying the rates of the basic schedule by three scalars, one set by the canton, one set by every municipality and one set by every parish (the 'multipliers').

Since 2009, the basic marginal wealth tax schedule in Bern has been 0 for the first CHF 35,000, 0.04% for the next CHF 40,000, 0.07% for the next CHF 135,000, 0.08% for the next CHF 215,000, 0.1% for the next CHF 360,000, 0.12% for the next CHF 535,000, 0.13% for the next CHF 2,300,000, 0.135% for the next CHF 2,500,000, and 0.125% for all net wealth above. Note that, whereas a positive marginal tax according to this schedule would already apply to net wealth above CHF 35,000, people do not have pay any wealth tax if their net wealth is CHF 97,000 or less, which leads to a notch.

[5] Note that in contrast to Bern, these brackets are defined in terms of net wealth minus the threshold, not in terms of net wealth.

[6] The first reform had initially been scheduled for 2008 but was subsequently postponed by a year.

Figure B1: Marginal and average wealth tax schedules with distributions of wealth and taxpayers for the cantons of Lucerne and Bern, 2015

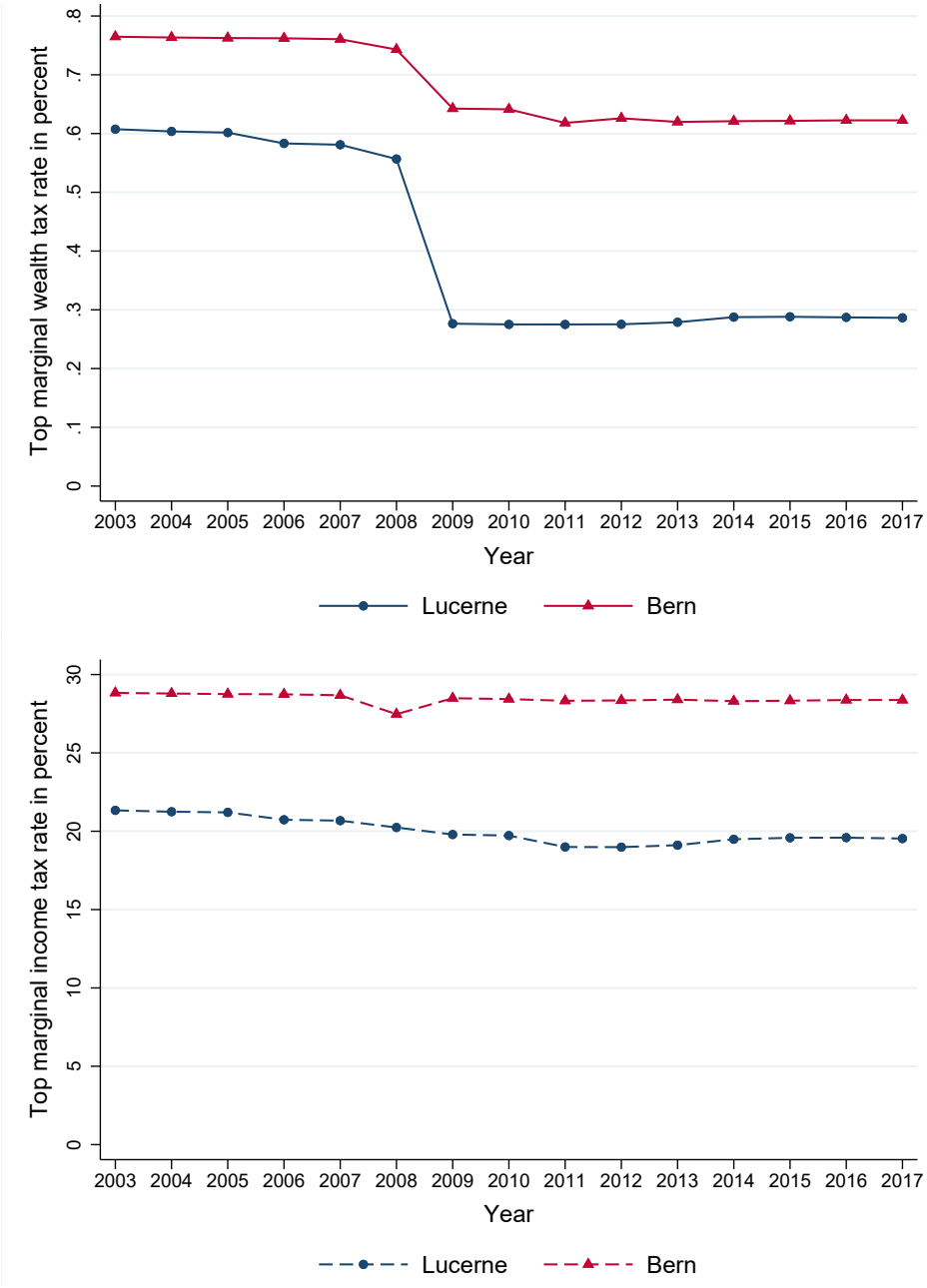


Notes: Marginal tax rates are computed over CHF 1,000 intervals, as taxable wealth is rounded by tax authorities to the nearest thousand. All numbers refer to married households as for those the exemption thresholds of CHF 115,000 in Bern and CHF 100,000 in Lucerne are comparable. The marginal tax rate at the exemption threshold in Bern of CHF 115,000 is 24.0%. The dotted gray bars represent total taxable 2015 wealth by wealth bracket in billion CHF. The area of the right-most bars in the bottom panels represents total taxable wealth held by taxpayers with wealth of CHF 9m and CHF 0.9m, respectively, or more. The dash-dotted green bars represent number of taxpaying married households in the year 2015. We only display these counts in the lower panels, as a mere 13.3% of taxpaying married households in Lucerne and 10.2% in Bern had wealth of CHF 1m or more.

The cantonal multiplier was changed three times between 2001 and 2015. First, in 2002, a number of tasks were shifted from the municipalities to the canton, which led to an increase in the cantonal multiplier from 2.3 to 3.06, while the population-weighted average municipal multiplier fell from 2.62 to 1.88. The cantonal multiplier was lowered again to 2.96 in 2008, and raised back to 3.06 in the following year. There was, however, substantial movement in municipal multipliers across municipalities and years. In 2015, mean population-weighted municipality multipliers were 1.83 (1.63 municipality, 0.2 parish) and the cantonal multiplier was 3.06, which, multiplied with the 0.125% from the basic schedule produced the 0.62% top marginal wealth tax rate displayed in the right-hand side panel of Figure B1 and in the upper panel of Figure B2.

Parishes apply specific multipliers to households declaring themselves to be Protestant or Catholic. As we do not know individual-level religious affiliations, we multiply the basic marginal tax rates with the sum of the municipal multiplier and the parish tax multiplier

Figure B2: Top tax rates on wealth and income in Lucerne and Bern



Notes: Upper panel: top tax rates on wealth; bottom panel: top tax rates on income.

applicable for the majority denomination of the respective municipality. The only municipality with a Catholic majority in the canton of Bern (throughout the 15 years in our panel) was Moutier; all other municipalities had Protestant majorities. Conversely, all municipalities in Lucerne were predominantly Catholic throughout.

Due to mergers, the number of municipalities decreased from 103 in 2005 to 83 in 2015 in the canton of Lucerne and from 398 in 2005 to 361 in 2015 in the canton of Bern. In some cases, the newly created municipalities received the name and identifier of one of the original municipalities. In other cases, the new municipalities were given new names and identifiers. As we do not work with municipality level tax base data, these mergers do not affect our analysis.

B.3. Bunching in Lucerne and Bern

Figure 1 and Appendix Figure B1 show that exemption thresholds in Lucerne and Bern are relatively low, at respectively CHF 100,000 and CHF 115,000 – roughly the top 35th percentile of the wealth distribution.[7] The Lucerne tax schedule has a kink at the threshold (i.e. a jump in the marginal tax rate), as the wealth tax only applies to amounts above the threshold value. In contrast, the Bern tax schedule has a notch at the threshold (i.e. a jump in the average tax rate), as the wealth tax applies to total net wealth once it exceeds the threshold value.

Appendix Figure B3 shows the distribution of taxpayers by CHF 1,000 bins around the exemption threshold, as well as fitted polynomial functions, separately for Lucerne and Bern. Following Chetty, Friedman, Olsen and Pistaferri (2011), the counterfactual frequencies are estimated using a 7-degree polynomial, where we included all observations outside the bunching area of CHF 15,000 to the left of the threshold. While the left-hand panels show a wide range around the exemption threshold, the right-hand panels zoom in on a narrow range of +/- CHF 10,000 around the respective thresholds.

We observe bunching at the thresholds, with evident excess mass relative to the counterfactual polynomial fit to the left of the threshold in both sample cantons. There is also some discernible missing mass to the right of the thresholds.

We can quantify bunching by expressing the excess mass below the exemption threshold as a share of the number of taxpayers above the threshold. In these computations, we define the bunching intervals as containing 3 CHF 1,000 bins below the threshold in Lucerne and 15 such bins in Bern. Since this analysis is for each canton independently, we do not need to constrain the data to identical sample periods. Hence, the computations are for 2005-2015 in Lucerne and 2001-2015 in Bern.

In Lucerne, the excess mass is some 1,800 taxpayers. This corresponds to 0.2% of the mass of filers above the threshold. In Bern, the excess mass is some 8,300 taxpayers, or 0.3% of the mass of filers above the threshold. Since, in the neighborhood of the threshold, the incentive for staying below the exemption level is stronger in Bern than in Lucerne, it is unsurprising that we find a somewhat bigger effect in Bern.

