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Behavioral Responses to Wealth Taxes: Evidence from Switzerland

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Behavioral Responses to Wealth Taxes: Evidence from Switzerland

Abstract

We study how reported wealth responds to changes in wealth tax rates. Exploiting rich intra-national variation in Switzerland, the country with the highest revenue share of annual wealth taxation in the OECD, we find that a 1 percentage point drop in the wealth tax rate raises reported wealth by at least 43% after 6 years. Administrative tax records of two cantons with quasi-randomly assigned differential tax reforms suggest that 24% of the effect arise from taxpayer mobility and 20% from house price capitalization. Savings responses appear unable to explain more than a small fraction of the remainder, suggesting sizable evasion responses in this setting with no third-party reporting of financial wealth.

JEL-Codes: H240, H310, H730.

Keywords: wealth taxation, behavioral responses, taxpayer mobility, evasion, Switzerland.

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1 Introduction

The rise in inequality seen in many developed nations over the past four decades has spurred new interest in the taxation of wealth. Inequality has increased in terms of both income (Atkinson, Piketty and Saez, 2011) and wealth (Piketty, 2014; Saez and Zucman, 2016). This has led economists to advocate increased taxation of wealth levels, either annually or at death. Most prominently, Piketty, Saez and Zucman (2013) have proposed the adoption of an 'ideal' combination of taxes on capital, covering annual net worth in addition to capital income and bequests.

Yet, there still exists only limited evidence on the behavioral responses triggered by recurrent wealth taxation. A lack of such evidence has been seen by some economists as a cause for caution. For example, according to McGrattan (2015, p. 6), '(w)ithout a quantitatively valid theory or previous experience with taxing financial wealth, economists cannot make accurate predictions about the impact that such taxes will have on either aggregate wealth or its dispersion. Thus, any proposals to tax wealth are, at this point, premature'. Auerbach and Hassett (2015, p. 41) 'find little support for Piketty's particular approach ... elsewhere in the literature'.

There are a host of studies to show that reported income is only modestly elastic with respect to income taxation (see Saez, Slemrod and Giertz, 2012, for a review). *Ex ante*, it is unclear whether taxable wealth will be more or less elastic than taxable income. On the one hand, for most taxpayers, income is predominantly labor income, which is at least partially in the control of their employers and not themselves, while wealth levels are arguably more fully in the control of the taxpayer. Moreover, labor income for the employed is easier for tax authorities to monitor than are wealth levels. On the other hand, most taxpayers hold much of their wealth in illiquid form (their home), and that is hard to adjust as tax rates change, at least in the short term.

Compared to research on the response of income to taxation, there has been less work on the response of wealth to taxation. This to some extent reflects that many countries tax only the very wealthiest individuals, and administrative data on wealth holdings are not available below the taxable threshold, making it difficult to measure behavioral responses. A recent literature on this topic has begun to emerge, and has already already informed high-profile policy evaluation (Saez and Zucman, 2019a,b).

The main current user of wealth taxes, and therefore in some respects the most propitious laboratory for studying their effects, is Switzerland. As shown in Table 1, recurrent taxes on private wealth account for 3.6% of tax revenue in Switzerland, followed at some distance by Norway (1.0%), Spain and France (both 0.5%). Wealth taxes have in recent years been losing political support: Table 1 shows that of the thirteen OECD nations that raised recurrent taxes on wealth in 1995, only four still did so in 2015.

Switzerland is an interesting case also in terms of the reach of its wealth taxes and availability of data: Swiss wealth tax schedules have very low exemption levels in international comparison, and data are available for all households. Importantly, these taxes are all raised at the cantonal and municipal level, with no centralized federal wealth taxation. This leads to sizeable intra-national variation across jurisdictions and over time.

Table 1: Wealth taxes in OECD countries.

	1995	2000	2005	2010	2015
Switzerland	2.86	3.09	3.36	3.40	3.62
Norway	1.31	1.09	1.02	1.12	1.08
Iceland	1.16	0.00	0.00	0.00	0.00
Netherlands	0.55	0.49	0.03	0.01	0.00
Spain	0.53	0.65	0.52	0.21	0.53
Sweden	0.41	0.69	0.36	0.00	0.00
Germany	0.26	0.02	0.01	0.00	0.00
France	0.25	0.38	0.40	0.53	0.52
Italy	0.21	0.00	0.00	0.00	0.00
Denmark	0.19	0.00	0.00	0.00	0.00
Finland	0.08	0.28	0.18	0.00	0.00
Austria	0.06	0.00	0.00	0.00	0.00
Greece	0.05	0.00	0.00	0.00	0.00

Notes: In % of total tax revenue; only OECD countries that had non-zero wealth taxes in 1995; source: OECD Global Revenue Statistics (code 4210, Individual Recurrent Taxes on Net Wealth). In 2018, France replaced its wealth tax with a real estate tax, and Belgium introduced a tax on certain types of financial wealth.

We exploit two complementary data sets that allow us to study how wealth responds to taxation. The first dataset contains aggregate taxable wealth by canton and wealth bracket over the period 2003-2015. This allows us to consider aggregate responses of wealth holdings – the ultimate response of policy interest – to rich inter-cantonal time variation in wealth tax levels. These aggregate data do not, however, allow us to investigate the mechanisms through which wealth changes as tax rates change. We therefore supplement them with individual-level tax records from two cantons, Lucerne and Bern, over the period 2005-2015. In these data, we can disaggregate the response of taxable wealth. We track how various components of aggregate reported wealth responded to a cut by half of Lucerne's wealth tax rate in 2009.

We find that reported wealth holdings in Switzerland are very responsive to wealth taxation. According to our baseline estimate, identified over all canton-level tax changes in our sample, a 1 percentage point drop in the top wealth tax rate raises reported wealth by 43%. The largest tax cuts are followed by even larger responses, in excess of 100%. However, even the largest observed responses do not seem to have implied Laffer revenue effects. Our finding of strong responses is robust to variations of the empirical model and appears fairly constant throughout the wealth distribution.

In the second part of the paper, we explore possible mechanisms of adjustment. To do so, we analyze individual-level tax records for Lucerne and Bern, exploiting the fact that Lucerne cut its wealth tax by half in 2009 whereas Bern only adopted a modest reform. The difference between the two cantons' policies can be considered quasi-random, as it hinged on a marginal decision against a larger reform in Bern made possible by a direct-democratic instrument that exists in Bern but not in Lucerne.

The Lucerne tax cut triggered a very large response, implying to a semi-elasticity with respect to a 1 percentage point tax cut of 226%. We find that this aggregate response can be decomposed as follows: up to 6% of the response can be attributed to increased savings, including the mechanical effect of lower wealth taxation, some 24% can be attributed to net

taxpayer migration, some 20% can be attributed to capitalization into housing prices, and some 50% can be attributed to changes in taxable financial assets of immobile taxpayers. Considering the fact that financial wealth is self-reported in Switzerland and in view of our findings (a) that bunching responses to exemption thresholds are larger in Switzerland than in other countries while (b) earnings do not seem to respond to wealth taxation, the most plausible explanation for the strong response by financial assets of non-movers are changes in evasion behavior.

Our paper proceeds as follows. We begin in Section 2 with a review of the related literature. Section 3 describes the Swiss institutional context. Section 4 presents our data. In Section 5, we show our results from the aggregate cross-canton data analysis, while Section 6 shows our a detailed analysis of a particularly large cut to a cantonal wealth tax rate. Section 7 concludes.

2 Related literature

Other researchers have recently sought to quantify behavioral responses to wealth taxation. We summarize their main results in Appendix Table A.1.

This literature has taken two approaches. One approach is to analyze bunching of reported wealth at discontinuities in tax schedules (Seim, 2017; Londoño-Velez and Ávila-Mahecha, 2019). This approach yields small elasticity estimates. Bunching-based estimates, however, have been shown to be potentially less revealing of long-run (frictionless) responses than reform-based estimates (Kleven and Schultz, 2014). Jakobsen, Jakobsen, Kleven and Zucman (2019) argue that bunching is particularly likely to underestimate real behavioral responses with respect to wealth taxation since changes in wealth depend to a large extent on asset prices that are uncertain and exogenously determined.

Other researchers use difference-in-difference analysis of changes in wealth tax schedules, comparing taxpayers who are affected differently by these changes for reasons that are arguably unrelated to their subsequent responses (Zoutman, 2018; Jakobsen et al., 2019; Durán-Cabré, Esteller-Moré and Mas-Montserrat, 2019). These studies find responses that are an order of magnitude larger than the bunching-based analyses, with semi-elasticities of reported wealth with respect to a one percentage point wealth tax cut ranging from 14% to 32%. All three studies use data from countries where wealth taxation is limited to large fortunes, mostly in the top 1% wealth bracket.

In this paper, we apply difference-in-difference estimation methods not based on how differently affected taxpayers react to a single policy reform, but through comparisons of policy reforms with different magnitudes and timings across Swiss cantons.[1] Our study is unique in that it can draw on within-country variation, which allows us to estimate moving responses and to consider the impact of wealth taxes and other taxes jointly.[2] Moreover,

[1] In an earlier version of this paper (Brülhart, Gruber, Krapf and Schmidheiny, 2017), we employed similar panel-data estimation using variations across municipalities within one canton (Bern). This yielded a baseline semi-elasticity estimate of 23%. However, the relatively small municipality-level tax changes did not offer much statistical power. This is why we now focus entirely on between-canton comparisons. In Brülhart et al. (2017), we also reported cross-canton estimates. Those estimates are updated and extended in Section 5 of this paper.

[2] Martinez (2017) estimates elasticities of the stock of wealthy taxpayers following a cut in top income and wealth tax rates in the Swiss canton of Obwalden. Her analysis does not allow separate identification of the effect

we are able to quantify the share of the aggregate response accounted for by the migration channel, in a setting where taxation affects not just the very wealthiest taxpayers but the top three deciles of the wealth distribution. This allows us to produce some of the 'still lacking systematic evidence on the mobility elasticities of the broader population' (Kleven, Landais, Muñoz and Stantcheva, 2019, p. 21).

Our work also relates to research on the impact of estate taxation on wealth holdings. This small literature is reviewed in Kopczuk (2009). There are several studies from the U.S., using either cross-sectional variation in estate taxes across states (Holtz-Eakin and Marples, 2001), national tax reforms interacted with age (Slemrod and Kopczuk, 2001), or aggregate time series (Joulfaian, 2006). These studies reach similar conclusions of a modest elasticity of the taxable base of estates with respect to the tax rate of between 0.1 and 0.2.

Also related are papers which study the impact of capital income taxation on the composition of wealth holdings (e.g. Poterba and Samwick, 2003; see Poterba, 2001 for a review). This research tends to find that the form of savings is fairly sensitive to its taxability, for example with rising taxes on capital income leading to more savings in tax preferred channels, and with taxes impacting the riskiness of portfolio holdings. But this literature does not focus on the impact of taxation on total wealth accumulation.

More broadly, a large literature has emerged on the impact of income taxation on total income (see Saez et al., 2012, for an overview). This literature has generally found modest elasticities of taxable income with respect to net-of-tax rates, with a central range of estimates of 0.1 to 0.4. These studies have furthermore shown that the summary elasticity estimate can mask considerable heterogeneity across various dimensions, such as the income distribution (Gruber and Saez, 2002; Kleven and Schultz, 2014). A number of studies have suggested that this response is largely driven by exclusions and deductions from income, rather than real savings or labor supply behavior. But there has been little attempt to decompose the impact of tax changes into capital and labor income. A notable exception is Kleven and Schultz (2014), who find capital income to be two to three times as elastic to income taxes as labor income.

3 Swiss institutional context

3.1 The importance of canton-level taxation

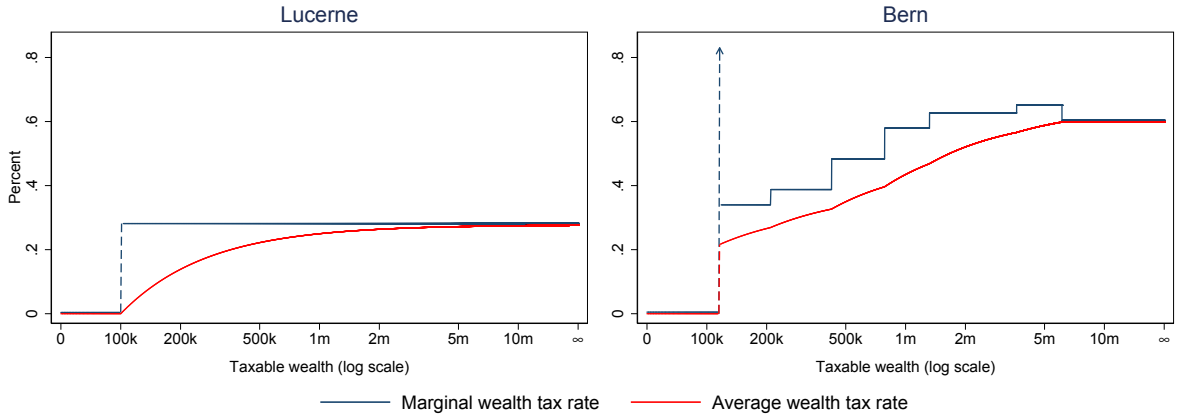
As shown in Table 1, Switzerland is unique in its reliance on wealth taxation and in the sub-national nature of that taxation. Wealth taxes are cantonal and municipal; there is no federal taxation of wealth.

Switzerland is divided into 26 cantons and some 2,300 municipalities. These sub-federal jurisdictions taken together autonomously raise 53% of total tax revenue. Cantons have almost complete autonomy over taxation and public spending.[3] Municipalities in most cantons can

of wealth taxes.

[3] The revenue percentages reported in this section are calculated over our main sample period, 2003-2015, and taken from https://www.efv.admin.ch/efv/en/home/themen/ finanzstatistik/berichterstattung.html. At the federal level, the main tax instruments are value added taxes (37% of federal tax revenue and the sole prerogative of the federal government), personal income taxes (16% of federal tax revenue, 17% of consolidated personal income tax revenue) and corporate income taxes (13% of federal tax revenue, 46% of consolidated corporate income tax revenue).

Figure 1: Marginal and average wealth tax schedules 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 is 21.0%. For additional detail, see Appendix Figure A.1.

determine their level of taxation by adding municipal 'multipliers' to the canton-level tax schedules. The Swiss constitution assigns taxation rights to the cantons by default, with the federal government allowed to raise taxes only subject to explicit legal provisions to be approved in nationwide referenda. The main constraint on the fiscal autonomy of cantons is a federal law in force since 1993 that standardizes the definitions of tax bases and sets out assignment principles for taxable income and assets that need to be allocated across cantons.

3.2 Wealth taxes

Cantons have been taxing wealth since the early 18th century.[4] Wealth taxes are paid annually on self-reported net wealth, declared to the tax authorities as an integral part of tax filings. In addition, net returns on financial assets are subject to personal income taxation at the federal, cantonal and municipal level, but capital gains are not taxed.

Residents aged 18 and over are legally obliged to submit an annual tax filing. All types of wealth (cash, financial assets, real estate and luxury durable goods) are subject to the same tax, net of debt (mortgage or other). Standard durable household goods, compulsory pension assets and a limited amount of voluntary pension savings are exempt from the wealth tax.[5] Wealth is taxed by the municipality and canton of a taxpayer's main legal residence irrespective of the taxpayer's nationality; except for real estate, which is taxed where it is located.[6] Married couples are taxed jointly, subject to a different schedule from that applied to single households.

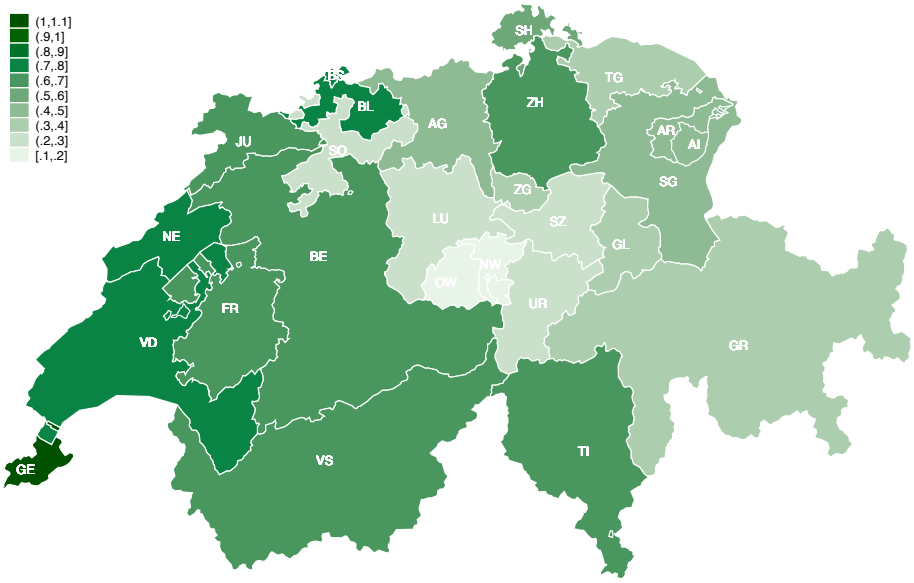
Exemption levels vary by canton but are always low in international comparison. In 2015,

[4] The federal government raised such taxes intermittently between 1915 and 1957, after which wealth taxation again became the sole prerogative of the cantons and municipalities (Dell, Piketty and Saez, 2007).

[5] In 2015, the maximum tax-exempt annual contribution to voluntary pension schemes was CHF 6,768 for employees and CHF 33,840 for the self-employed. This ceiling is changed annually in line with inflation.

[6] This means that Swiss nationals residing abroad are liable for Swiss wealth taxes only to the extent that they own real estate in Switzerland. Conversely, Swiss residents do not owe Swiss wealth taxes on real estate located abroad.

Figure 2: 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.

they ranged from CHF 25,000 (USD 25,000) to CHF 200,000 (USD 200,000).[7] The wealth tax thus affects much of the middle class in addition to the wealthiest families.

Figure 1 presents representative wealth tax schedules for married couples in Lucerne and Bern, the two cantons used for our case study in Section 6. We focus on these two cantons because we have individual-level tax data for both, and because they offer a useful event study as Lucerne dramatically lowered its wealth tax rate in 2009.[8] In Lucerne (left-hand panel of Figure 1), the couples exemption threshold in 2015 stood at CHF 100,000, and a constant marginal tax rate applied above the threshold. In Bern (right-hand panel of Figure 1), a progressive schedule applied, with marginal tax rates rising from the threshold at CHF 115,000 up to a taxable wealth level of CHF 6.1m for married couples.[9] Our data show that 42% of filers in Lucerne and 34% of filers in Bern had wealth above the exemption level (see Appendix Figure A.1). Total wealth below the exemption level accounted for only 2.5% of total wealth in Lucerne and 5.4% of total wealth in Bern. Hence, most declared private wealth in Switzerland is non-exempt from the wealth tax.

In our cross-canton panel analysis, we focus on top marginal tax rates. The map of Figure 2 illustrates the considerable variation in those rates that exists across cantons. In 2015, top wealth tax rates varied by a factor of almost eight, ranging from 0.13% to 1.00%. Wealth taxes are generally highest in the French-speaking cantons of western Switzerland and lowest in the small German-speaking cantons of central Switzerland.

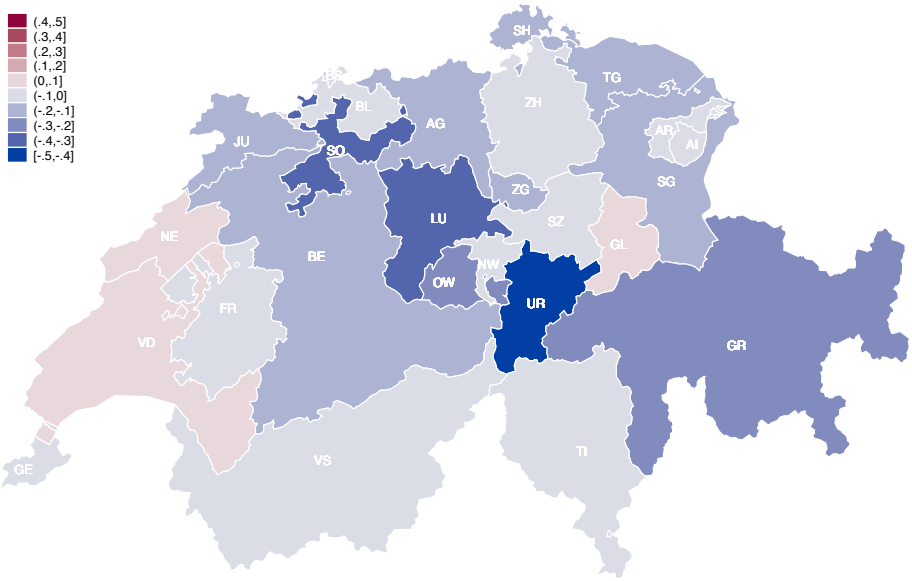
Figure 3 shows that wealth taxes have been on a general downward trend in recent years,

[7] The Swiss franc (CHF) has been trading roughly at parity with the US dollar since 2015. We therefore do not report separate figures in USD in the remainder of this paper.

[8] In 2015, Lucerne had a population of 0.4m and Bern of one million, representing some 5 and 12 percent, respectively, of the national population (8.3m). Further details are given in Section 6.

[9] In Bern, unlike Lucerne, taxpayers above the exemption level pay tax on their entire wealth holdings. This creates a 'notch' in the wealth tax schedule, which we will discuss below. The 2015 exemption thresholds for singles were CHF 50,000 and CHF 97,000 in Lucerne and Bern, respectively.

Figure 3: Change in top marginal wealth tax rates across Swiss cantons, 2003-2015



Notes: Change in marginal tax rate on wealth > CHF 5m, in percentage points. 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.

but there is considerable variation in the size and timing of tax changes. The cumulative changes in the top wealth tax rate range from -0.46 percentage points to +0.01 percentage points. Tax changes are most pronounced in cantons located in central Switzerland, among which tax competition has been particularly intense in the early 2000s; but other, more outlying cantons such as Solothurn (SO) or Graubünden (GR) have significantly lowered their wealth tax rates as well. The high-tax western cantons left their rates largely unchanged over the sample period.[10]

There is no institutional reporting of financial wealth, and tax authorities have no direct access to bank information except in criminal cases. This in principle offers scope for tax evasion through non-reporting. However, a 35% federal withholding tax is applied to income from all financial assets (mainly interest and dividends). Withholding tax payments are returned upon declaration of the assets in tax filings, backed up with bank statements. This implies an incentive for declaring financial assets because statutory income tax rates are below 35% except for top incomes in a few cantons. Tax authorities in addition carry out randomized audits and request documentation for all changes in wealth holdings that are not evidently compatible with changes in other positions of the tax declaration (income, inheritance, real estate transactions, etc.). To our knowledge, no rigorous estimates exist of the extent of wealth tax evasion in Switzerland. We return to this issue below, when interpreting our estimates.

3.3 Other canton-level taxes

The annual wealth tax is the most prominent form of wealth taxation in Switzerland, accounting for 9% of tax revenues of sub-federal governments. However, other types of wealth taxation exist.

[10] See also Figure 4 below for details on the largest canton-level wealth tax reforms. Appendix Figure A.2 shows the universe of tax rate changes in our sample.

Bequest taxes account for 2% of revenues. Tax rates are low in international comparison: the effective average tax rate on inheritance was 3.0% in 2008, with bequests to direct descendants exempt from taxation in most cantons.[11] Over the sample period we study, 17 cantons had no bequest tax on direct descendants, 5 cantons had a bequest tax in all years, and 4 had a tax in some years. We will control for cross-cantonal variation in the bequest tax in our cross-canton analysis. There are also various taxes on real estate.[12] The complicated nature of these taxes and data limitations make it difficult to quantify these taxes precisely. However, a qualitative analysis suggests that there was minimal panel variation in real estate taxes over our sample period (see Appendix B.1).

The most important source of sub-federal tax revenues is the tax on personal income, which accounts for 62% of those revenues. The personal income tax includes all capital income other than capital gains, and net capital income is treated like labor or transfer incomes in the computation of taxable income. The income tax rate therefore can influence wealth accumulation both directly, by affecting wealth returns, and indirectly, by affecting returns to labor supply. We therefore control for income tax rates in our cross-canton analysis as well.

4 Data

4.1 Cross-canton panel

We work with two complementary datasets. The first one covers all 26 cantons over the 2003-2015 period. This dataset has the advantage of offering a maximum of identifying variation on wealth and personal income tax rates, as cantons frequently change their tax schedules.

Our dependent variable is a canton-year measure of total wealth holdings, which has been collected by the federal administration in the context of the fiscal equalization scheme since 2003.[13] As our main explanatory variable, we use consolidated (cantonal + municipal) top marginal wealth tax rates. These tax rates depend on the basic cantonal wealth tax schedules as well as on cantonal and municipal multipliers, and they are averaged across municipalities, weighted by the number of taxpayers, for every canton.[14]

We control for personal income taxes, which account for the largest share of personal tax revenue and are the most salient jurisdiction-specific tax variable. We, again use top marginal rates. Given their potential relevance for wealth accumulation, we also control for representative bequest tax rates by canton and year.

[11] This tax rate is weighted by observed shares of heir categories, based on data from Brülhart and Parchet (2014).

[12] Real estate taxes come in three forms that are of comparable importance in revenue terms: land taxes (amounting to a top-up on wealth taxes on real estate), real-estate capital gains taxes (a tax on real estate speculation with rates decreasing in the length of time over which a property is held) and real estate transaction taxes (akin to stamp duties).

[13] There are no individual wealth tax records at the federal level, because wealth is not taxed by the federal government. The available aggregate data report taxable wealth as well as the number of taxpayers in each of 11 brackets of taxable asset holdings per canton and year, ranging from a bracket for zero net wealth to one for more than CHF 10m. See Appendix B.1 for details.

[14] While only a fraction of taxpayers pay the top marginal tax rate, these top rates turn out to be highly correlated with a wealth-weighted average across taxpayers. Results using the weighted marginal wealth tax rate are therefore very similar to the reported estimates. Average and marginal tax rates too are highly correlated such as to yield virtually identical results. See Appendix B.1 for details.

Table 2: Descriptive statistics: Cross-canton panel data

		Levels					First differences			
	Obs	Mean	Standard deviation		Min	Max	Mean	Std. dev.	Min	Max
			Overall	Within						
Top marginal wealth tax rate (in %)										
level	338	0.534	0.217	0.078	0.127	1.005	-0.010	0.040	-0.398	0.057
Top marginal income tax rate (in %)										
level	338	33.546	5.537	1.250	29.767	39.152	-0.160	0.828	-7.559	4.367
Bequest tax rate (in %)										
level	338	0.607	1.421	0.642	0	5.9	-0.046	0.428	-5.800	0.100
Taxable wealth (in million CHF)										
level	338	53,829	66,763	13,322	2,717	39,115	2,475	5,145	-27,288	39,400
log	338	10.300	1.144	0.204	7.907	12.877	0.050	0.064	-0.165	0.521
Wealth share of millionaires										
level	338	0.564	0.138	0.049	0.236	0.866	0.012	0.019	-0.060	0.105

Notes: Data for the 26 Swiss cantons, 2003-2015. See Appendix B.1 for details.

Table 2 provides summary statistics for the cross-canton panel dataset. Top wealth tax rates range from 0.127% to 1.005%, with an average of 0.534%. The panel offers considerable identifying variation, as evident in within-canton standard deviation of 0.078%, i.e. fully 15% of the mean wealth tax rate.[15] Table 2 also shows that canton-level wealth tax rates were changed considerably more within our sample period than income tax rates.

4.2 Lucerne and Bern micro data

Our second dataset contains the universe of individual-level administrative tax records for the cantons of Lucerne and Bern over the period 2005-2015. These confidential data, containing the majority of items recorded in individual tax declarations, were made available to us in anonymized form by the respective cantonal tax administrations. We observe a host of useful individual characteristics in addition to income and wealth, including residence municipality and marital status. These records were matched with data from population registers allowing us to identify moves into and out of the canton (either within Switzerland or abroad), deaths, coming-of-age (age 18), and changes in marital status.

The combined dataset for the two cantons covers 9.45m taxpayer-years, 6.88m of which feature positive declared net wealth.[16] Of those, 3.03m feature net wealth above taxable thresholds.[17] This reflects the broad-based nature of the Swiss wealth tax: it is paid by the top-44% of taxpayers with positive net wealth, which includes many households commonly considered as middle class.

While we have uncensored data for Bern, stock items in the Lucerne data are top coded above CHF 40m and flow items above CHF 2m. However, we were provided with average

[15] We show the evolution of these top marginal wealth tax rates in all cantons over the years 2001-17 in Appendix Figure A.2.

[16] Married couples are treated as one taxpayer. For Bern we also have data for the years 2001-2004. While we cannot use those data in the comparative analyses with Lucerne, we will use them for the bunching analysis.

[17] In 2005-2015, the taxable threshold in Lucerne remained unchanged at CHF 50,000 for singles and CHF 100,000 for married couples, plus CHF 10,000 for every dependent child. In Bern, the taxable threshold for singles was increased from CHF 92,000 to CHF 94,000 in 2008, and then to CHF 97,000 in 2011. These thresholds were CHF 17,000 (CHF 18,000 as of 2011) higher for married couples, and additionally for every dependent child.