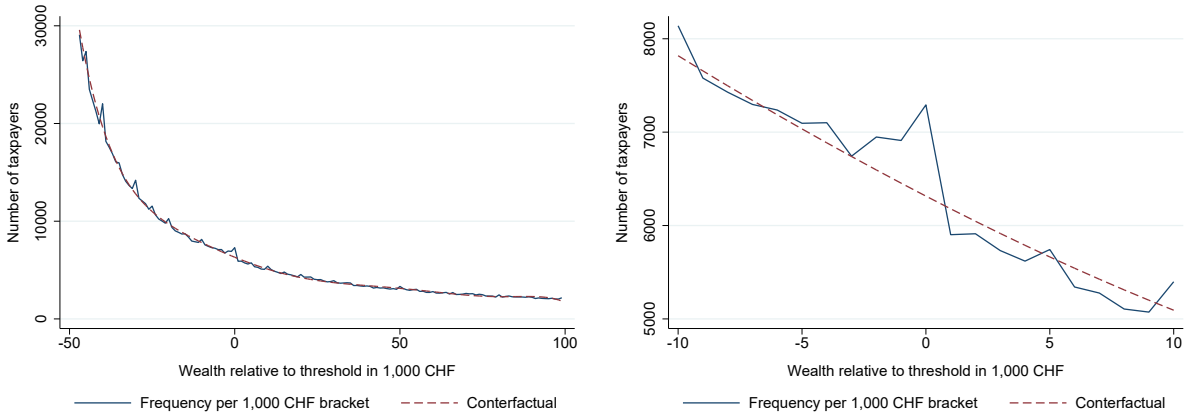
We can quantify and compare bunching effects through implied net-of-tax elasticities. These are computed following Chetty et al. (2011) as $\epsilon = (bunch \times \beta)/(W^* \times \Delta\tau)$, where $bunch$ expresses the excess mass below the threshold as a share of the counterfactual mass in the bin at the threshold, β denotes bin width, W^* is the relevant wealth threshold, and $\Delta\tau$ is the jump in the marginal tax rate at the threshold. Our estimates of $bunch$ are 0.28 and 0.64, respectively, for Lucerne and Bern. We quantify the jumps in marginal tax rates as 0.4% for Lucerne and 0.8% in Bern.[8] Hence the implied net-of-tax elasticity estimate is about 0.7 in Lucerne and 0.8 in Bern.

[7] These thresholds are for married couples. Exemptions for single filers are even lower (see Section B.1.1).

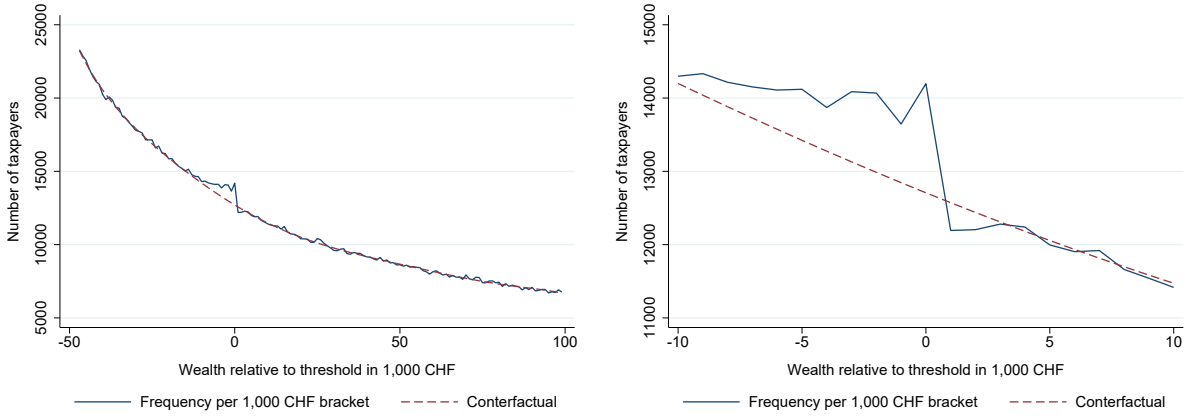
[8] These are time averages over the respective sample periods (see Figure B2). In Bern, we use double the marginal tax rate at CHF 1,000 above the threshold, because, given the notch in the tax schedule, the marginal tax rate for the first CHF 1,000 above the threshold amounts to more than 20%. We take CHF 100,000 as the representative wealth threshold for both cantons (see Appendix Figure B1).

Figure B3: Bunching at exemption thresholds

(a) Lucerne (tax kink)



(b) Bern (tax notch)



Notes: The graphs show observed frequencies of taxpayers per CHF 1,000 bin, cumulative for 2005-2015 (Lucerne) and 2001-2015 (Bern). They also show counterfactual distributions based on 7-degree polynomial regressions including all observations outside the bunching area of CHF 3,000 (Lucerne) and CHF 15,000 (Bern) to the left of the threshold. The right-hand panels zoom in on a section of the support of the left-hand panels close to the threshold.

B.4. Within-Lucerne estimation of the aggregate response using the tax shield

Here, we describe in detail the institutional context and estimation strategy underlying Figure 8.

Until 2008, Lucerne's tax code specified that if the combined cantonal plus municipal burden of wealth and income taxes amounted to more than 35% of total income, the marginal wealth tax rate would be reduced by half. If, taking this reduction into account, the combined tax burden exceeded 50%, the marginal wealth tax rate was further reduced to zero. As of 2009, these thresholds were changed to 30% and 45% of total income, respectively. Here, we exploit the fact that there was a group of taxpayers whose marginal wealth tax rate remained unchanged between 2008 and 2009 based on their wealth and income in 2008. According to the 2008 tax code, their marginal wealth tax rate was reduced in half because of the limitation. While the 2009 reform reduced statutory wealth tax rates by half, it also reduced these taxpayers' tax burden such that they no longer benefited from the limitation. Thereby, the marginal wealth tax rate of 251 taxpayers remained unaffected by the reform. These taxpayers

Table B2: Descriptive statistics for within-Lucerne analysis

	Treatment group (not tax shielded)					Control group (tax shielded)					Diff.
Variable	Obs.	Mean	Std. dev.	Min.	Max.	Obs.	Mean	Std. dev.	Min.	Max.	t-stat.
Wealth	5,915	1,871	881	1,001	4,998	251	2,709	1,121	1,001	4,964	14.59
Income	5,915	154	147	0	2,000	251	57	34	11	155	-10.35
Age	5,915	64.3	13.5	23	100	251	66.4	15.5	20	100	2.39

Notes: Taxpayers with wealth between CHF 1m (threshold for top wealth tax bracket) and CHF 5m (allowing us to avoid bias from censoring at CHF 40m) in 2008. Taxpayers in the treatment group paid the full wealth tax in 2008 and in 2009. Taxpayers in the control group benefited from a 50% reduction in the marginal tax rate in 2008 and no reduction in 2009, resulting in unchanged marginal wealth tax rates in the pre-reform and post-reform years. Wealth and income are reported in CHF 1,000 for the year 2008. The differences in means are statistically significant at the 1% level for wealth and income, and at the 5% level for age.

constitute our control group in the within-Lucerne analysis.

In order to minimize potential estimation biases, we take as the treatment group taxpayers with 2008 taxable wealth between CHF 1m and CHF 5m. The CHF 1m lower bound is chosen so that all taxpayers fall into the top marginal wealth tax bracket, thus avoiding bias from endogenous tax rate changes as wealth accumulates. The CHF 5m upper bound is chosen so as to avoid estimation bias arising from the fact that our individual-level data for Lucerne are censored at CHF 40m. The CHF 1-5m wealth bracket corresponds to the 96.5-99.5 percentiles of the 2008 Lucerne wealth distribution. Table B2 shows that the two goups are not perfectly balanced, with members of the control goup (benefitting from the tax shield) on average having higher wealth and lower income than the treatment group. Also, the members of the control group are on average somewhat older than members of the treatment group. Given the importance of wealth changes around retirement age, Figure 8 therefore also shows estimations that control for age.

B.5. Decomposition by wealth quantiles

Instead of decomposing the aggregate response across types of wealth as in Section V.C, we can also decompose it across types of taxpayer. We focus on the contribution by taxpayers in different ranges of initial wealth.