Table 3: Descriptive statistics: Lucerne and Bern

	Lucerne			Bern		
	Taxpayers	Wealth	Wealth/ taxpayer	Taxpayers	Wealth	Wealth/ taxpayer
		CHF m	*CHF m*		*CHF m*	*CHF m*
Panel A: 2005-2015						
All households	215,077	62,089	0.29	600,206	141,047	0.23
Stayer households	206,620	59,075	0.29	584,115	139,116	0.24
Financial		39,615	0.19		91,227	0.16
Non-financial		52,506	0.25		116,687	0.20
Debt		33,046	0.16		68,798	0.12
Stable households	181,293	54,616	0.30	510,957	125,105	0.24
Inmovers Switzerland	3,986	826	0.21	6,604	717	0.11
Inmovers abroad	747	334	0.45	1,761	330	0.19
Outmovers Switzerland	3,440	408	0.12	6,552	647	0.10
Outmovers abroad	766	127	0.17	2,002	151	0.08
Wealth > CHF 40 m	82	9,566	117.66	94	15,595	165.90
Panel B: 2008						
All households	208,574	51,571	0.25	590,479	132,302	0.22
Stayer households	199,430	50,408	0.25	573,219	130,684	0.23
Financial		31,729	0.16		80,630	0.14
Non-financial		49,229	0.25		114,557	0.20
Debt		30,550	0.15		64,502	0.11
Stable households	191,363	49,043	0.26	549,737	127,848	0.23
Inmovers Switzerland	4,408	684	0.16	7,112	536	0.08
Inmovers abroad	852	138	0.16	2,020	232	0.11
Outmovers Switzerland	3,623	309	0.09	7,170	789	0.11
Outmovers abroad	799	60	0.08	2,028	121	0.06
Wealth > CHF 40 m	61	6,941	113.79	71	16,268	229

Notes: Data for taxpayers with positive net wealth. 'Stayer households' refers to taxpayers who who are observed in the same canton in both $t-1$ and t; 'stable households' refers to taxpayers who in addition have no change in marital status over that period. See Appendix B.3 for details.

values in the truncated range, which we attribute to every truncated observation. To make the data comparable across the two cantons, we replace actual wealth above CHF 40m with yearly average wealth conditional on wealth being greater than CHF 40m also in Bern. Moreover, negative net wealth is reported as such in the Bern data but not in the Lucerne data, where it is recorded as zero. In line with the definition of net wealth underlying the federal government's data used in our cross-canton analysis, we only consider non-negative net wealth to construct canton-year wealth aggregates from the Lucerne and Bern micro data.

Table 3 shows summary statistics. While Bern is considerably larger than Lucerne, Lucerne is slightly wealthier, with pre-reform per-capita net wealth of CHF 0.25 in Lucerne and CHF 0.22 in Bern. In both cantons, international inmovers have more wealth on average than international outmovers; and in both cantons the very wealthy, defined as having wealth above CHF 40m, accounted for about 13% of total taxable wealth in 2008.

5 Cross-canton analysis

In this Section, we draw on the considerable panel variation in wealth tax rates across Swiss cantons to obtain estimates of the aggregate response of taxable wealth. In Section 6, we shall draw on individual-level data and a specific tax reform in order to analyse the mechanisms underlying the aggregate response.

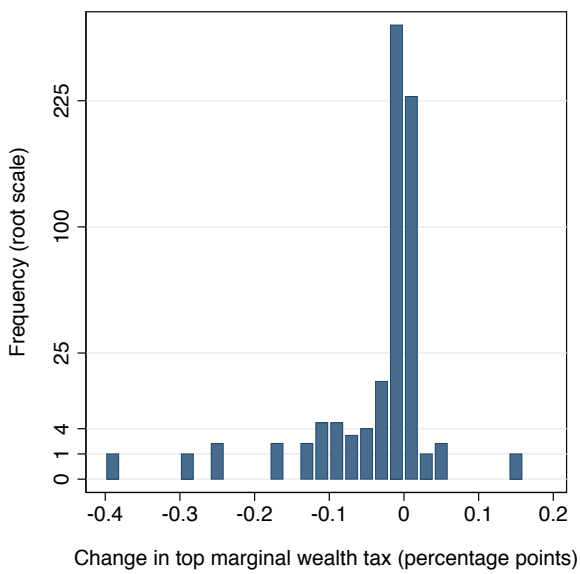
5.1 Event study model

We start by estimating 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 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. 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 $\beta_j = \beta_{-3}$

Figure 4: Canton-level wealth tax changes 1996-2017



1	Uri	2009	-0.40
2	Lucerne	2009	-0.28
3	Obwalden	2006	-0.25
4	Solothurn	2008	-0.25
5	Jura	2005	-0.18
6	Thurgau	2008	-0.17
7	Glarus	2001	-0.12
8	Solothurn	2012	-0.12
9	Schwyz	2007	-0.12
10	Graubünden	2008	-0.12
11	Graubünden	2010	-0.11
12	Thurgau	2002	-0.10
13	Bern	2009	-0.10
14	Basel-Stadt	2003	-0.10
15	Schwyz	2001	-0.10
16	Appenzell I.	2001	-0.09
17	Vaud	2001	-0.09
18	Zug	2009	-0.08
19	St. Gallen	2009	-0.08
20	Aargau	2009	-0.07

Notes: The left panel is the frequency distribution; the right panel lists rank, canton, year and magnitude of the 20 largest tax reductions.

Table 4: 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 4). In 'single event' regressions, cantons with more than one event are dropped from the sample. 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.

for all $j < -3$. These two assumption are typically called 'binning of the endpoints'.[18]

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 4).

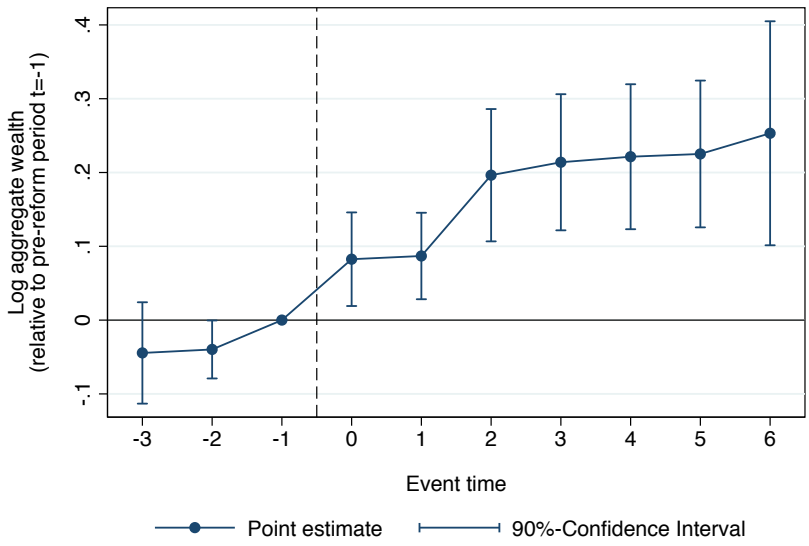
Two of the ten largest tax reductions took place in the same canton (Solothurn). In our baseline event-study estimations, we therefore drop this canton from the sample. However,

[18] 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.

Figure 5: 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 4). One canton (Solothurn) with two of the 10 largest events was dropped.

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.[19]

Table 4 shows our estimation results.[20] 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 4, 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 Table 2), 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 4 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 5 presents such an illustration, based on the top-8 single events (column 2 of Table 4). The

[19] In that case, the binned treatment dummies have to be formed according to the first of the two versions described in footnote 18.

[20] We dropped five observation from the balanced panel described in Table 2 (Lucerne, 2003-2005, and Vaud 2003-2004). According to a Federal Finance Administration report, the values reported by the cantons in those years were incorrect (see `https://www.efv.admin.ch/dam/efv/de/dokumente/finanzausgleich/wirksamkeitsberichte/Wirksamkeitsbericht-d.pdf.download.pdf/Wirksamkeitsbericht-d.pdf`).

Table 5: 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 4). 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.

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 5 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 4. We find semi-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 Appendix Table A.1). 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 5, 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.

5.2 Distributed-lag model

Event study designs are useful for establishing and graphically demonstrating the existence of an effect in an intuitive way, but by focusing only on large events they ignore identifying variation from smaller events. Moreover, through their non-parametric nature, they do not yield directly interpretable effect sizes. Having established that large wealth tax cuts are followed by significant increases in declared wealth, we now proceed to estimate the effect of all tax reforms on aggregate wealth using the magnitudes of all changes in cantonal wealth tax rates as identifying variation. We estimate the following distributed-lag model in first differences:

$$\Delta \ln W_{it} = \sum_{j=-2}^{6} \gamma_j \Delta \log(1 - \tau_{i,t-j}) + \theta_t + \Delta\varepsilon_{it}, \tag{3}$$

where $\tau_{i,t}$ is the top marginal wealth tax rate in canton i and year t. First differencing, $\Delta \ln W_{it} = \ln W_{it} - \ln W_{i,t-1}$, eliminates canton fixed effects μ_i which are therefore controlled for. The cumulative effect after j years can be recovered from the distributed-lag coefficients γ as

$$\beta_j = \begin{cases} -\sum_{k=j+1}^{-1} \gamma_k & \text{if} \quad -3 \leq j \leq -2 \\ 0 & \text{if} \quad j = -1 \\ \sum_{k=0}^{j} \gamma_k & \text{if} \quad 0 \leq j \leq 6, \end{cases} \tag{4}$$

which expresses the effect β_j relative to the year prior to the reform. Hence, we use the same standardization $\beta_{-1} = 0$ as in the event study. Limiting the distributed-lag model to 2 leads and 6 lags is equivalent to binning the endpoints in the event study model at 3 years before and 6 years after the event.[21]

We use the log of the net-of-tax tax rate as the main explanatory variable, in line with the convention in the elasticity of taxable income literature. However, as wealth tax rates are smaller than 1%, $\ln(1 - \tau_{i,t-j})$ is almost exactly equal to $-\tau_{i,t-j}$. β_j can therefore either be interpreted as net-of-tax rate elasticity or as the semi-elasticity w.r.t. a 100 percentage point increase in the wealth tax rate. We report $\beta_j/100$ as the effect on aggregate wealth j years after the reform of a one percentage point cut in the wealth tax rate $\tau_{i,t-j}$.

Table 6 shows our estimation results. Column 1 reports estimates of equation 3. We fur-

[21] Schmidheiny and Siegloch (2018) show that the estimation of the coefficients γ in a distributed-lag model and subsequent calculation of the cumulative effects β is the natural generalization of the event study model to multiple events of varying size. Note that an event study model with periods $j = -3$ to $j = 6$ and the standardization $\beta_{-1} = 0$ corresponds exactly to a distributed-lag model with 6 lags and -2 leads.

Table 6: Cross-canton distributed-lag model in first differences for aggregate wealth

	[1]	[2]	[3]	[4]
Wealth tax effect				
3 and more years before event	0.078	0.042	0.016	0.092
	(0.077)	(0.081)	(0.120)	(0.113)
2 years before event	-0.041	-0.042	-0.081	-0.052
	(0.054)	(0.061)	(0.088)	(0.085)
1 year before event	0	0	0	0
at event	0.167 *	0.214 **	0.222 **	0.182 *
	(0.099)	(0.090)	(0.109)	(0.108)
1 year after event	0.124	0.205 *	0.190 *	0.126
	(0.096)	(0.105)	(0.114)	(0.112)
2 years after event	0.399 **	0.486 ***	0.436 **	0.368 *
	(0.158)	(0.176)	(0.198)	(0.203)
3 years after event	0.408 ***	0.495 ***	0.488 **	0.425 **
	(0.156)	(0.181)	(0.204)	(0.214)
4 years after event	0.391 **	0.463 ***	0.459 **	0.411 **
	(0.157)	(0.175)	(0.183)	(0.200)
5 years after event	0.435 **	0.511 **	0.471 **	0.432 **
	(0.179)	(0.199)	(0.206)	(0.220)
6 and more years after event	0.485 **	0.517 **	0.483 *	0.461 *
	(0.245)	(0.254)	(0.265)	(0.276)
Income tax effect				
5 years after event			0.002	0.005
			(0.008)	(0.009)
Bequest tax effect				
5 years after event				-0.011
				(0.015)
Year fixed effects	yes	yes	yes	yes
Initial share of millionaires x year f.e.		yes	yes	yes
Number of observations	307	307	307	307
Number of cantons	26	26	26	26

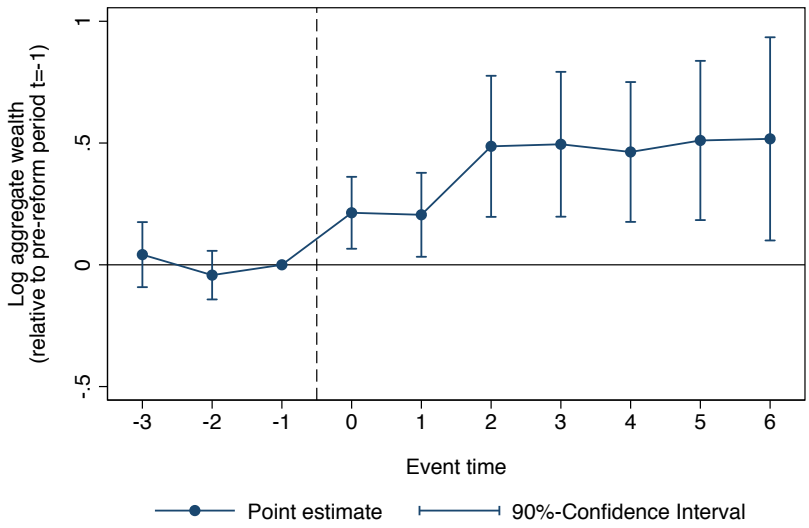
Notes: Regression of aggregate taxable cantonal wealth (in first differences of logs) on 6 lags and 2 leads of net-of-wealth-tax rate (in first differences of logs) and control variables. If included as control variables, the net-of-income-tax and net-of-bequest-tax rate and are also included in first 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. The table reports cumulative log differences in wealth w.r.t. a 1% increase in the net-of- tax rate. In the case of wealth and bequest taxes, the reported effects w.r.t. a 1% increase in the net-of- tax rate can also be interpreted as the effect w.r.t. a 1 p.p. decrease in the tax rate. Standard errors clustered for cantons in parentheses. Significance * p<0.10, ** p<0.05, *** p<0.01.

thermore show specifications that include interaction terms of initial-year millionaire shares and year fixed effects (columns 2-4) that control for canton-level personal income taxes (columns 3-4), and for bequest taxes (column 4).

The results of Table 6 confirm our finding from the events study: tax changes triggered significant tax-base responses. While we again see no statistically significant trends in wealth accumulation prior to the tax cuts, all four specifications shown in Table 6 imply statistically significant increases in taxable wealth subsequent to tax cuts.

We again illustrate the implied tax-base response in a graph of the sequencing of average effects, in Figure 6 (based on the estimates in column 2 of Table 6). Similar to the event-study estimates illustrated in Figure 5, this graph shows a strong response that plateaus out after some three years. Figure 6 also clearly illustrates the absence of pre-trends in our first-differences panel model.

Figure 6: Cross-canton distributed-lag model estimated in first differences



Notes: Distributed-lag cumulative effects according to equation (4), estimated through the first-differences empirical model (3) with nonparametric controls (initial share of millionaires × year dummy) for all wealth tax rate changes. Effects are the cumulated coefficients after and before the reference year, i.e. one year prior to the event. Estimated effects × 100% can be interpreted as the percentage effect of a 1 p.p. reduction in the wealth tax rate on aggregate wealth. Note that the largest tax reduction in our sample is 0.4 p.p. (see Figure 4).

In the first-difference panel design employed here, estimated coefficients can be interpreted directly as implied semi-elasticities with respect to a 1 percentage point decrease in the wealth tax rate. If we consider responses over a 5-year horizon, our estimates in Table 6 imply semi-elasticities between 0.43 and 0.51. These responses – albeit somewhat smaller than the corresponding event-study estimates – are again larger than all estimates reported elsewhere (see Appendix Table A.1). The slight shrinkage of the estimated effects compared to those found with the event-study design again suggests that tax-base elasticities increase in the size of the tax change.

Changes in income tax rates or in bequest tax rates, however, have no discernible impact on taxable wealth.

In Table 7, we explore differential responses across wealth categories, distinguishing wealth by taxpayers declaring more than CHF 500,000, CHF 1m and CHF 5m, respectively. We report estimates of the specification with the full set of control variables (as in column 4 of Figure 6).