For this decomposition, we consider only *stable* taxpayers, defined as having no change of marital status or residence canton between year $t-1$ and t.[9]

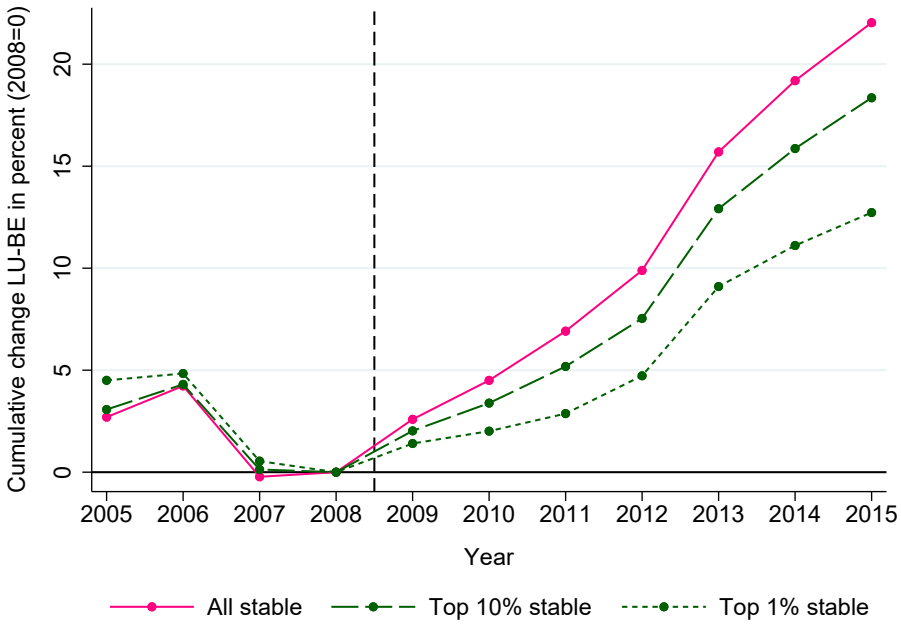
Specifically, we perform the following decomposition for e.g. the top 1%:

$$\Delta W_{it}^{\text{stable}} = \Delta W_{it}^{\text{top 1\%}} + \Delta W_{it}^{\text{bottom 99\%}}, \tag{3}$$

where $\Delta W_{it}^{\text{top 1\%}}$ is the change in taxable wealth accounted for by stable taxpayers who belonged to the top percentile of the nationwide wealth distribution in year $t-1$ (see Section B.1.3 for the calculation of wealth quantiles). We then again calculate the corresponding

[9] For a decomposition by wealth it is important to assign taxpayers to wealth quantiles in year $t-1$, as we want to track the contribution of taxpayers of different quantiles to the *change* in taxable wealth. We therefore remove movers for this decomposition, as we do not observe $W_t - 1$ of inmovers and W_t of outmovers. Similarly, given joint taxation of married couples, the correct W_t is unknown for recent divorcees and the correct W_{t-1} is unknown for newlyweds. Specifically, married couples have a single identification number that in most cases corresponds to the husband's identification number prior to and, in the case of separation or of death of the spouse, subsequent to the marriage.

Figure B4: Contribution of changes in wealth by top-1% and top-10% taxpayers, stable households only



Notes: The graph shows cumulative differential changes in wealth of Lucerne relative to Bern for taxpayers who do not move or change marital status between $t-1$ and t ('stable households'), scaled to differential wealth in 2008. It also shows the contributions to the total effect from stable households in the top 1% and top 10% of the wealth distribution at $t-1$. The 2015 values of the depicted series are, respectively, 22.0 p.p. for differential wealth, 18.4 p.p. for the top-10%, and 12.7 p.p. for the top-1%. Separate graphs for Lucerne and Bern are shown in Figure B6 below.

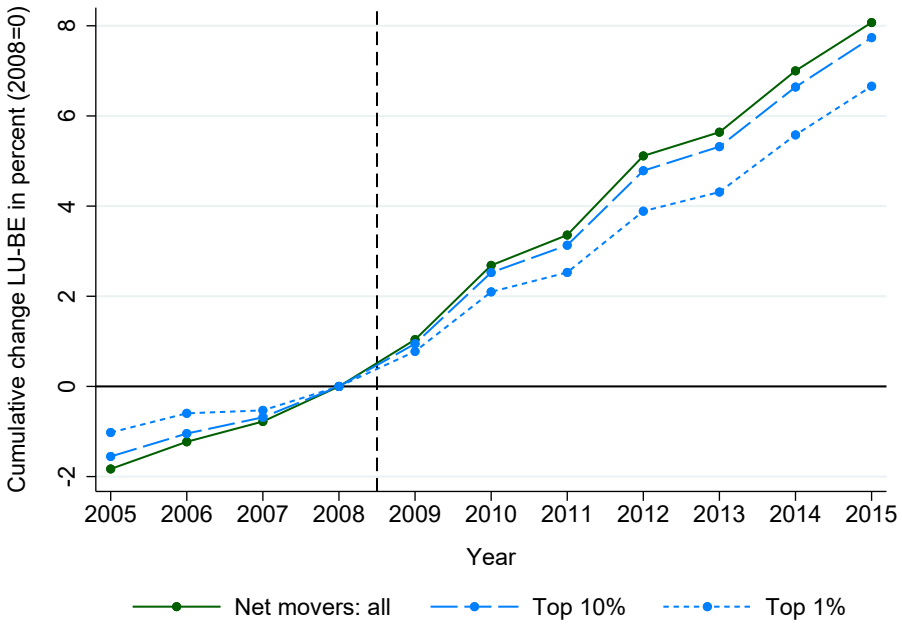
cumulative change $w_{it}^{\text{top 1\%}}$, analogously to equation (3), and report the difference between Lucerne and Bern.

Figure B4 shows the results. It emerges clearly that taxable wealth grew faster post-2008 in Lucerne than in Bern, as in Section V.B. The aggregate response of stable households amounted to 22.1 percentage points by 2015. Of these 22.1 percentage points, fully 18.4 percentage points were due to top-10% taxpayers, and 12.8 percentage points were driven by top-1% taxpayers. Top-1% taxpayers thus accounted for 58% of the aggregate response by stable households.

In Figure B5, we analogously decompose the cumulative 8.1 percentage point effect from net migration into the top 10% and top 1% contributions. Among movers, the very wealthy dominate even more: fully 83% of the migration effect are accounted for by moves of taxpayers in the top 1% wealth bracket.

The migration response is thus more strongly dominated by high-wealth taxpayers than the response by non-movers. In both cases, however, these estimated contributions are driven by a combination of two factors: the wealth share of the top 1% in the relevant group, and the behavioral elasticity of the top 1%. The large contribution of the top 1% wealth bracket to the aggregate response therefore does not necessarily reflect a greater sensitivity to wealth taxation by the wealthy (see Section V.D).

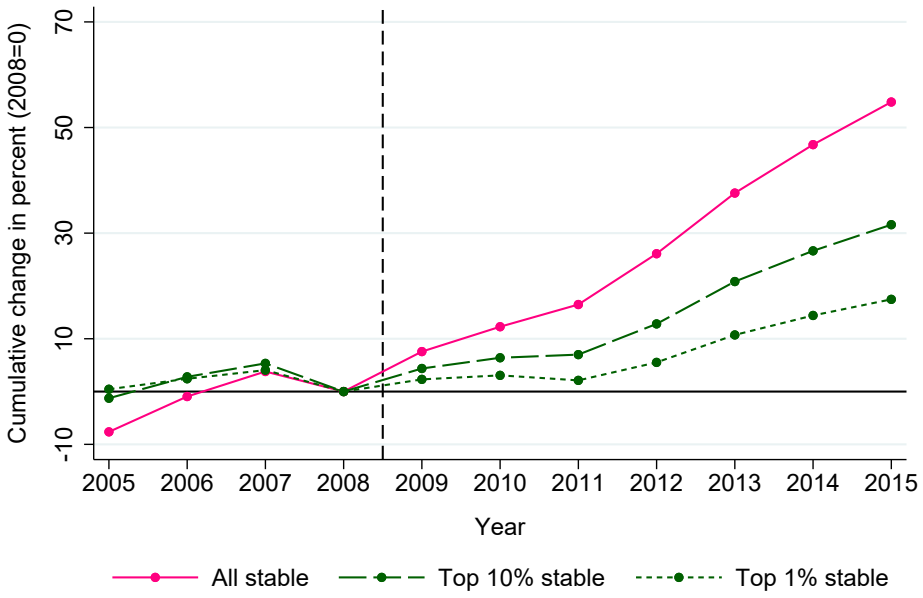
Figure B5: Contribution of changes in wealth by top 1% and top 10% taxpayers, movers only



Notes: The graph shows cumulative differential changes in wealth of Lucerne relative to Bern for taxpayers who move in or out of the canton between $t-1$ and t ('movers'), scaled to differential wealth in 2008. It also shows the contributions to the total effect from movers in the top 1% and top 10% of the wealth distribution at t (inmovers) or $t-1$ (outmovers). The 2015 values of the depicted series are, respectively, 8.1 p.p. for wealth of all net movers, 7.7 p.p. for wealth of net movers in the top-10%, and 6.7 p.p. for wealth of net movers in the top-1%. Separate graphs for Lucerne and Bern are shown in Figure B7 below.

Figure B6: Evolution of wealth at the top: Cumulative change in wealth of 'stable households' (stayers whose marital status does not change) relative to year 2008 with top 10% and top 1% separately displayed in Lucerne and Bern.

(a) Lucerne

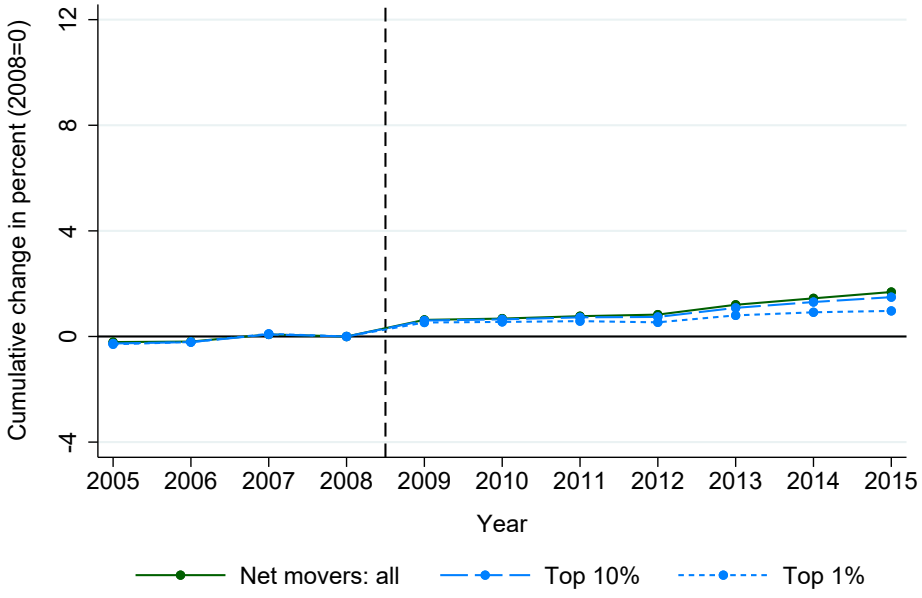


(b) Bern

Figure B7: Evolution of wealth of movers: Cumulative change in wealth of movers relative to year 2008 with top 10% and top 1% separately displayed in Lucerne and Bern.