Like in the event-study estimates of Table 5, we find some evidence 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 wealth of millionaires after 5 years is 0.51, which is somewhat higher than the 0.43 estimated for wealth by all taxpayers combined. However, these estimates are again 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. Indeed, when considering wealth of the very wealthiest (CHF 5m and more), we do not even find a statistically significant response anymore. While this is likely due to a lack of statistical power (the magnitude of the effect is still larger than that for total wealth), our cross-canton panel estimates do not suggest that the very wealthy react significantly more sensitively to changes in wealth taxation than the moderately wealthy.

Table 7: Cross-canton distributed-lag model in first differences 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 rate effect				
3 and more years before event	0.092	0.169	0.200	0.380
	(0.113)	(0.158)	(0.195)	(0.305)
2 years before event	-0.052	-0.001	0.030	0.216
	(0.085)	(0.111)	(0.133)	(0.194)
1 year before event	0	0	0	0
at event	0.182 *	0.218 *	0.230	0.425
	(0.108)	(0.132)	(0.150)	(0.259)
1 year after event	0.126	0.163	0.166	0.258
	(0.112)	(0.143)	(0.162)	(0.288)
2 years after event	0.368 *	0.454 *	0.455 *	0.384
	(0.203)	(0.257)	(0.270)	(0.364)
3 years after event	0.425 **	0.528 *	0.550 *	0.610
	(0.214)	(0.271)	(0.285)	(0.386)
4 years after event	0.411 **	0.471 *	0.463	0.423
	(0.200)	(0.264)	(0.282)	(0.406)
5 years after event	0.432 **	0.507 *	0.507 *	0.469
	(0.220)	(0.285)	(0.297)	(0.401)
6 and more years after event	0.461 *	0.516	0.532	0.510
	(0.276)	(0.351)	(0.369)	(0.475)
Income tax effect				
5 years after event	0.000	-0.002	-0.006	-0.024 **
	(0.007)	(0.009)	(0.009)	(0.012)
Bequest tax effect				
5 years after event	-0.011	-0.013	-0.013	0.003
	(0.015)	(0.019)	(0.021)	(0.035)
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) 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. The table reports cumulative log differences in wealth w.r.t. a 1% increase in the net-of-tax rate. In the case of wealth and bequest taxes, the reported effects w.r.t. a 1% increase in the net-of- tax rate can also be interpreted as the effect w.r.t. a 1 p.p. decrease in the tax rate. Standard errors clustered for cantons in parentheses. Significance * p<0.10, ** p<0.05, *** p<0.01.

To summarize the results of our cross-canton analysis, we find large aggregate responses to canton-level wealth tax changes. Our lowest estimated semi-elasticity, identified over all tax-rate changes within our sample, is 0.43. This is higher than panel-based estimates reported for other countries, which range from 0.14 to 0.32 (see Appendix Table A.1). We estimate even higher elastiticies when we focus on the largest tax reforms only, where we obtain effects even in excess of 1. However, evidence of stronger responses by wealthier taxpayers is weak at best. We also observe that while declared wealth in Swiss cantons reacts very sensitively to wealth taxation, it does not discernibly respond to personal income or bequest taxes.

6 The Lucerne wealth tax cut

6.1 An almost random policy difference

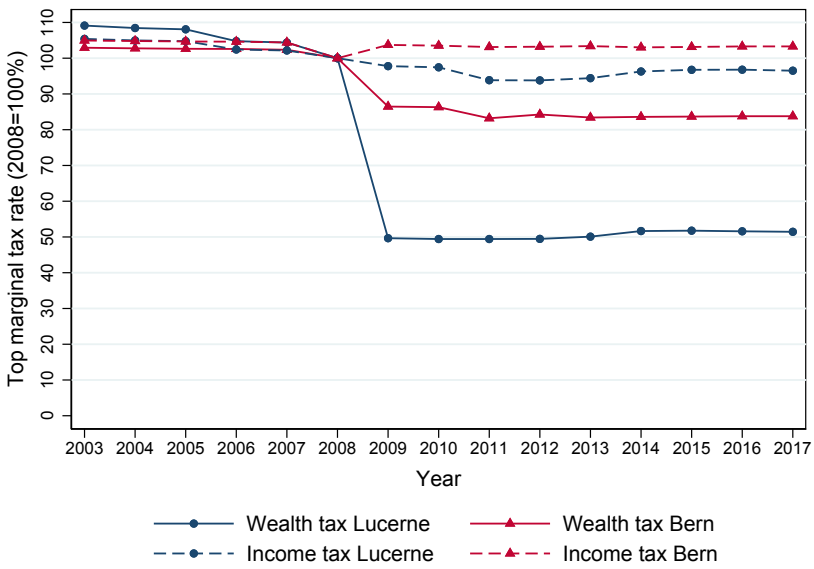
The cross-cantonal panel analysis of Section 5 has allowed us to estimate the aggregate behavioral response that is of main interest from a fiscal policy perspective. For more detailed insights into response heterogeneity and mechanisms, however, we need disaggregated information. We have obtained access to the universe of individual-level tax records for two cantons that offer a well suited empirical setting: Lucerne and Bern.

In 2009, the canton of Lucerne cut its wealth tax rate in half. This meant that top rates fell from 0.56% in 2008 to 0.28% in 2009. In the same year, the neighboring canton of Bern cut its top wealth tax rate more modestly, from 0.74% to 0.64%. The Lucerne wealth tax cut was thus nearly three times larger than the Bern tax cut, with a difference of 0.18 percentage points. Usefully for our comparative analysis, these simultaneous wealth tax cuts represented isolated events: in both cantons, wealth tax rates remained essentially unchanged in the years prior to and after those reforms, and personal income tax rates remained stable throughout the 2003-2017 period (see Figure 7). Both cantons also left their laws and regulations for valuing real estate and non-traded financial assets unchanged throughout our sample period.

Comparing the evolution of taxable wealth between Lucerne and Bern around the year 2009 can thus offer difference-in-differences evidence of taxpayer responses to a large change in the wealth tax rate.

Lucerne and Bern offer an attractive empirical setting for two additional reasons. First, Lucerne and Bern resemble each other in a number of important respects: they are contiguous neighbors, they are predominantly German speaking, they are among the larger cantons, they have comparable urban-rural demographic compositions, and they both straddle Alpine and

Figure 7: Wealth and income tax rates in Lucerne and Bern (2008=100)



Notes: The graph shows consolidated cantonal and municipal top marginal tax rates, scaled to their 2008 level. Municipal tax rates are weighted annually by the number of taxpayers. The unscaled statutory tax rates are shown in Figure B.3 of the Online Appendix.

lowland regions. 2008 aggregate net wealth was CHF 51.6bn in Lucerne and CHF 132.8bn in Bern, and per-capita net wealth was somewhat over CHF 0.2m in both cantons (see Table 3).[22]

Second, and even more importantly for our analysis, the difference between their 2009 tax reforms came about almost randomly. In September 2006 (Lucerne) and in March 2007 (Bern), the two cantonal parliaments adopted tax reform packages to cut top wealth tax rates by around half.[23] The two reforms were submitted to compulsory popular referenda in the subsequent year. Uniquely, the cantonal constitution of Bern allows citizens to submit amendments. This meant that Lucerne voters could only vote for or against the large tax cut proposed by their parliament, whereas the Bern voters had a choice between parliament's large tax cut and a smaller tax cut proposed by a citizen committee as a compromise solution. The principle of a wealth tax cut passed with solid majorities in both cantons (77% in Lucerne, 60% in Bern), but in a tie-breaking vote in Bern a very narrow majority of 50.9% against 49.1% preferred the smaller version of the tax cut proposed by the citizen committee. The fact that Bern adopted a much smaller reduction of its wealth tax rate than Lucerne in an otherwise comparable environment thus hinged on a tiny electoral margin.

6.2 The aggregate response

We begin by estimating the aggregate response of the Lucerne tax cut. We compute the response as the cumulative change in reported wealth between 2008 and t in percent of net wealth in 2008:

$$w_{it} = \begin{cases} -\sum_{s=t+1}^{2008} \Delta W_{is}/W_{i,2008} & \text{if} \quad t \leq 2007 \\ \quad 0 & \text{if} \quad t = 2008 \\ \sum_{s=2009}^{t} \Delta W_{is}/W_{i,2008} & \text{if} \quad t \geq 2009, \end{cases} \tag{5}$$

where $\Delta W_{it} = W_{it} - W_{i,t-1}$ is the change in net wealth between $t-1$ and t. We use discrete changes rather than log changes, because this allows us to decompose the aggregate response into different components, and we then interpret the difference between Lucerne and Bern, $w_{\text{LU},t} - w_{\text{BE},t}$, as the cumulative effect of the large 2009 wealth tax cut in Lucerne relative to the small 2009 wealth tax cut in Bern.[24]

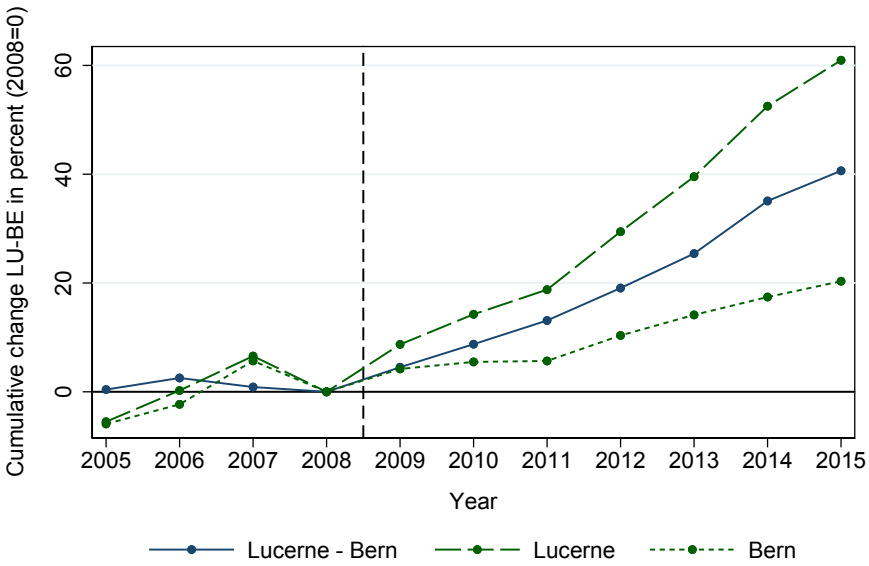
We show the aggregate response as computed from the Lucerne-Bern comparison in Figure 8. Total wealth in these two cantons grew slowly and at almost identical rates prior to the 2009 reform, with a symmetric drop in 2008 explained by the global financial crisis, but significantly more strongly thereafter. Importantly, the post-2009 increase in aggregate wealth was more pronounced in Lucerne than in Bern. By 2015, the cumulative post-reform growth of total wealth was 40.6 percentage points larger in Lucerne than in Bern. This is the aggregate

[22] Lucerne, with 0.4m inhabitants, is the 7th largest of Switzerland's 26 cantons. Bern, with 1m inhabitants, is the second largest canton. Both cantons have per-capita tax bases that are below the Swiss average, and they are thus net recipients of fiscal equalization transfers. The 2018 tax capacity index of Lucerne stood at 89.4 and that of Bern at 75.1, for a Swiss average of 100. For the impact of linguistic and cultural similarity on fiscal preferences, see Eugster and Parchet (2019).

[23] The reform proposals were motivated by their proponents with earlier wealth tax cuts in small neighbor cantons attracting away wealthy taxpayers, combined with the introduction of a new federal fiscal equalization scheme scheduled for 2008 that promised greater fiscal leeway for net recipient cantons.

[24] We will use log changes to quantify behavioral responses in Section 6.4.

Figure 8: Differential growth of aggregate wealth: Lucerne vs Bern



Notes: The graph shows cumulative differential changes in wealth of Lucerne relative to Bern, scaled to differential wealth in 2008. It also shows cumulative changes, relative to 2008, in Lucerne and Bern separately. The 2015 values of the depicted series are, respectively, 60.9 p.p. for Lucerne, 20.3 p.p. for Bern, and 40.6 p.p. for the difference.

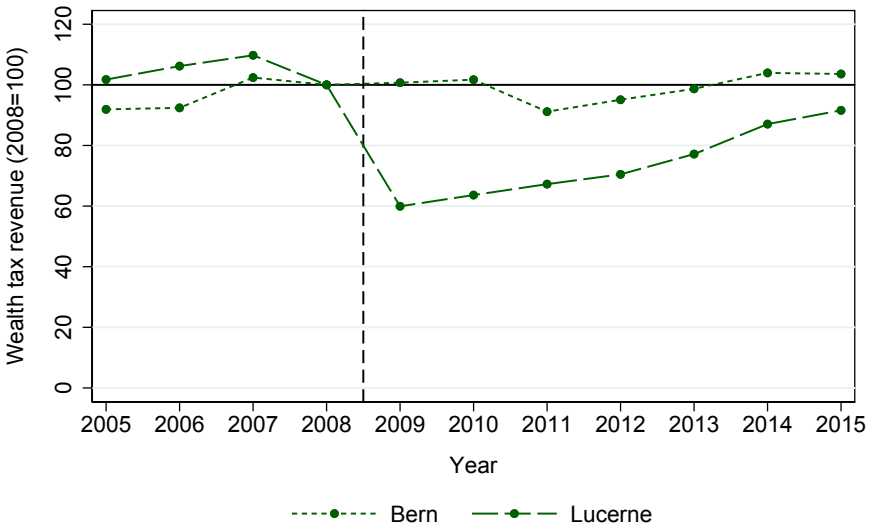
response we shall seek to decompose.

Given that the Lucerne tax cut was 0.18 percentage points larger than the Bern tax cut, this cumulative response implies a semi-elasticity with respect to a 1 percentage point decrease in the wealth tax rate of 226% - some five times larger than the baseline effect estimated in the cross-canton analysis of Section 5 and more than twice the effect estimated from the top-10 largest tax cuts (Table 4). Moreover, Figure 8 suggests that the effect of the 2009 tax cut continued to accumulate beyond 2015. Hence, the 40.6 percentage point effect observed in 2015 is most likely a lower-bound estimate of the long-run aggregate wealth response to the Lucerne tax cut. This strong response is consistent with our finding that larger reforms trigger disproportionately larger responses, Lucerne's tax cut being the second largest wealth tax change observed in our sample (see Figures 3 and 4).

In view of the large observed response to the Lucerne tax cut it is interesting to consider the revenue implications of this policy. Relative to the pre-reform top wealth tax rate of 0.58%, the differential 0.18 percentage point tax cut in Lucerne represented a change of -31%. After six years, this drop in the tax rate had triggered a 40.6% increase in declared wealth (our estimated aggregate response), implying an revenue-relevant elasticity of -0.92 $(= \ln[1 + 0.406])/\ln[1 - 0.31])$ – still below unity in absolute value. Looking at the evolution of wealth tax receipts in Lucerne and Bern (Figure 9), we indeed observe that by 2015 Lucerne's wealth tax revenues remained below their pre-reform level. The strong aggregate tax-base response was not strong enough, up to 2015, for the tax cut to yield Laffer effects.[25]

[25] The main reason why wealth tax revenues in Bern did not fall in 2009, despite the tax cut, is the recovery of asset prices subsequent to the financial crisis. For a full assessment of the fiscal effects of the Lucerne wealth tax cut, one would need to take account also of other taxes paid by inmovers attracted by low wealth taxes.