(a) Lucerne

(b) Bern



B.6. Estimation at the individual level

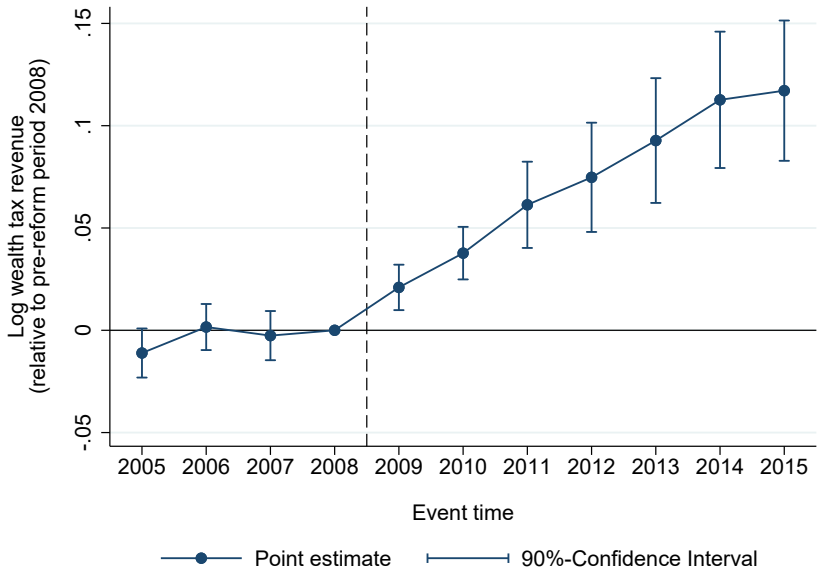
Here, we show estimates of the effect of the Lucerne tax reform using individual-level data from Lucerne and Bern for our sample period 2005 to 2015. We estimate the following distributed-lag model in first differences for log individual wealth:

$$\Delta \ln W_{imt} = \sum_{j=-\infty}^{\infty} \gamma_j d_{i,t-j} + \theta_t + \Delta \varepsilon_{it}, \tag{4}$$

where W_{imt} is wealth of individual i in municipality m and year t, and θ_t is a year fixed effect. The event indicator d_{it} is a dummy variable set to 1 in the year 2009 – the year of the Lucerne wealth tax reform – for individuals in the canton of Lucerne. We report the cumulative effects β_j according to eq. (2) in the main text, standardizing $\beta_{-1} = 0$. β_j are the dynamic effects of the event, j years subsequent or prior to the event, for positive and negative values of j, respectively. We restrict our sample to "stayer" households, that do not move across cantons between t and $t-1$ and whose wealth was below the Lucerne censoring threshold of 40m CHF in both t and $t-1$. The results are shown in Table B3 and Figure B8.

How do results based on individual changes square with the estimated aggregate response on wealth totals? Figure 10 in the body of the paper shows an aggregate response of 25.6 p.p. for stayer households. The response of stayers in Figure 10 is computed as a residual after subtracting in- and out migration. Changes due to deaths and coming-of-age are not factored out (see footnote 10). Correcting for this leads to an estimated aggregate response of 20.7 p.p. Some of this effect is due to changes in wealth above 40m and to zero wealth. The former is not included in the individual analysis because of censoring at 40m; the latter is not included

Figure B8: Distributed-lag Model for individual wealth of stayers in Lucerne and Bern



Notes: Effects of the Lucerne tax reform from the distributed-lag Model for individual wealth of stayers in Table B3, column 4. Controlled for lagged wealth deciles, lagged income deciles and age groups in 2008.

Table B3: Distributed-lag model for individual wealth of stayers in Lucerne and Bern

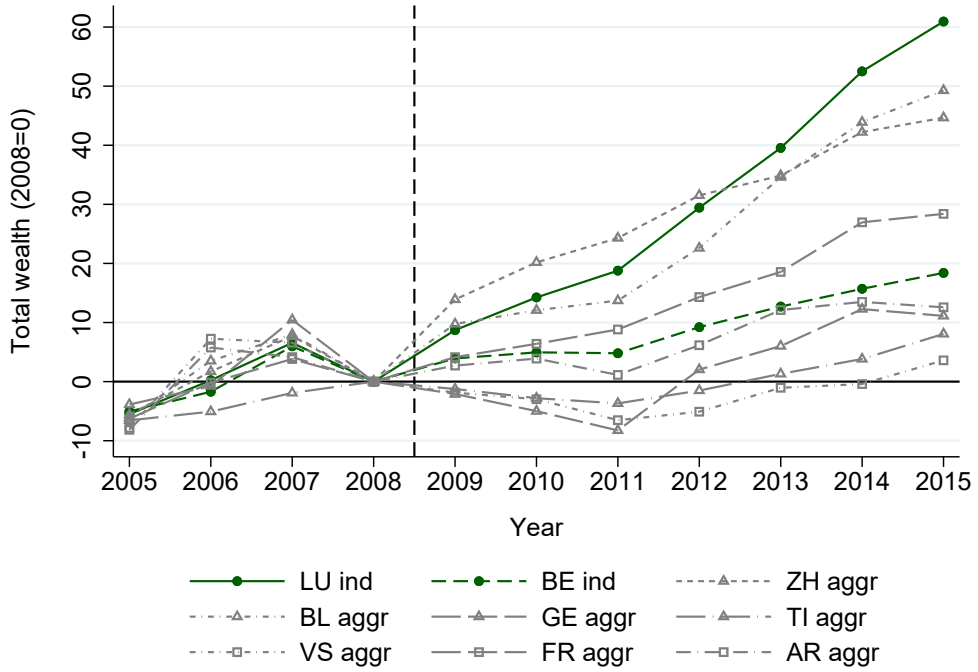
	[1]	[2]	[3]	[4]
Lucerne wealth tax reform				
4 years before event	-0.027 ***	-0.028 ***	-0.014	-0.011
	(0.010)	(0.010)	(0.010)	(0.007)
3 years before event	-0.009	-0.010	-0.001	0.002
	(0.011)	(0.008)	(0.005)	(0.007)
2 years before event	-0.009	-0.009	-0.004	-0.003
	(0.010)	(0.008)	(0.006)	(0.007)
1 year before event	0	0	0	0
at event	0.027 ***	0.028 ***	0.023 ***	0.021 ***
	(0.005)	(0.007)	(0.008)	(0.007)
1 year after event	0.048 ***	0.053 ***	0.042 ***	0.038 ***
	(0.006)	(0.008)	(0.011)	(0.008)
2 years after event	0.077 ***	0.085 ***	0.068 ***	0.061 ***
	(0.012)	(0.014)	(0.017)	(0.013)
3 years after event	0.093 ***	0.106 ***	0.083 ***	0.075 ***
	(0.014)	(0.018)	(0.021)	(0.016)
4 years after event	0.113 ***	0.130 ***	0.101 ***	0.093 ***
	(0.017)	(0.022)	(0.025)	(0.019)
5 years after event	0.136 ***	0.159 ***	0.124 ***	0.113 ***
	(0.019)	(0.024)	(0.028)	(0.020)
6 years after event	0.140 ***	0.170 ***	0.129 ***	0.117 ***
	(0.021)	(0.026)	(0.030)	(0.021)
Year fixed effects	yes	yes	yes	yes
Wealth decile dummies		yes	yes	yes
Age group dummies			yes	yes
Income decile dummies				yes
Number of observations	5,773,119	5,773,119	5,773,119	5,771,478
Number of municipalities	492	492	492	492

Notes: Regressions of log(wealth) of individual taxpayers in the cantons of Lucerne and Bern from 2006 to 2015. Estimation in first differences weighted by wealth (in levels). Only taxpayers who do not move across cantons between t-1 and t (stayers) and with uncensored wealth between zero and 40m CHF are included. Columns 2 to 4 control for wealth at t-1 in deciles of the pooled Lucerne and Bern wealth distribution. Columns [3] and [4] control for age in 2008 in groups (0-19, 20-29, 30-39, 40-49, 50-64, 65-79, 80-) and for income at t-1 in deciles of the pooled Lucerne and Bern income distribution. The linear time trend in column 4 is a dummy variable for Lucerne in first differences. Standard errors clustered for municipalities in parentheses. Significance * p<0.10, ** p<0.05, *** p<0.01.

because we use the log of wealth. Correcting for this two-sided censoring leads to a discrete effect of 13.4% or 0.126 log points. The effects estimated at the individual level and shown in Table B3 are in the range of 12% to 17%, depending on the exact specification. These estimates are thus in line with the effects reported in Section V. The estimates also turn out to be highly statistically significant. However, one must keep in mind that municipality-level clustering as applied in Table B3 cannot account for all the treatment-level non-random correlation. Since treatment is at the level of the entire canton, and we only have one treated canton in this exercise, fully rigorous inference is not possible, and the Lucerne-Bern comparison should therefore be considered as a (large-scale) case study.

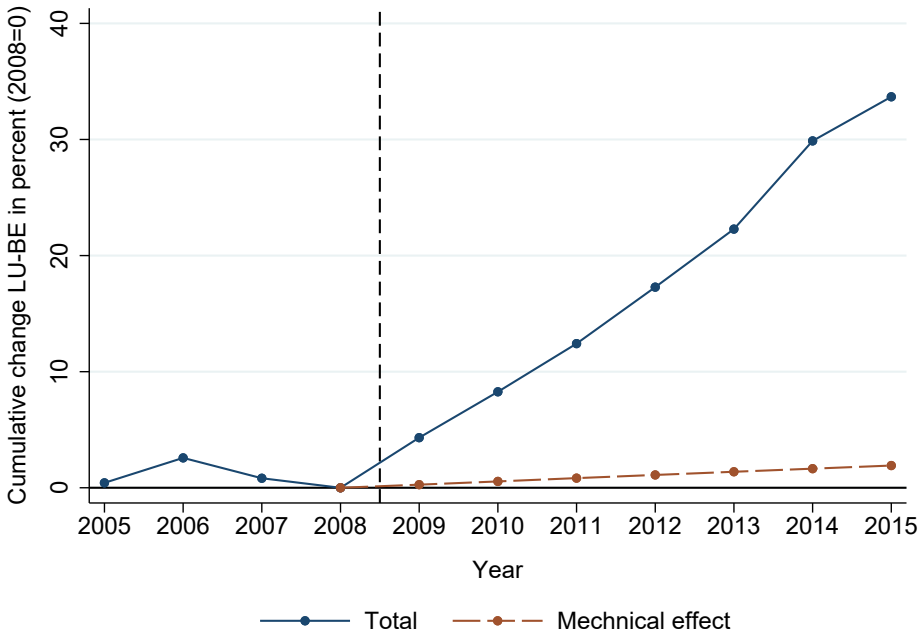
B.7. Additional graphs

Figure B9: Aggregate effects: alternative comparison cantons



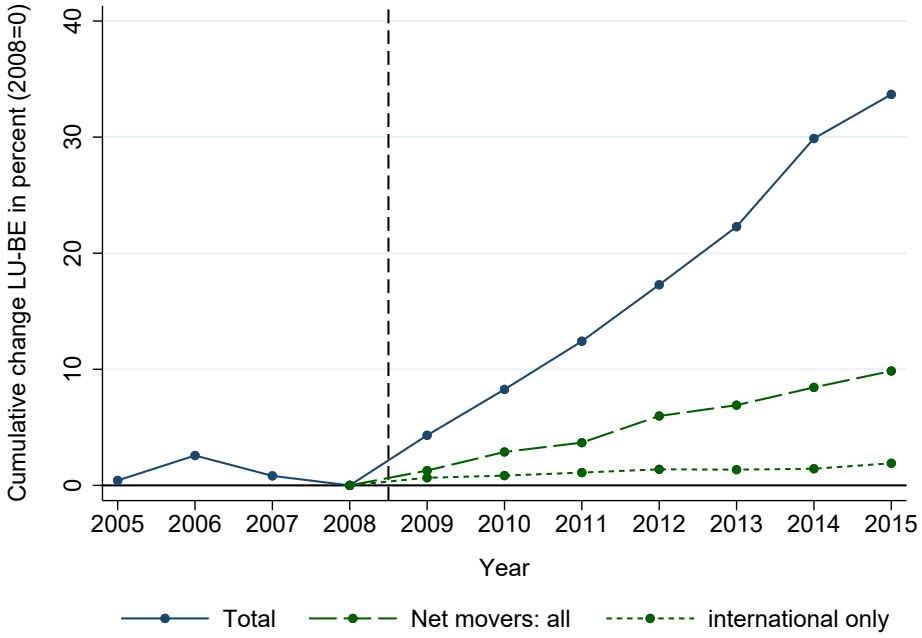
Notes: The graph replicates the left-hand side of Figure 7 for Lucerne. The other lines show the evolution of total wealth for Bern and alternative comparison cantons with no or only small changes to wealth taxation after 2008 (c.f. Figure A2). Taxable wealth for the alternative comparison cantons is taken from the cross-canton panel data described in Section III.A. We correct all comparison cantons by a linear trend which minimizes the average difference between the pre-trends in the respective canton and the pre-trends in Lucerne. Even after this correction, pre-trends deviate in most comparison cantons from the ones in Lucerne. As can be seen in Figure 7, pre-trends in Bern are practically the same as in Lucerne with and without correction.

Figure B10: Aggregate and mechanical effects



Notes: The graph shows cumulative differential changes in wealth of Lucerne relative to Bern that are purely mechanical. The 2015 values of the depicted series are, respectively, 33.7 p.p. for differential wealth and 1.9 p.p. for the mechanical effect.

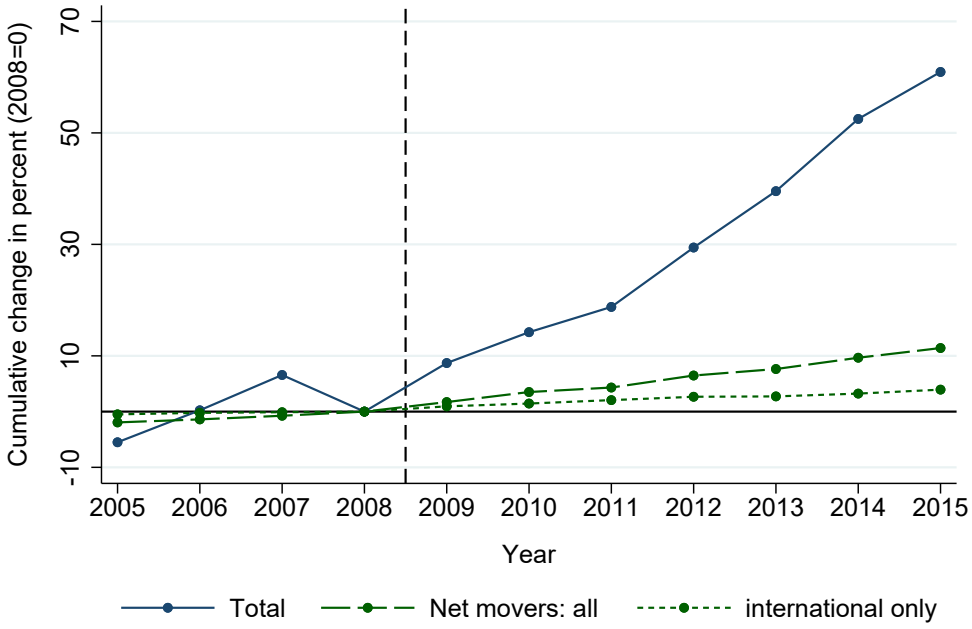
Figure B11: Contribution of intra-national and international taxpayer mobility, including accumulation after arrival



Notes: The graph shows cumulative differential changes in wealth in Lucerne relative to Bern, scaled to differential wealth in 2008. It also shows the contributions to the total effect by net intra-national and international taxpayer moves, including, for inmovers from 2009 onward, differential accumulation over the years subsequent to arrival in the canton. The 2015 values of the depicted series are, respectively, 33.7 p.p. for differential wealth, 9.9 p.p. for wealth of all net movers, and 1.9 p.p. for wealth of international net movers only.

Figure B12: Evolution of net wealth: Cumulative change in net wealth relative to year 2008 with components all movers and international movers in Lucerne and in Bern separately (not including accumulation after arrival).

(a) Lucerne



(b) Bern

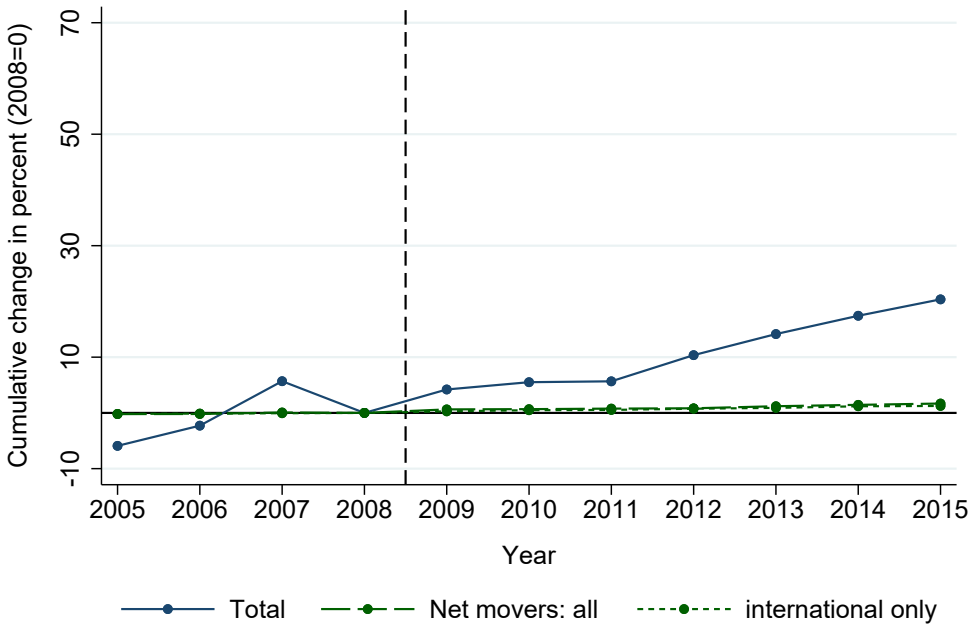
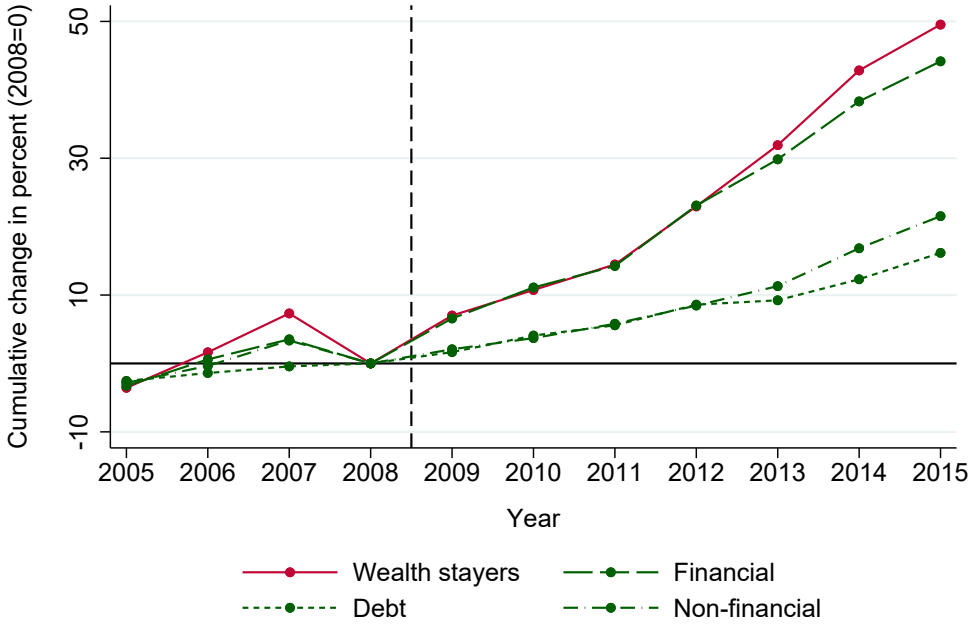