Figure 9: Wealth tax revenue: Lucerne vs Bern



Notes: The graph shows annual wealth tax revenues in Lucerne and Bern, scaled relative to 2008 values set to 100. Revenue aggregated from individual tax records. The 2015 values of the depicted series are, respectively, 103.6 for Bern and 91.6 for Lucerne.

6.3 Decomposing the aggregate response

The main appeal of the Lucerne-Bern case study is that it allows us to decompose the aggregate response into different components. We therefore take the 40.6 percentage point cumulative difference in wealth growth between Lucerne and Bern seven years after the tax cut as the response to be disaggregated into the contributions from different components of the wealth tax base. The share of each of these components in explaining the aggregate response depends both on the respective component's share of base-year aggregate wealth and on the magnitude of their respective response.

6.3.1 Mechanical effect

A first decomposition is into effects that result from taxpayer choices versus effects that are mechanical – i.e. the mere result of higher post-tax wealth due to the lower tax rate, *ceteris paribus*. To this end, we simulate how aggregate wealth in Lucerne would have evolved after the tax cut in the absence of any behavioral responses.

We calculate the counterfactual post-reform growth rate of wealth as the growth rate of aggregate wealth in the canton of Bern before tax payments, i.e $g_t = (W_{\text{BE},t} + T_{\text{BE},t-1} - W_{\text{BE},t-1})/W_{\text{BE},t-1}$, where $W_{\text{BE},t}$ is observed aggregate wealth in Bern at time t and $T_{\text{BE},t-1}$ are tax payments on wealth at time $t-1$.[26] We find post-reform annual growth rates of pre-tax aggregate wealth in Bern between 0.9 and 5.9 percent, with an average of 3.8 percent. We then iteratively calculate the post-reform evolution of counterfactual wealth in Lucerne without

[26] For simplicity, we assume a linear wealth tax, i.e. $T_{\text{BE},t} = \tau_{\text{BE},t} \times W_{\text{BE},t}$, where $\tau_{\text{BE},t}$ is the observed top marginal tax rate in the Bern, and hence $g_t = \Delta W_{\text{BE},t}/W_{\text{BE},t-1} + \tau_{\text{BE},t-1}$. The true average wealth tax rates are lower than the top marginal rate because of the exemption threshold and, in the case of Bern, the progressivity of the tariff above the threshold (see Appendix Figure A.1). Hence, our reported mechanical effect is an upper-bound estimate.

behavioral responses as $\widetilde{W}_{\text{LU},t-1}(1+g_t-\tau_{\text{LU},t})$, where $\tau_{\text{LU},t-1}$ is the Lucerne wealth tax rate.[27] We calculate $\widetilde{W}_{\text{LU},t}$ with and without wealth tax reform, i.e. $\tau_{\text{LU},t} = \tau_{\text{LU},2008}$ for all $t > 2008$. The difference, expressed as a percentage of pre-reform wealth $W_{\text{LU},2008}$, is then the mechanical effect, assuming that tax savings are invested and yield the same return as the stock of wealth.

We find a cumulative mechanical effect of 2.3 percentage points in 2015.[28] Hence, only some 5.7% of the estimated 40.6 percentage point aggregate response can be attributed to mechanical tax savings and the return thereon. If some of the mechanical tax savings were consumed – which we implicitly assume not to be the case – this effect would be even smaller (see Section 6.3.6 below).

6.3.2 Taxpayer mobility

Next, we ask what proportion of the post-reform increase in taxable wealth was due to net in-migration. And we further break down the migration effect into intra-national and international taxpayer mobility.

To this end, the year-on-year change of aggregate wealth can be decomposed as follows:

$$\Delta W_{it} = \Delta W_{it}^{\text{stayer}} + W_{it}^{\text{in}} - W_{i,t-1}^{\text{out}} = \Delta W_{it}^{\text{stayer}} + W_{it}^{\text{mover}}, \tag{6}$$

where $\Delta W_{it}^{\text{stayer}}$ is the change of wealth of all taxpayers whose tax residence was canton i in both $t-1$ and t, W_{it}^{in} is the wealth of taxpayers who moved into canton i in year t and $W_{i,t-1}^{out}$ is the wealth of taxpayers who moved out of canton i in year $t-1$. Net mover wealth between $t-1$ and t is defined as $W_{it}^{\text{mover}} = W_{it}^{\text{in}} - W_{i,t-1}^{\text{out}}$. We calculate the change in aggregate wealth of stayers as the residual $\Delta W_{it}^{\text{stayer}} = \Delta W_{it} - W_{it}^{\text{mover}}$. We calculate the cumulative change of wealth attributed to movers relative to aggregate wealth in 2008, $W_{i,2008}$, as in (5), where $W_{is}^{\text{mover}} = W_{it}^{\text{in}} - W_{i,t-1}^{\text{out}}$ is the change in the stock of wealth ΔW_{is} attributed to movers.

We observe that Lucerne's large wealth tax cut triggered a net inflow of wealthy taxpayers. The result of this computation is shown in Figure 10. Of the aggregate 40.6 percentage point cumulative difference in wealth growth between Lucerne and Bern by 2015, 9.8 percentage points were due to additional wealth of net inmovers in their year of arrival, of which 2.7 percentage points were due to international movers. Expressed differently, of the total tax base response, about 24% are explained by the migration margin thus defined, and about 7% are due to migration from abroad.

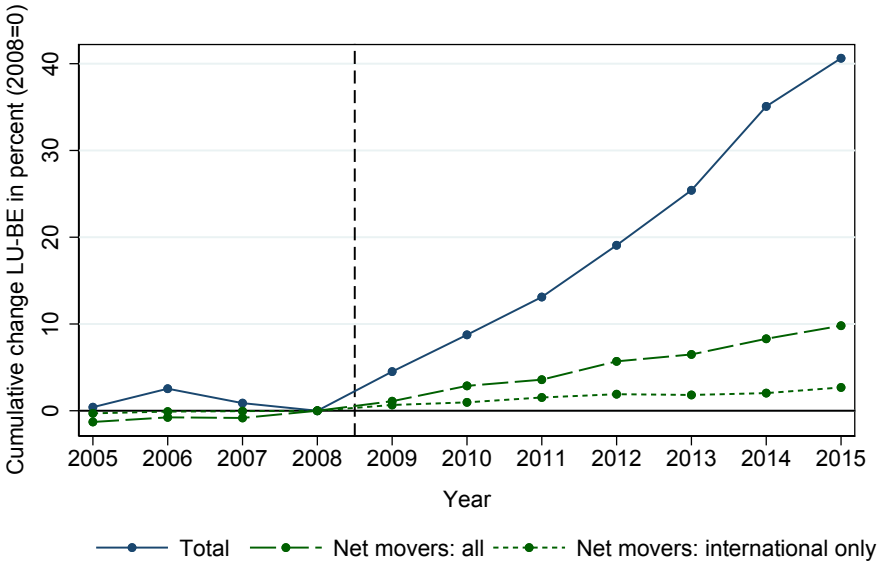
This measure considers wealth of inmovers at the time of arrival only. One could argue that considering only wealth on arrival will not capture the full contribution of the migration margin, as movers' subsequent accumulation behavior should also be considered. The contribution of taxpayer mobility computed in that (generous) way amounted to 11.9 percentage points by 2015, or some 29% of the aggregate response.[29]

[27] This calculation takes account of deferred tax payment in Switzerland by assuming that taxes on wealth at time $t-1$ are paid in the subsequent year t and hence still yield a return g_t between $t-1$ and t.

[28] For a graphical representation, see Figure B.4 in the Online Appendix.

[29] For this computation, we attribute to inmovers not only their wealth in the year of arrival but also changes in their reported wealth in subsequent years, for as long as they remain in the canton. The results are shown in Figure B.5 of the Online Appendix.

Figure 10: Contribution of intra-national and international taxpayer mobility



Notes: The graph shows cumulative differential changes in wealth of 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, in the year of moving. The 2015 values of the depicted series are, respectively, 40.6 p.p. for differential wealth, 9.8 p.p. for wealth of all net movers, and 2.7 p.p. for wealth of international net movers only. Separate graphs for Lucerne and Bern are shown in Figure B.6.

Considering the size of Lucerne – smaller in both area and population than any U.S. state – it is striking that less than 30% of the tax-base response are attributable to mobility, with most of the increase in the tax base accounted for by responses of already resident taxpayers.[30]

6.3.3 Financial and non-financial wealth

We have found most of the aggregate response to come from non-mover households. Changes in net wealth declared by stayers could come from two main wealth categories: real estate, and financial assets. Our data allow us to distinguish between financial and non-financial wealth, where non-financial wealth primarily captures real estate wealth.[31]

In gross terms, the change in aggregate wealth of stayers from year $t-1$ to t can be decomposed into

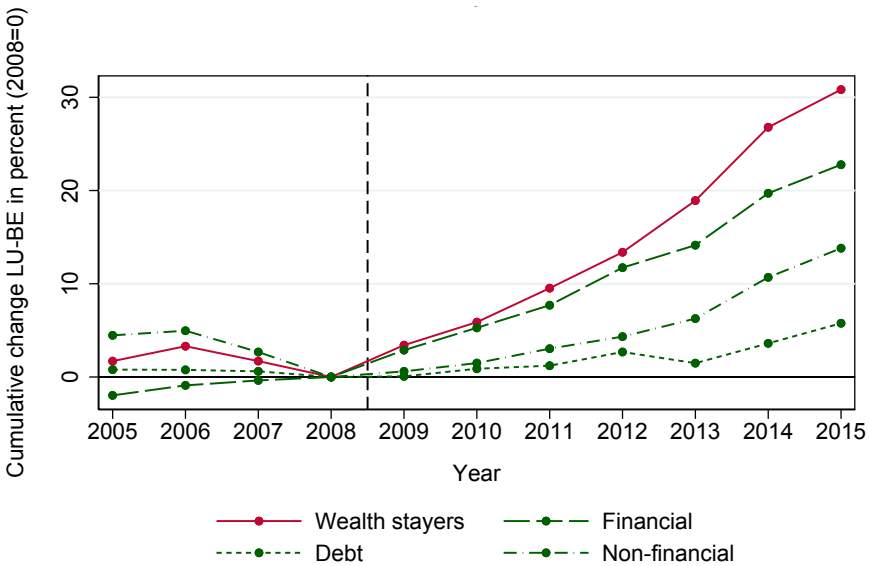
$$\Delta W_{it}^{\text{stayer}} = \Delta W_{it}^{\text{financial}} + \Delta W_{it}^{\text{non-financial}} - \Delta W_{it}^{\text{debt}}, \tag{7}$$

where stayers are again defined as taxpayers who were resident in canton i in both year $t-1$ and year t. $W_{it}^{\text{financial}}$ are the aggregate financial assets of stayers such as bank accounts, stocks, etc.; $W_{it}^{\text{non-financial}}$ are non-financial assets including housing; and W_{it}^{debt} denotes aggregate debt including mortgages. Aggregate gross wealth defined as $W_{it}^{\text{financial}} + W_{it}^{\text{non-financial}}$ exceeds

[30] Interestingly, the cantonal government's first and most prominent argument in the referendum campaign in favor of the wealth tax cut was fiscal attractiveness for mobile taxpayers (see `https://www.lu.ch/-/media/Kanton/Dokumente/JSD/Wahlen_und_Abstimmungen/volksbotschaft_2007_03_11.pdf`). Our results suggest this emphasis to have been based on an overestimate of taxpayer mobility.

[31] According to the Lucerne data, some 78% of non-financial wealth are real estate. Some 3% are wealth from closely held firms. The remainder consists mainly of durable luxury items and life insurance assets. The Bern data allow no such decomposition.

Figure 11: Contribution of changes in financial wealth and debt, stayers only



Notes: The graph shows cumulative differential changes in wealth of Lucerne relative to Bern for taxpayers who do not move between $t-1$ and t ('stayers'), scaled to differential wealth in 2008. It also shows the contributions to the total effect from stayers by changes in financial wealth and in debt. The 2015 values of the depicted series are, respectively, 30.8 p.p. for differential wealth, 22.8 p.p. for financial wealth, 5.8 p.p. for debt, and 13.8 p.p. for non-financial wealth. Separate graphs for Lucerne and Bern are shown in Figure B.7 of the Online Appendix.

aggregate wealth because of debt. We calculate the cumulative change of e.g. financial wealth relative to the stock of wealth in 2008, $W_{i,2008}$, analogously to the computation of aggregate response according to equation (5).

Figure 11 shows the difference of the cumulative change between Lucerne and Bern. Both financial and non-financial taxable wealth clearly increased subsequent to the Lucerne tax cut. The cumulative effect by 2015 was 22.8 percentage points for gross financial wealth, 13.8 percentage points for gross non-financial wealth, and 5.8 percentage points for debt.[32]

6.3.4 Housing

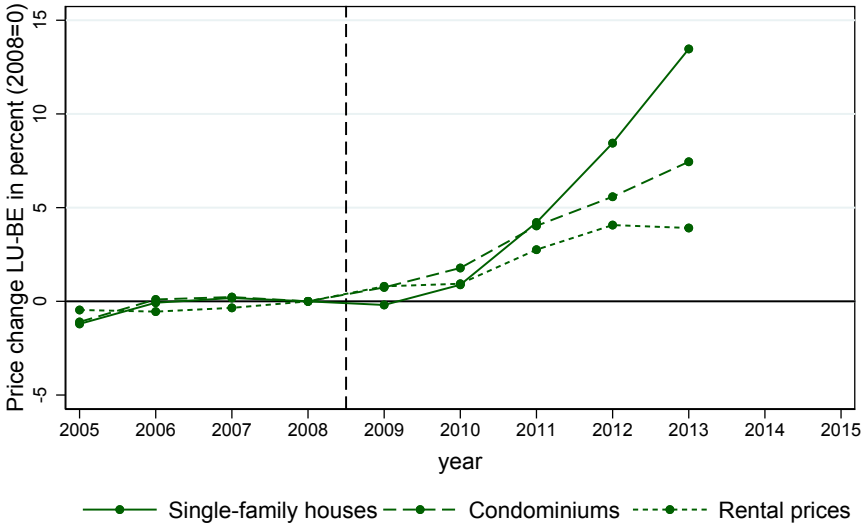
Gross non-financial wealth is mostly housing wealth. As we do not observe mortgage debt separately in the data, we apportion debt to the two wealth types. According to Swiss National Bank statistics, mortgage loans account for 94% of household debt.[33] For an approximative decomposition, we shall therefore apportion 94% of debt to non-financial assets and the remaining 6% to financial assets. With this attribution of debt to assets, the total increase of wealth of stayers of 30.8 percentage points can be decomposed into 8.3 percentage points (or 27%) from non-financial wealth and 22.5 percentage points (73%) from financial wealth. Relative to the initial share of non-financial wealth of 40.7% (Table 3), the increase of 8.3 percentage points implies an increase of 20.4% (= 8.3%/40.7%) in non-financial assets, i.e. mainly housing.

The estimated effect on non-financial wealth corresponds well to observable differential growth of real estate prices in Lucerne relative to Bern. The cumulative price growth differ-

[32] The 22.8 percentage point response by stayers and the 9.8 percentage point response by movers (Section 6.3.2 add up to the aggregate response of 40.6 percentage points (Section 6.2).

[33] See `https://data.snb.ch/en/topics/uvo`.

Figure 12: Evolution of housing prices, Lucerne vs. Bern



Notes: The graph shows the difference in price indices for single-family houses and condominiums in Lucerne and Bern up to 2013. The difference in 2013 relative to 2008 was 13.5 p.p. for single-family houses, 7.5 p.p. for condominiums, and 3.9 p.p. for rental prices. Separate graphs for Lucerne and Bern are shown in Figure B.8 of the Online Appendix.

ential between 2008 and 2013 was 3.9 percentage points for rental properties, 7.5 percentage points for condominiums and 13.5 percentage points for single-family houses (see Figure 12).[34] Considering that increased taxable housing wealth includes also new builds, the observed price changes by 2013 seem roughly consistent with a 20.4% rise in average housing wealth by 2015.

We moreover note that the evolution of housing prices shown in Figure 12 confirms the pertinence of our empirical setting: while Lucerne and Bern housing prices evolved in parallel prior to 2009, a very clear divergence appears concurrently with Lucerne's wealth tax cut of 2009. The parallel trends in housing prices confirm that there were no diverging tendencies in locational attractiveness between the two cantons prior to the 2009 wealth tax reform.

Summarizing the results obtained so far, we find that the aggregate response can be decomposed as follows. Some 6% are due to the mechanical effect, some 20% are due to capitalization into housing prices, some 24% are due to taxpayer mobility, and some 50% are due to changes in taxable financial assets of immobile taxpayers.

6.3.5 Earnings

One mechanism through which wealth of immobile taxpayers could respond is adjustments to labor supply: individuals could accumulate more wealth in response to lower wealth taxes by generating higher earnings.

For this mechanism to have explanatory power over the seven-year time horizon we consider, it would require sizable earnings adjustments. For example, for the roughly 22.5 per-

[34] We use a municipality-year-level housing price index based on hedonic pricing regressions by the real estate consultancy firm Fahrländer Partner and compute population-weighted means for both cantons using population data for 2010. The hedonic model does not include fiscal variables (for a detailed description, see `https://www.fpre.ch/wp-content/uploads/methodenpapier-immo-indizes.pdf`).

centage point non-mechanical response of stayer financial wealth to be explained solely by changed earnings, given an average wealth/earnings ratio of around five and a savings rate of around 0.2, the Lucerne wealth tax would need to have triggered a differential increase in Lucerne annual earnings of more than 10% annually.

We explore the response of earnings of stable households aged 30-50 in 2008, thus focusing on prime working years and eliminating effects due to retirement. We find no effect of the wealth tax cut on earnings. If anything, earnings growth in Lucerne post-2008 was somewhat lower than in Bern. However, that appears to have been the continuation of a trend that applied already before 2009, and the tax cut did not have any discernible effect. In the top 0.1% wealth category, the wealth tax cut seems to have been associated with lower earnings growth, but this series is based on less than 80 taxpayers and thus rather volatile.[35]

6.3.6 Savings

Another potential 'real' response to wealth taxation is changed consumption and savings behavior. Unfortunately, tax data do not contain information about consumption and therefore do not allow researchers to investigate this mechanism directly. We therefore resort to survey data on household finances.

We use data from the Swiss Household Budget Survey for a difference-in-difference estimation of the changes in incomes and savings associated with the Lucerne tax reform. These calculations are shown in the final column of Table 8. We find that, between 2007 and 2013, per-household disposable incomes have increased by 4.4 percentage points more in Lucerne than in Bern, and per-household savings have increased by 3.6 percentage points more. This implies that savings rates have increased by 0.9 percentage points more in Lucerne than in Bern – consistent with an increase in household savings rates in Lucerne associated with the 2009 wealth tax reform.

How large is this effect relative to the aggregate response implied by the tax data? If we linearly interpolate total income as observed in Table 8, an immediate and constant 0.9 percentage point increase in the savings rate from 2009 onwards translates into a stock of wealth that is some CHF 0.9bn higher by 2015. We can compare this to our estimated aggregate response of 40.6%. Applied to Lucerne's 2008 aggregate wealth of CHF 51.6bn, this implies a tax-cut-induced increase in reported wealth of CHF 20.9bn by 2015. Taken litererally, therefore, our estimated savings response can account for (0.9bn/20.9bn =) 4.3% of the aggregate response.[36]

The savings response estimated from survey data is thus smaller than the mechanical effect, which we estimate as 5.7% of the aggregate response (see Section 6.3.1). Recall that

[35] For a graphical representation, see Figure B.14 in the Online Appendix.

[36] The modest size of the behavioral savings response could be attributed to the fact that Table 8 relies on survey data, and that surveys sometimes struggle to accurately capture high-wealth households. Some 85% of the aggregate response to the Lucerne tax cut, after all, are driven by top-1% taxpayers (see Figure B.1). However, it is striking how well the survey aggregates reported in Table 8 match aggregates from our administrative tax data. One variable that is comparable across the two data sets is income from wealth (interest, dividends and rental income). When we compare these values for Lucerne as reported in Table 8 to aggregate wealth income from the tax records, we find the latter to be only 10% larger than the former on average. (We cannot make this comparison for Bern, as the Bern tax data do not separately identify income from wealth.) While there does seem to be some underestimation of wealth through household surveys, the difference appears to be minor.

Table 8: Savings and wealth: evidence from household survey data

	Lucerne (LU)			Bern (BE)			LU – BE
	2007	2013	Growth =([2]/[1])–1	2007	2013	Growth =([5]/[4])–1	Diff-in-diff =[3]–[6]
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Income/househ. (CHF)	75,600	84,052	11.2%	76,140	81,288	6.8%	4.4%
Total income (bn CHF)	11.07	13.57	22.6%	32.53	36.17	11.2%	11.4%
Savings/househ. (CHF)	11,724	17,940	53.0%	9,384	14,016	49.4%	3.6%
Total savings (bn CHF)	1.72	2.90	68.6%	4.01	6.24	55.6%	13.0%
Savings/income	15.5%	21.3%	5.8%†	12.3%	17.2%	4.9%‡	0.9%
Wealth inc./househ. (CHF)	3,252	4,644	42.8%	3,996	4,512	12.9%	19.3%
Total wealth inc. (bn CHF)	0.48	0.75	57.4%	1.71	2.01	17.6%	39.8%
Households	146,400	161,500		427,200	444,900		

Notes:† =([2]–[1]). ‡ =([5]–[4]). All CHF amounts reported per annum. Income defined as recurrent disposable income after taxes and compulsory insurance contributions, plus sporadic income. Savings defined as disposable income minus consumption expenditure and voluntary insurance contributions. Wealth income defined as interest and dividends from financial assets and rental income from real estate. Data based on stratified random household samples; annual sample size $\approx 10,000$ nationwide. Data for 2007 in the table are averages for sampling years 2006-2008. Data for 2013 in the table are averages for sampling years 2012-2014. Households are defined here as people co-habiting. They can comprise more than one taxpayer (e.g. in the case of unmarried couples or of adult children living with their parents). Due to data availability, reported numbers of households are for 2005 and 2012. Data source: Swiss Household Budget Survey (`https://www.bfs.admin.ch/bfs/en/home/statistics/economic-social-situation-population/income-consumption-wealth/household-budget.html`).

our computation of the mechanical effect assumes that all additional income from the tax cut is saved and invested. Our estimated savings effect therefore implies that households save only a fraction of the tax savings and spend the remainder on additional consumption. If we instead assume that the post-2009 Lucerne savings rate of around 21% (Table 8) also applied to tax savings, then the mechanical effect shrinks from 5.7% of the aggregate response to some 1.2%. In view of the likely imprecision of our survey-based estimate of the savings response, we shall continue to consider 5.7% of the aggregate response as our upper-bound estimate for the savings response inclusive of the mechanical effect.

Our estimate of the 5.7% weight of savings in explaining the aggregate response at first sight contrasts with Jakobsen et al. (2019), who interpret the sizeable behavioral wealth responses observed in Denmark entirely in terms of responses in savings rates. However, recall from Section 6.2 that the implied semi-elasticity with respect to a 1 percentage point tax cut estimated from the Lucerne event study is 226%. 5.7% of a 226% response are a response of roughly 13%. Thus, the savings response we estimate is in the ballpark of the 17% semi-elasticity estimated for the second-highest wealth percentile in Denmark (see Table A.1). Indeed, to replicate their observed behavioral responses, Jakobsen et al. (2019) need to calibrate their savings-only model with elasticity values that are 'much larger than existing estimates' and recognize that their estimates 'represent upper bounds on real wealth accumulation responses'. While the magnitudes of estimated savings responses therefore seem comparable, we are able to quantify additional response margins, including mobility, house price capitalization and (by a process of elimination) evasion, all of which are likely to be larger in Swiss cantons than in Denmark, given cantons' smaller scale and lack of third-party reporting.

6.3.7 Evasion

Yet another conceivable mechanism for the stayer response is evasion: after the wealth tax cut, taxpayers may have found tax savings from hiding wealth no longer to outweigh the associated monetary and psychic costs, and thus decided to declare formerly undeclared assets.

Given the absence of third-party reporting in Switzerland, both domestically and (in the period covered by our data) internationally, non-declaration of domestic financial assets and all foreign assets was relatively easy.[37] However, non-declaration carries costs even in a system with purely self-reported financial wealth. The 35% withholding tax on domestic financial assets cannot be claimed back unless the assets are declared. Moreover, non-declared assets cannot be used for large domestic real estate purchases (as this would be visible to tax authorities), they place a burden on heirs when they are bequeathed, and they risk back taxes, fines and even prison sentences if detected.[38]

While evasion by definition is not observed, there are ways of finding suggestive patterns in the data. We consider three complementary approaches: tracking income from wealth in household survey data, analyzing bunching behavior at tax thresholds, and exploring voluntary self-disclosure before and after tax reform.

Reported income from wealth

Our first approach is to return to the household survey data summarized in Table 8. Difference-in-difference analysis suggests that Lucerne savings rates increased only modestly after the wealth tax cut relative to those observed in Bern. Nonetheless, due to higher income growth in Lucerne, Lucerne savings per household grew 3.6 percentage points faster than Bern savings per household. Over the same period, however, reported per-household income from wealth increased 19.3 percentage points faster in Lucerne than in Bern. Other than measurement error, there are only two possible explanations for this phenomenon: either Lucerne residents managed to generate considerably higher asset returns post-reform than Bern residents, or Lucerne residents revealed more of their previously hidden wealth post-reform than Bern residents.[39] Given that the two cantons are part of a frictionless capital market, the evasion margin appears as the more plausible of the two mechanisms.

Bunching below tax thresholds

As argued by Jakobsen et al. (2019) and empirically supported by Seim (2017), bunching of taxable wealth likely reflects evasion and avoidance behavior rather than real earnings and savings responses. Precise targeting of taxable wealth is difficult, as prices of financial assets

[37] Domestic real estate, being recorded in land registries, was much riskier not to declare. Assets held abroad were entirely self-reported until 2017, when Switzerland adopted the OECD's global standard on the automatic exchange of financial account information.

[38] Swiss tax law is relatively lenient on tax evaders in that it distinguishes between 'tax evasion', defined as the non-declaration of assets and income components, and 'tax fraud', defined as the evasion of tax liabilities through falsified documents. Tax evasion, when detected, is sanctioned through back taxes and fines but generates no criminal record. Detection mainly occurs through audits by the tax authorities triggered by inconsistent income and wealth filings or through denunciation. Penal sanctions apply only to tax fraud.

[39] Wealth revelation in the survey data means declaration to an interviewer, not to the tax authority. While not verifiable in the data, it is plausible to assume wealth declarations to tax authorities and to the statistical office to be highly correlated.

and, to a lesser extent, real estate are are uncertain and often volatile. Hence, bunching can be considered a lower-bound indicator of evasion responses.

We observe evident bunching of reported wealth just below exemption thresholds both in Lucerne and Bern (for details, see Appendix A.3). Assuming equal movement from the wealth distribution above the threshold to below the threshold, our analysis suggests that bunching in the exempt range accounts for a 0.2-0.3% reduction in taxable wealth of the two cantons. At face value, this would suggest a small role for avoidance/evasion behavior. However, bunching should realistically be considered as providing a measure that is (a) local, i.e. relevant mainly for filers with true wealth close to the threshold, and (b) downward biased due to the difficulty a targeting taxable wealth at a particular value. To the extent that these two features apply across countries, it is informative to compare our bunching results to those found elsewhere.

We find that observed bunching below exemption thresholds implies net-of-tax elasticities of about 0.7 in Lucerne and 0.8 in Bern (see Appendix A.3). These magnitudes can be compared to bunching-based estimates found for other countries. Seim (2017) reports an elasticity of up to 0.27 for Sweden, and Londoño-Velez and Ávila-Mahecha (2019) find a value of 0.6 for Colombia. The results reported by Jakobsen et al. (2019) imply a corresponding bunching-based estimate of 0.14 for Denmark. Hence, bunching behavior below exemption thresholds, while quantitatively negligible relative to aggregate taxable wealth, seems to be more elastic in Switzerland than in other countries – especially Scandinavia. This is particularly striking given that bunching thresholds apply for much lower wealth levels in Switzerland than in Sweden and Colombia, and given that evasion technologies are commonly viewed as more easily accessible for very wealthy individuals (Alstadsæter, Johannesen and Zucman, 2019).

Our finding that bunching-based elasticities in Switerland are large even at low wealth levels implies that fixed costs of evasion are low. This is likely due to the self-reporting principle of the Swiss tax system, combined with banking secrecy. Hence, evasion may well be 'affordable' also for the moderately wealthy. This is consistent with our finding in Section 5 that the magnitude of behavioral responses to wealth taxes is only weakly increasing in wealth.[40]

Voluntary self-disclosures

Characterizing the evasion response is notoriously difficult. We attempt this through the lens of voluntary self-disclosures.[41] Undeclared assets discovered by Swiss tax authorities through denunciation or audits are usually charged 10 years' worth of back taxes plus a fine equivalent to 100% of those back taxes. Until 2010, taxpayers had the option of voluntarily declaring formerly hidden assets, which reduced the fine to 20% of the back taxes. A federal law passed in 2008 and in force since 2010 reduces the fine imposed on first-time voluntary self-disclosures to zero. This law is sometimes referred to as the 'mini tax amnesty'.

We can establish that voluntary disclosures in Lucerne were larger than those in Bern, and they clearly increased after 2009 tax cut and the 2010 mini tax amnesty.[42]

[40] A similar invariance of effects to wealth levels also emerges in our analysis of heterogeneous responses in Section 6.4 below.

[41] Another conceivable approach is to match administrative tax records to leaked offshore account data such as those made public in the Panama Papers (see Londoño-Velez and Ávila-Mahecha, 2019). This is not possible in our case, as our tax records are anonymized.