Figure B13: Evolution of asset types: Cumulative change in wealth of stayers relative to year 2008 with components with components of wealth decomposed into financial assets and debt in Lucerne and Bern separately displayed.

(a) Lucerne



(b) Bern

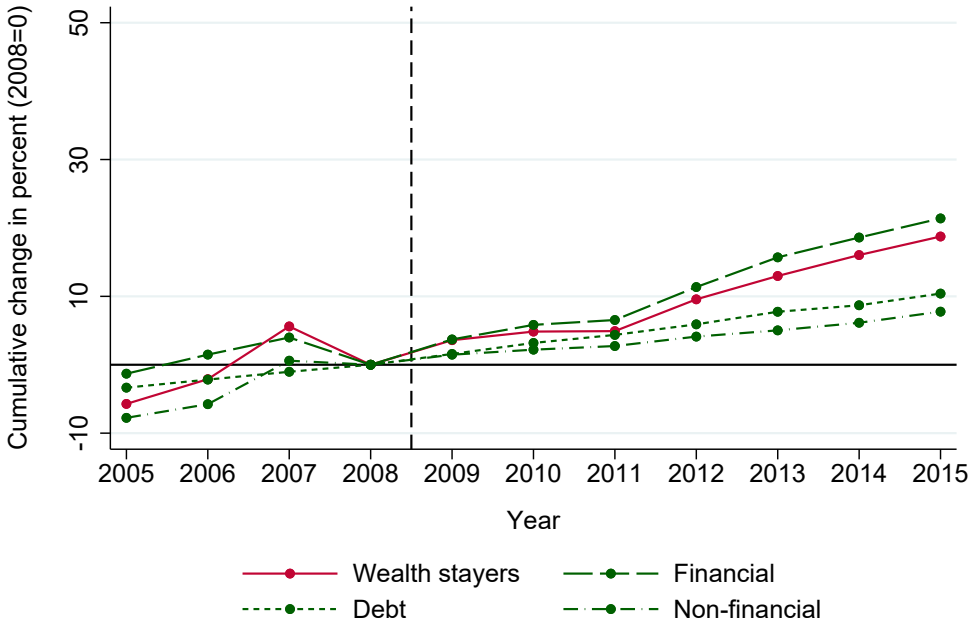
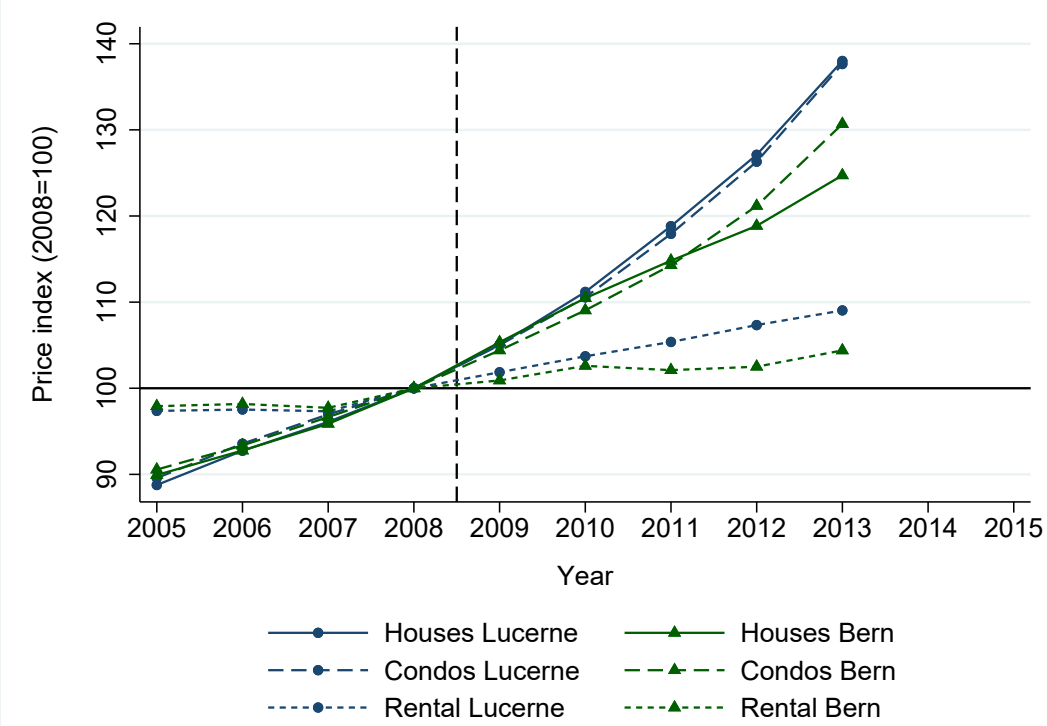


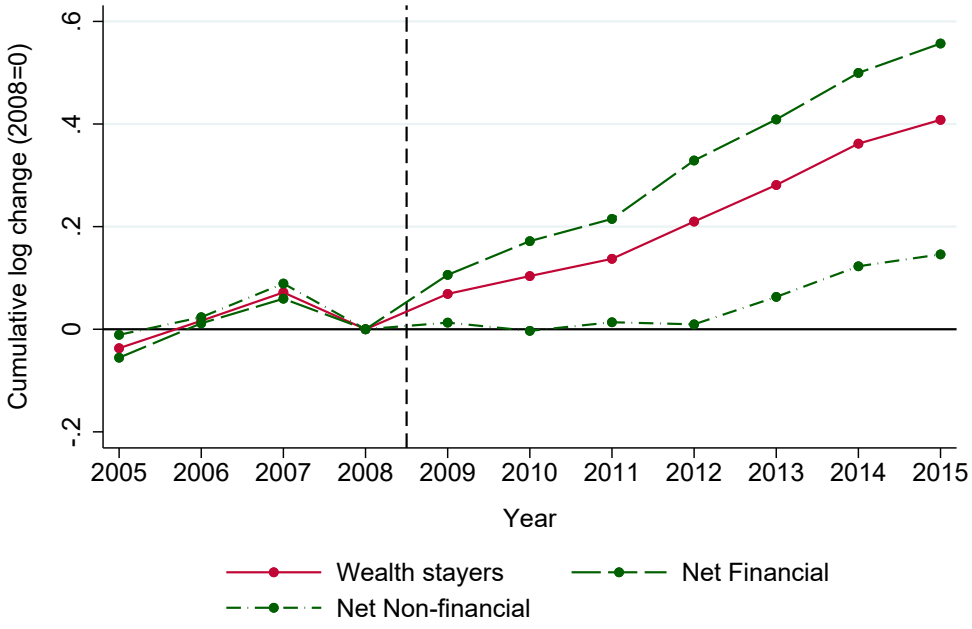
Figure B14: Evolution of housing prices, Lucerne and Bern



Notes: The graph shows the evolution of prices for single-family houses and condominiums in Lucerne and Bern up to 2013. The price increase relative to 2008 was 38.0% for houses in Lucerne, 24.7% for houses in Bern, 37.6% for condominiums in Lucerne, 30.7% for condominiums in Bern, 9.0% for rental prices in Lucerne, and 4.4% for rental prices in Bern.

Figure B15: Evolution of cumulative log wealth by component: Cumulative change in net financial wealth (net of 6% of debt), and net non-financial wealth (net of 94% of debt) of stayers. Top panel displays evolution in Lucerne and bottom panel displays evolution in Bern.