[42] Voluntary self-disclosures are not integrated into administrative tax records and thus poorly docu-

We estimate that the Lucerne tax cut triggered voluntary self-disclosures of previously hidden assets worth some CHF 256m – about 1.3% of the aggregate response.[43] The fact that we do not detect much of an interaction effect between the tax cut and the voluntary disclosure program is consistent with theory. When penalties are proportional to back taxes owed, as is the case in Switzerland, the Allingham-Sandmo-Yitzhaki model of tax evasion implies that cheating is independent of tax rates.[44]

The self-disclosures documented here concern only cases in which taxpayers formally announce previously undeclared assets and the tax authority opens a special procedure resulting in a separate invoice for back taxes and penalties owed. They do not include situations in which taxpayers reveal formerly undeclared assets without notifying the authority about that fact.[45] According to our decomposition of the aggregate response in Section 6.3.3, some 45% of the aggregate response remain unexplained after considering savings and mechanical effects, house-price capitalization and taxpayer mobility. With only between 1 and 2% of the aggregate response attributable to self-disclosures, the natural conclusion is that more than 40% of the aggregate response are due to declarations of previously hidden assets that are not disclosed as such to the tax authority. This is consistent with our finding that the response builds up gradually and over a long time horizon, since large undeclared wealth can be declared only in small installments if it is not to arouse the tax authority's suspicion.

6.4 Response heterogeneity

The decompositions of Section 6.3 are informative from a fiscal policy viewpoint, but they do not show whether behavioral responses differ across the wealth distribution. To complement those decompositions, we now report behavioral responses, which we compute as cumulative changes relative to wealth at the beginning of each yearly change.

Analogously to Section 6.3.3, we decompose year-t aggregate wealth of stayer households into financial wealth, non-financial wealth and debt, but unlike in Section 6.3.3, we calculate the cumulative change by adding up the yearly log differences with respect to the reference

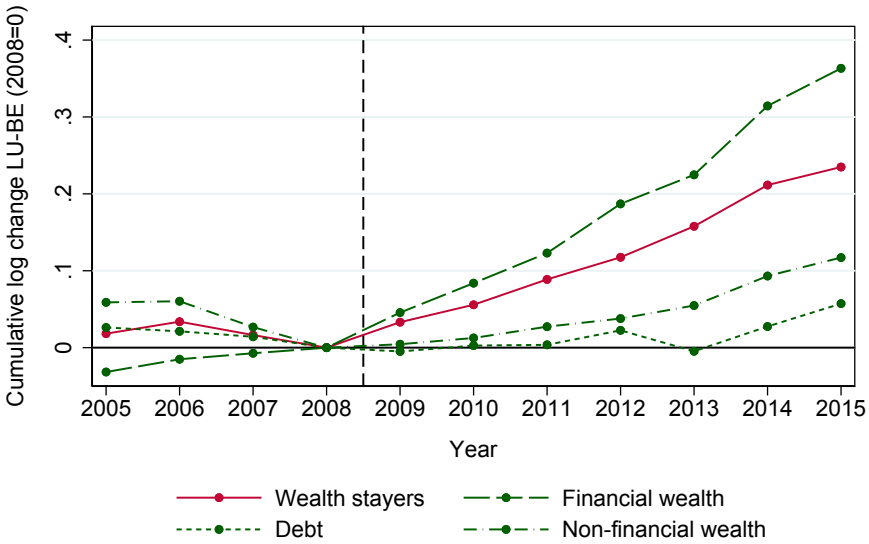
mented. However, we have obtained data on aggregate voluntary disclosures in Lucerne for our full 2005-2015 sample period and in Bern for the post-amnesty period 2010-2015. The data for Lucerne were generously made available to us by the Lucerne cantonal tax administration. Their pre-2010 data are estimates based on aggregate revenues from back taxes and fines. The data for Bern are published at `https://www.be.ch/portal/de/index/mediencenter/medienmitteilungen/suche.assetref/dam/documents/portal/Medienmitteilungen/de/2019/01/2019-01-24-sv-praesentation-de.pdf`. The evolution of the two data series in per-taxpayer terms is illustrated in Figure B.15 of the Online Appendix.

[43] We net out the post-2009 increase in voluntary self-disclosures in Lucerne relative to Bern as follows. The cumulative volume of voluntarily self-disclosed assets in Lucerne over the period 2010-2015 was CHF 828m. The corresponding total for 2004-2009 was CHF 117m. Hence, the net increase post-2010 was CHF 711m. Self-disclosures in Bern corresponded to 64% of those in Lucerne, in per-capita terms post-2009 (see Figure B.15 of the Online Appendix). Assuming that the higher self-disclosure volume in Lucerne was due to the interaction of the mini tax amnesty and the tax cut, we can interpret the difference in post-2009 per-capita disclosures as the effect of the Lucerne tax cut. The upper bound of our estimated cumulative response by financial assets is 22.5 (see Section 6.3.4). Given that Lucerne total taxable wealth was CHF 50.4bn in 2008, this implies that the Lucerne tax cut triggered an increase in declared assets of CHF 11.3bn. Hence, about 2.3% of the response of financial assets can be explained by voluntary self-disclosures.

[44] See, e.g., Slemrod and Yitzhaki (2002); Kleven, Knudsen, Kreiner, Pedersen and Saez (2011).

[45] They also do not cover cases where taxpayers make a formal announcement but the tax authority does not open a special procedure, instead incorporating additional taxes owed in the standard annual tax invoice. This 'simplified procedure' is applied in about 10% of self-disclosures, where the disclosed amounts are too small to justify the opening of a special procedure. These cases are therefore of negligible importance.

Figure 13: Behavioral response financial wealth and debt, stayers



Notes: The graph shows cumulative differential log changes in wealth, financial wealth, non-financial wealth and debt of Lucerne relative to Bern for stayers. The graph shows cumulative differential log changes in total wealth and its components of Lucerne relative to Bern for taxpayers who do not move between $t-1$ and t ('stayers'). The 2015 values of the depicted series are, respectively, 0.235 for total wealth, 0.363 for financial wealth, 0.057 for debt, and 0.117 for non-financial wealth. Separate graphs for Lucerne and Bern are shown in Figure B.11 of the Online Appendix.

year 2008

$$\omega_{it}^{\text{financial}} = \begin{cases} -\sum_{s=t+1}^{2008} \ln(W_{is}^{\text{financial}} / W_{i,s-1}^{\text{financial}}) & \text{if} \quad t \leq 2007 \\ \quad 0 & \text{if} \quad t = 2008 \\ \sum_{s=2009}^{t} \ln(W_{is}^{\text{financial}} / W_{i,s-1}^{\text{financial}}) & \text{if} \quad t \geq 2009. \end{cases} \tag{8}$$

The cumulative log change computed in this way approximately corresponds to the percentage change of the wealth component. As before, we report the difference between the change in Lucerne and Bern.

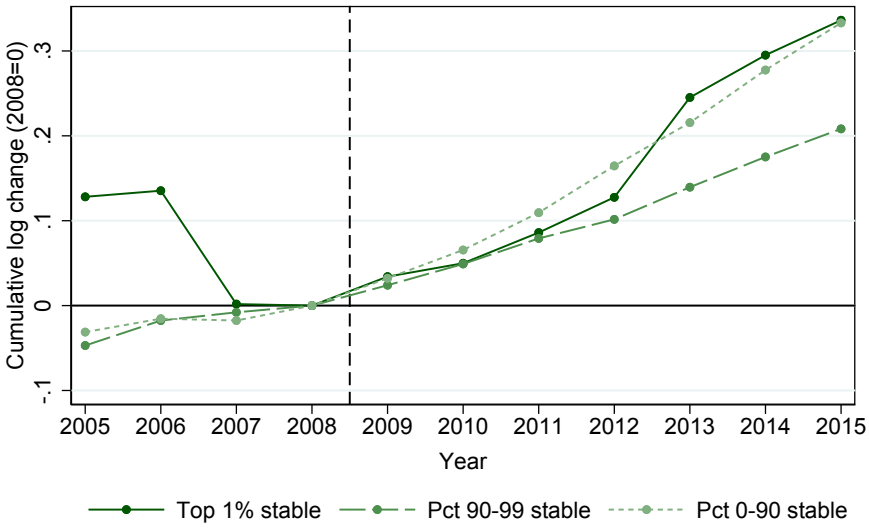
Figure 13 shows those calculations for financial wealth, non-financial wealth and debt. Behavioral responses are most pronounced for financial wealth. By 2015, Lucerne reported financial wealth had increased some 0.36 log points (44%). This shows that the large contribution of financial wealth to the aggregate effect found in Figure 11 is due both to the stronger response of financial wealth and to its larger share in the base-year total.[46]

In Figure 14, we show responses across wealth quantiles, focusing on the top 10% and top 1% brackets.[47] Strikingly, the behavioral response of top 1% taxpayers is almost identical in magnitude to that of bottom 90% taxpayers, while that of the top 90-99% taxpayers appears to be considerably lower.

[46] According to Table 3, and if we attribute 94% of debt to non-financial assets, we find that in the base year 2008, the share of financial wealth was 59.3% in Lucerne and 58.7% in Bern.

[47] The top 1% category exhibits a negative pre-trend in Figure 14, and a similar pattern appears for non-financial wealth in Figure 13. Examination of the individual-level data shows this to be linked to the residential choices of a single exceptionally wealthy family in the canton of Bern. Ignoring the observations linked to that family would remove those pre-trends, but we prefer not to selectively omit data points.

Figure 14: Behavioral response by top 1% and top 10% taxpayers, stable households only



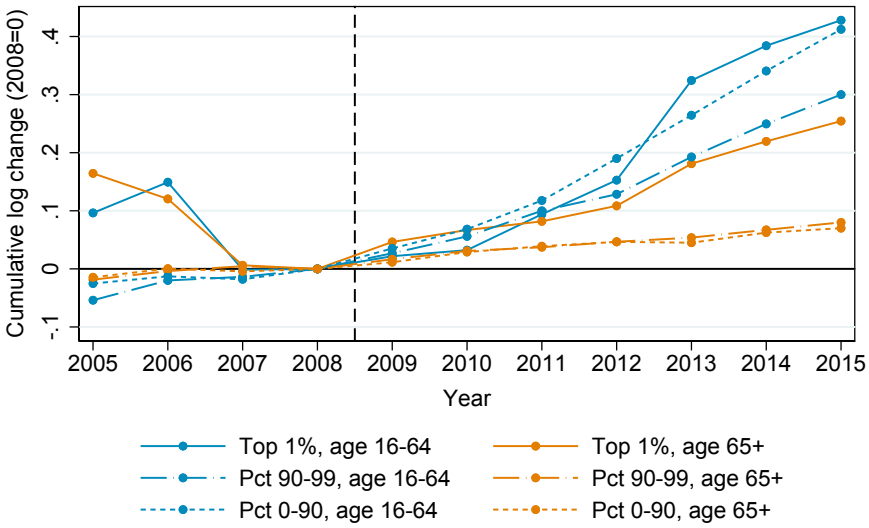
Notes: The graph shows cumulative differential log changes in wealth by quantiles of the wealth distribution in Lucerne relative to Bern for 'stable' taxpayers. The 2015 values of the depicted series are, respectively, 0.336 for the top 1%, 0.208 for percentiles 90-99, and 0.333 for the remaining percentiles 0-90. Separate graphs for Lucerne and Bern are shown in Figure B.12 of the Online Appendix.

The patterns shown in Figure 14 do not point towards systematically stronger behavioral responses as one moves up the wealth distribution. This result might, however, be influenced by unobserved confounding factors. A natural candidate is age: wealthier taxpayers tend to be older, and older households might be less flexible in re-optimizing their financial affairs subsequent to a wealth tax cut. We have therefore additionally divided taxpayers into those below the official retirement age of 65 in 2008 and those above the official retirement age. These results are shown in Figure 15. It can be seen that younger taxpayers react more strongly than older taxpayers, irrespective of their level of wealth. There is evidence of top 1% taxpayers reacting more strongly than the rest irrespective of age. Among the younger taxpayer group, however, we again observe that top 90-99% taxpayers respond somewhat less strongly than the bottom 90% taxpayers. The general conclusion is that the young, defined as being below retirement age, respond significantly to wealth taxation, whereas among the old only the very wealthy show significant responses.

An approximately constant behavioral elasticity across wealth levels of course does not mean that all wealth brackets contributed equally to the aggregate response documented in Section 6.2. Given their disproportionately higher shares of total pre-reform wealth, the top wealth brackets still accounted for the major part of the aggregate response. We for instance find that top-1% taxpayers accounted for 58% of the aggregate response by stable households.[48]

[48] For further details and graphical representations, see Section B.4 in the Online Appendix.

Figure 15: Behavioral response by age and wealth quantiles, stable households only



Notes: The graph shows cumulative differential log changes in wealth of different wealth quantiles by age groups older/younger than 65 in 2008, in Lucerne relative to Bern for 'stable' taxpayers. The 2015 values of the depicted series are, respectively, 0.428 for the top 1%, age 16-64; 0.254 for the top 1%, age 65 and older; 0.300 for percentiles 90-99, age 16-64; 0.080 for percentiles 90-99, age 65 and older; 0.412 for percentiles 0-90, age 16-64; and 0.070 for percentiles 0-90, age 65 and older. Separate graphs for Lucerne and Bern are shown in Figure B.13 of the Online Appendix.

7 Concluding discussion

The growth in wealth inequality observed in many countries has led to a renewed focus on redistributive taxation. This focus has included the notion of expanding the package of redistributive tax tools to include an annual wealth tax. In fact, OECD nations have been moving in the opposite direction over the past decade, with most nations abandoning annual wealth taxation. The major exception is Switzerland, which has by far the largest wealth tax in the OECD relative to the size of government. Despite the policy interest in this area and renewed scientific attention, ours is the first analysis of responses to wealth taxation that is based on variation across multiple jurisdictions.

In this paper we explore the role of annual wealth taxes using policy heterogeneity within Switzerland. We can draw both on aggregate data reporting wealth holdings across cantons, matched to cantonal variation in wealth taxes, and on micro data reporting individual-level wealth holdings in two cantons, Lucerne and Bern, exploiting a quasi random difference in the size of their wealth tax cuts in 2009. Both data sets deliver the same bottom line: reported wealth holdings are highly sensitive to wealth taxation. According to our baseline cross-canton panel estimate, a 1 percentage point increase in wealth taxes leads to 43% lower wealth holdings after five years. When we focus on the ten largest reforms, this semi-elasticity doubles in size. And our event study based on the canton of Lucerne cutting its wealth tax in half even implies a semi-elasticity of 226%. Nevertheless, even our largest estimated elasticities imply that wealth tax cuts caused revenue losses.

We can compare our findings to existing estimates in the elasticity of taxable income lit-

erature. As the wealth tax is an annual tax on a stock of wealth while the income tax is an annual tax on a flow of wealth, we ask how large our estimated wealth response is relative to the implied net-of-tax rate on the annual flow of capital income. For the purpose of this illustrative calculation, we assume a rate of return of 4.5%.[49] With this assumed rate of return, a 1 percentage point increase in the wealth tax corresponds to a 41.1% reduction in the keep rate.[50] Such as drop in the keep rate, according to our baseline estimate, lowers wealth by 43%, which corresponds to an elasticity of $43\%/41.1\% = 1.05$.

This elasticity of approximately one is large relative to previously estimated taxable income elasticities. It is, however, important to note that this keep-rate elasticity is sensitive to what we assume the rate of return to be. If we take 3% as our representative return, instead of 4.5%, the elasticity drops to 0.70; and if we instead assume 10%, the elasticity rises to 2.32%. Even the conservatively estimated elasticity implied by a 3% return clearly exceeds the range of estimates for the net-of-tax elasticity of taxable income of 0.12-0.40 reported by Saez et al. (2012).