(a) Lucerne



(b) Bern

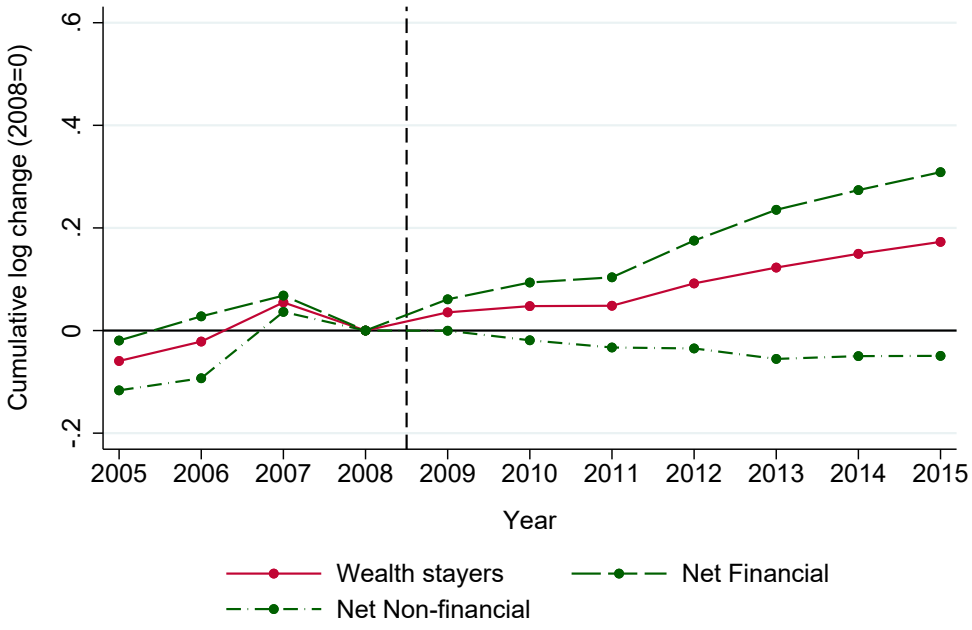
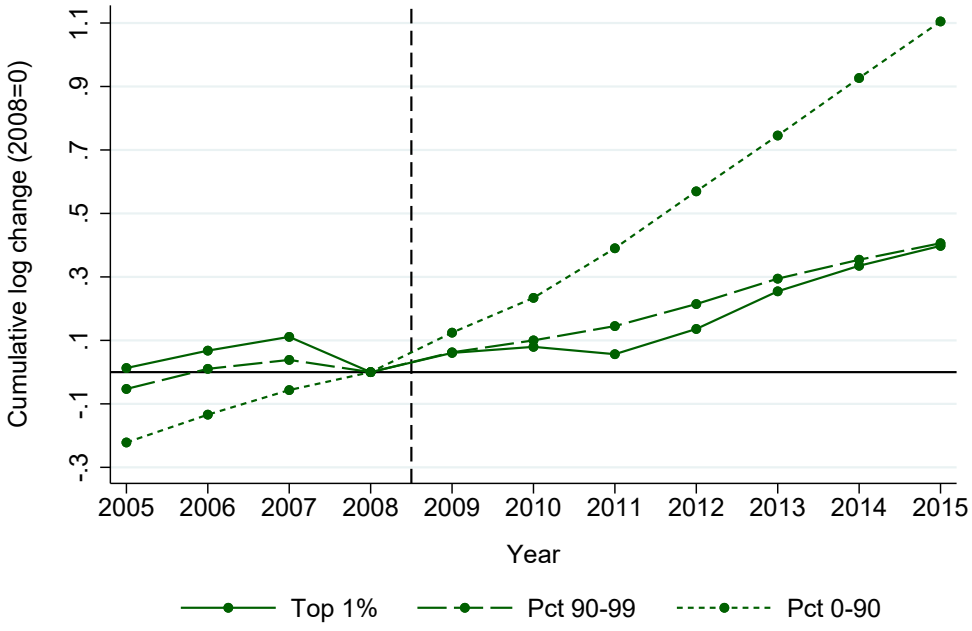


Figure B16: Evolution of cumulative log wealth at the top: Cumulative change in wealth of 'stable households' in percentiles 0-90, 90-99, and 99-100. Top panel displays evolution in Lucerne and bottom panel displays evolution in Bern.

(a) Lucerne



(b) Bern

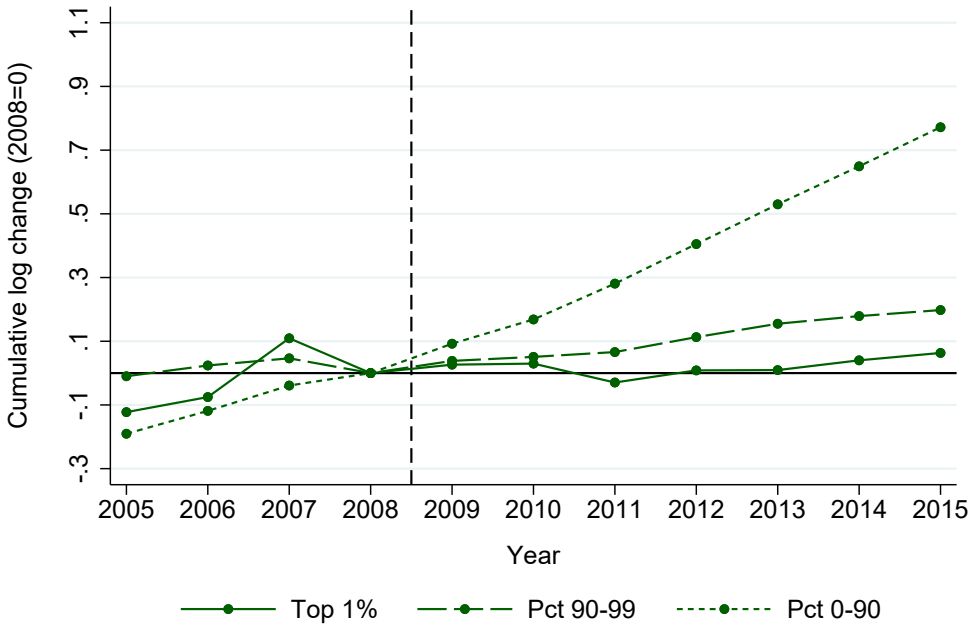
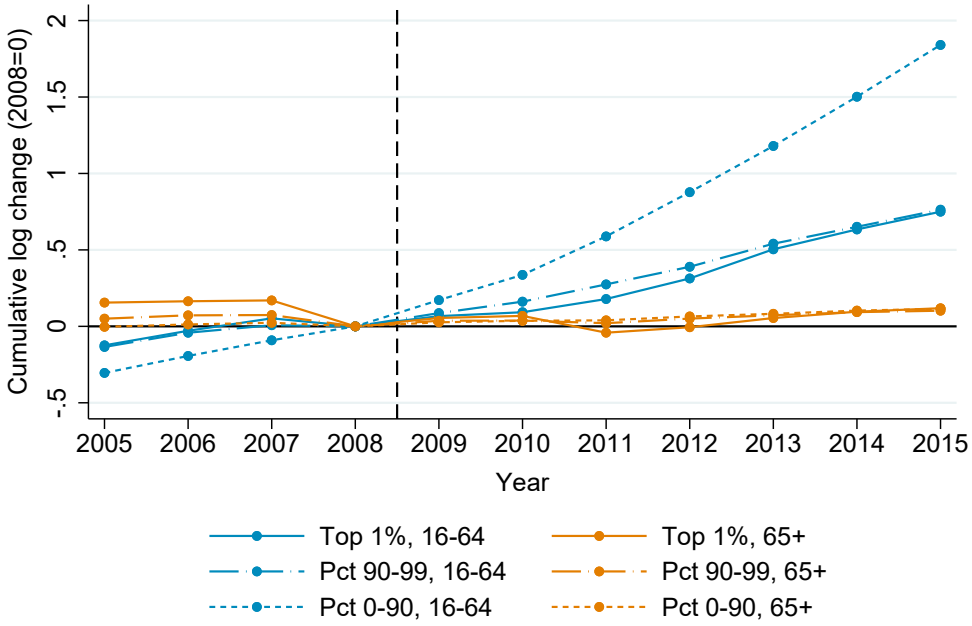


Figure B17: Evolution of cumulative log wealth at the top by age group: Cumulative change in wealth of 'stable households' in percentiles 0-90, 90-99, and 99-100 by older/younger than 65 in 2008. Top panel displays evolution in Lucerne and bottom panel displays evolution in Bern.

(a) Lucerne



(b) Bern

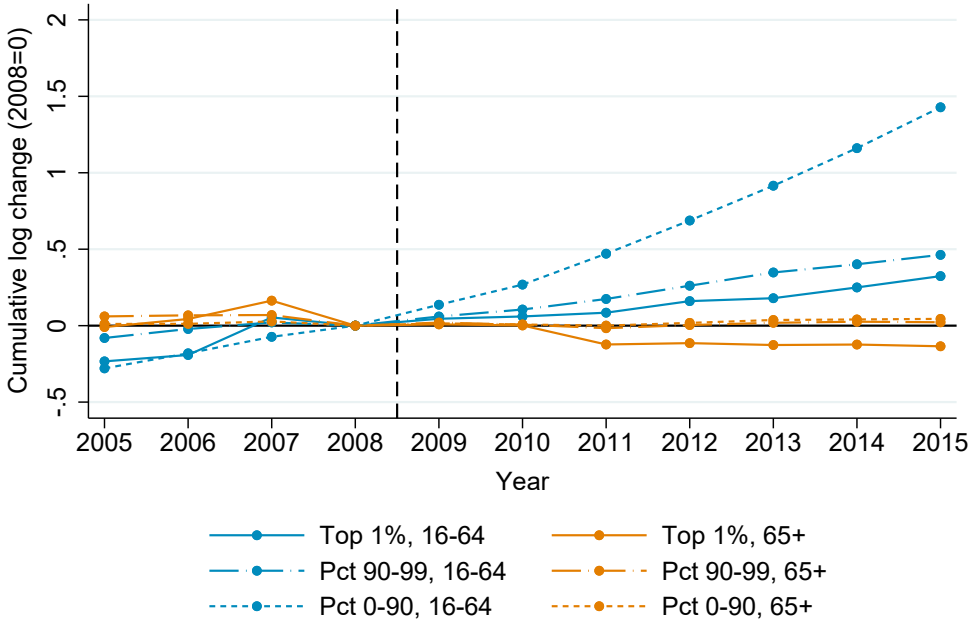
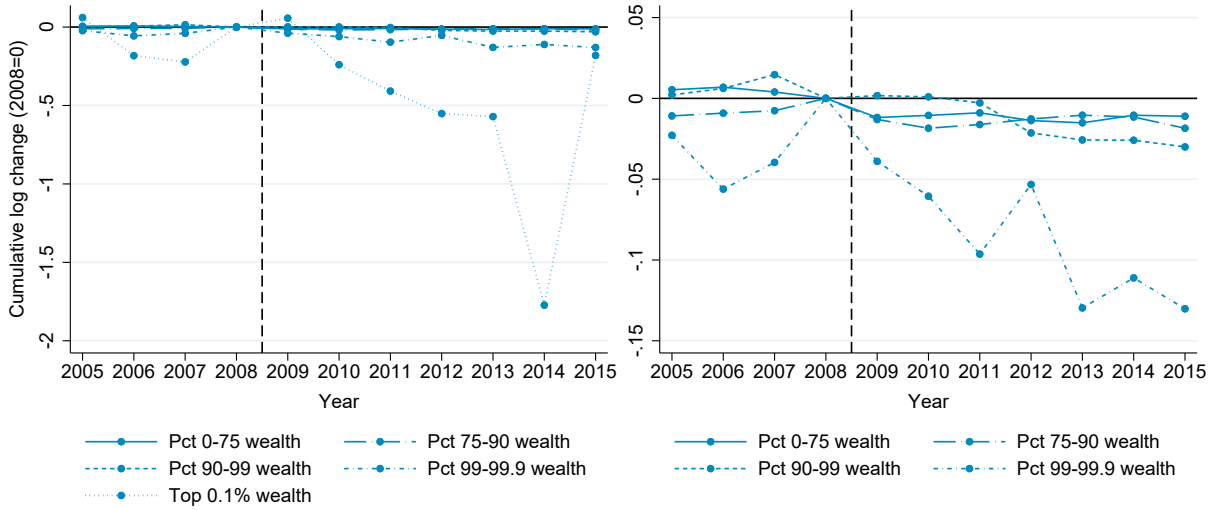
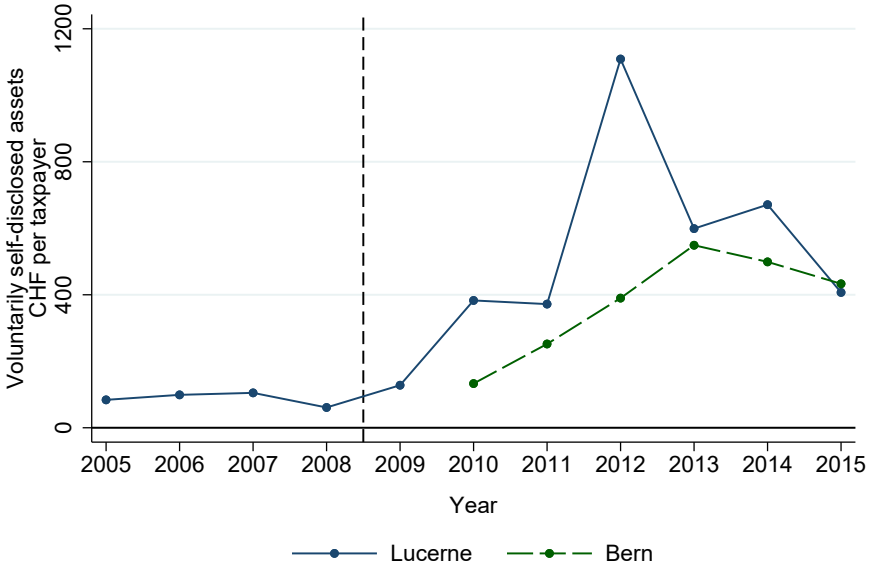


Figure B18: Evolution of earnings of stable households by wealth quantile



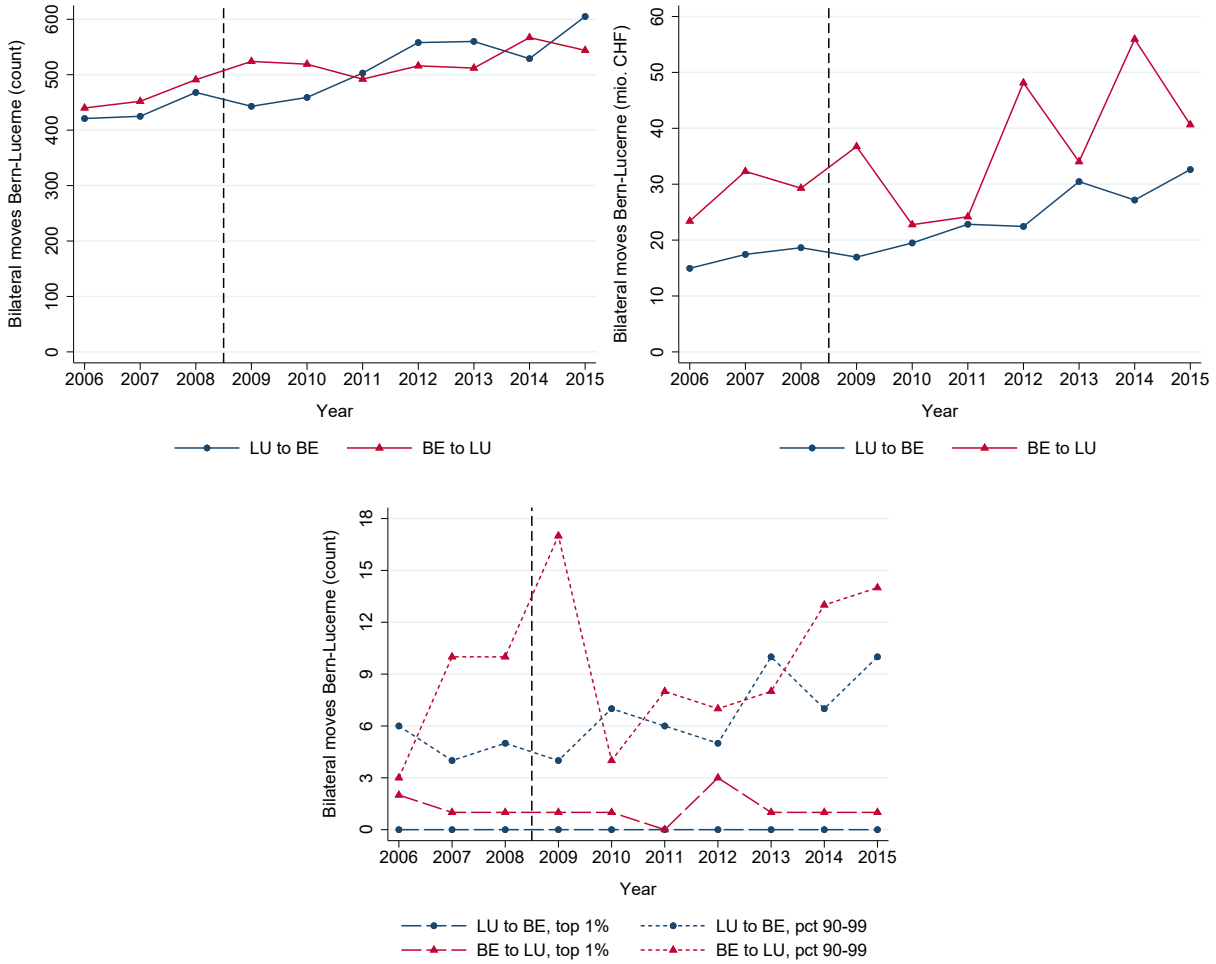
Notes: The graphs show cumulative differential log changes in earnings of Lucerne relative to Bern for taxpayers who have stable family characteristics and are aged between 30 and 50 in 2008, the year prior to the tax reform. Evolutions are shown separately for households in the top 0.1%, group 99-99.9, 90-99, 75-90 and 0-75 of the wealth distribution in 2008. The 2015 values of the depicted series are, respectively, -0.011 for taxpayers below the 75th percentile, -0.019 for class 75-90, -0.030 for class 90-99, -0.130 for class 99-99.9, and -0.180 for the top-0.1%. The spike in earnings of top 0.1% taxpayers in Bern 2014 is due to exceptionally high one-off incomes of just two Bern taxpayers whose earnings reached double-digit millions for that year, from earnings in the low single digit millions before and after. In the left-hand panel we therefore show the same data without the top 0.1% series (note different y-axis scale).

Figure B19: Voluntary self-disclosures in Lucerne and Bern



Notes: The graph shows estimated amounts of voluntarily self-declared assets per taxpayer (i.e. relative to the canton-year taxpayer total). Computations based on data obtained from the Lucerne and Bern cantonal tax authorities.

Figure B20: Bilateral moves between Lucerne and Bern



Notes: The graphs show the evolution of intercantonal moves between Lucerne and Bern over our sample period, for all taxpayers in terms of counts (top left panel) and taxable wealth in the year of moving (top right panel), and for taxpayers at the top of the distribution in terms of counts (bottom panel). Inmovers in e.g. 2006 were not yet resident in the arriving canton in 2005 but in 2006, and outmovers were resident in the departing canton in e.g. 2005 but not in 2006. Hence, we only have 10 sample years for this analysis.

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