Crucially, available individual-level tax records for two cantons allow us to decompose the tax-base response to the large and quasi-random Lucerne tax cut relative to the response to the much smaller tax cut in neighboring Bern. We find that some 24% of the aggregate response can be attributed to net taxpayer migration, 20% can be attributed to higher real estate values, and up to 6% can be attributed to increased savings, including the mechanical effect of lower wealth taxation. We observe no effect on earnings. Hence, by a process of elimination, it would appear that the remaining unexplained changes in declared financial assets – fully 50% of the aggregate response – could be driven by evasion and avoidance behavior. Of that, only a little over 1% can be attributed to increased voluntary self-disclosures. Close to half of the apparent wealth accumulation following the tax cut would thus appear to be explained by gradual and stealthy self-reporting of previously hidden assets.

[49] We do not have exact measures of returns to private wealth in Switzerland, but evidence from neighboring countries suggests returns in 2010 of 4-4.5% in France and 7-7.5% in Germany (Piketty and Zucman, 2014). Probably the most precise estimates have been produced for Norway, where the average return on wealth, including capital gains, is estimated at 3.8% for the 2005-2015 period (Fagereng, Guiso, Malacrino and Pistaferri, 2019), and for Sweden, where the real return on median-household wealth is estimated at 4.6% for the 2000-2007 period (Bach, Calvet and Sodini, 2019).

[50] The calculation is as follows. The mean (municipal + cantonal + federal) income tax rate on high-income households in Switzerland is around 35%. To this we add the mean average wealth tax rate of 0.5%, which corresponds to 11.1% of a 4.5% capital return. Hence, the 'keep rate' after consolidated income + wealth taxes is $1 - (0.35 + 0.11) = 54\%$. A 1 percentage point increase in the wealth tax would represent an increase in the tax rate on capital income by 22.2 percentage points, from 11.1% to $(0.5\% + 1\%)/4.5\% = 33.3\%$. This in turn implies a fall in the keep rate by 22.2 percentage points, i.e. $22.2\%/54\% = 41.1\%$.

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A Appendix

A.1 Related empirical literature

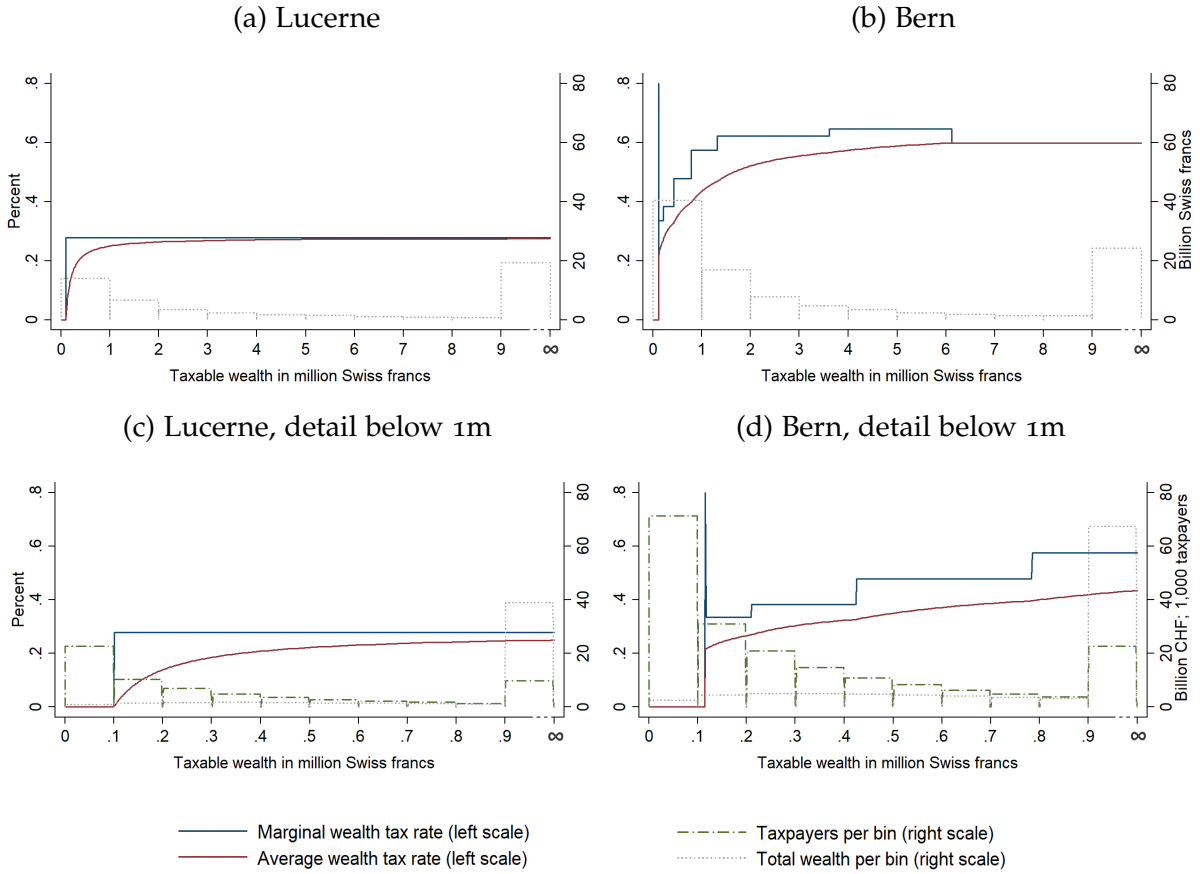
Table A.1: Estimates of the aggregate response of taxable wealth

Citation	Country	Wealth bracket	Time horizon	Semi-Elasticity	Identification
Seim (2017)	Sweden	top 4%	n.a.	0.3%	bunching at tax kink
Londoño-Velez and Ávila-Mahecha (2019)	Colombia	top 1%	1 year	2%	bunching at tax notch after policy change
Zoutman (2018)	Netherlands	n.a.[1]	4 years	14%	diff-in-diff on change in tax schedule
Jakobsen et al. (2019)	Denmark	top 1%	8 years	25%	diff-in-diff on change in tax schedule
	Denmark	98%-99%	8 years	17%	diff-in-diff on change in tax schedule
Durán-Cabré et al. (2019)	Catalonia, Spain	top 1%	4 years	32%	diff-in-diff on change in tax schedule
Brülhart et al. (2017)	Switzerland	top 34%[2]	5 years[4]	34%	diff-in-diff on change in canton tax rates
	Bern, Switzerland	top 34%[2]	5 years[3]	23%	diff-in-diff on change in municipal tax rates
This paper	Switzerland	top 34%[2]	5 years	43%	diff-in-diff (dynamic effects) on change in canton tax rates
	Switzerland	top 34%[2]	5 years	96%	diff-in-diff (dynamic effects) on change in canton tax rates (largest changes only)

Notes: Estimated elasticities expressed as percentage effect on taxable wealth of a one percentage point wealth tax cut. [1] The Dutch wealth tax affected net wealth above EUR 17,000. The paper does not state the share of taxpayers with net wealth above that threshold. [2] According to the Lucerne and Bern micro data, 34% of all taxpayer-year observations involved net wealth above taxable thresholds. [3] The estimates are based on a 10-year panel of data, which means that the average post-reform time horizon is around 5 years.

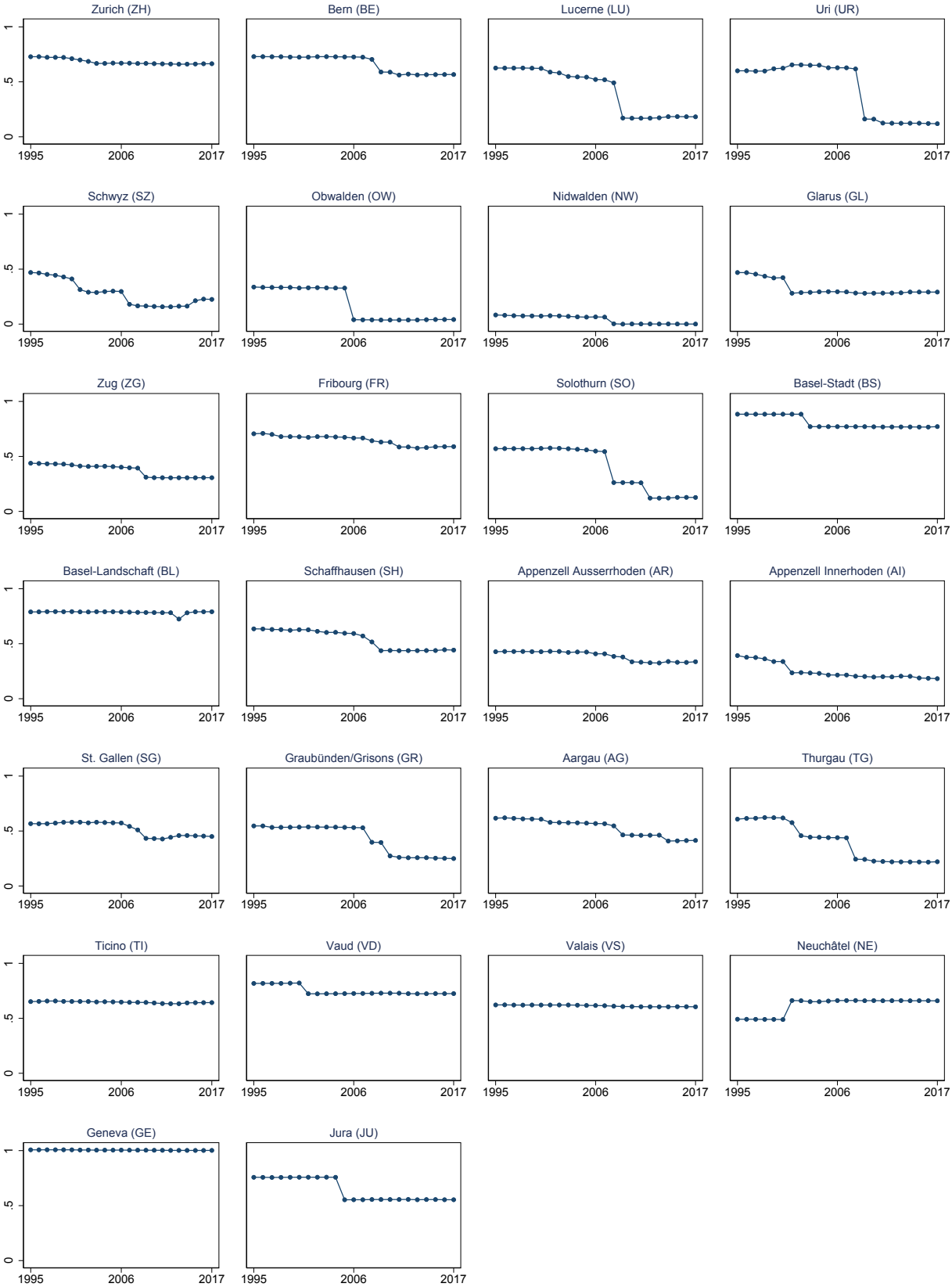
A.2 Wealth tax rates

Figure A.1: 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.

Figure A.2: 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.3 Bunching in Lucerne and Bern

Figure 1 and Appendix Figure A.1 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.[51] 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 A.3 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.

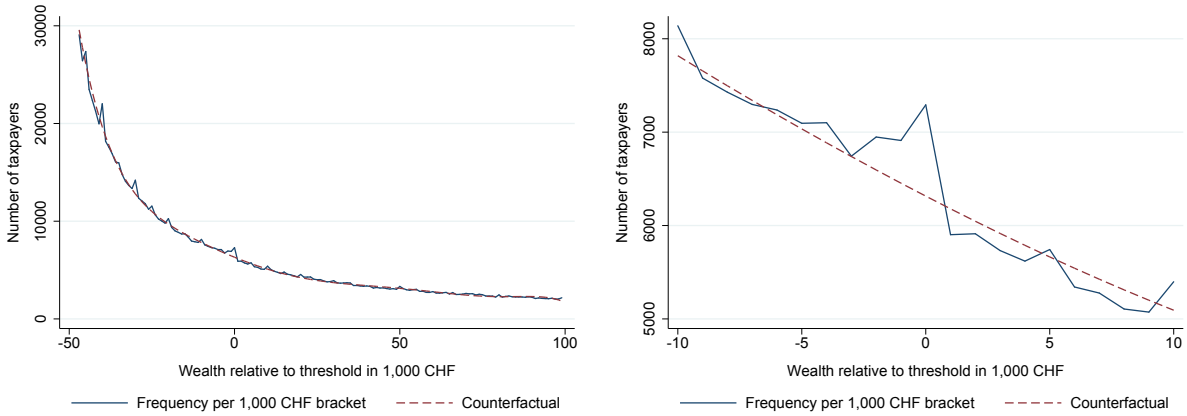
We can quantify and compare bunching effects through implied net-of-tax elasticities. These are computed following Chetty et al. (2011) as $\epsilon = (bunch \times \beta)/(W^* \times \Delta\tau)$, where $bunch$ expresses the excess mass below the threshold as a share of the counterfactual mass in the 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.[52] Hence the implied net-of-tax elasticity estimate is about 0.7 in Lucerne and 0.8 in Bern.

[51] Thresholds for married couples (see Online Appendix B.3 for details).

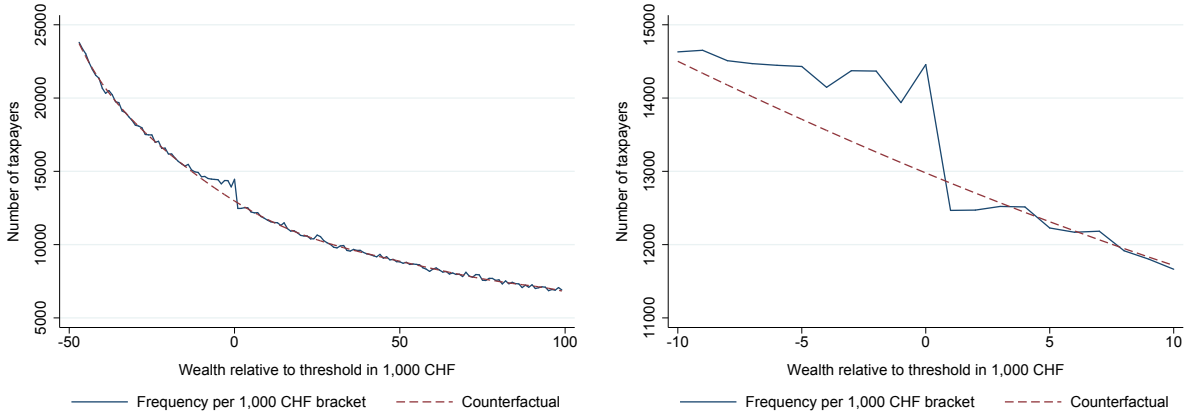
[52] These are time averages over the respective sample periods (see Appendix Figure B.3). In Bern, we use double the marginal tax rate at CHF 1,000 above the threshold, because, given the notch in the tax schedule, the marginal tax rate for the first CHF 1,000 above the threshold amounts to more than 20%. We take CHF 100,000 as the representative wealth threshold for both cantons (see Appendix Figure A.1).

Figure A.3: 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 Online Appendix

B.1 Cross-canton data

Data on aggregate *taxable wealth* by canton are taken from the Swiss Federal Department of Finance ('Gesamtschweizerische Vermögensstatistik der natürlichen Personen', available online at https://www.estv.admin.ch/estv/de/home/allgemein/steuerstatistiken/fachinformationen/steuerstatistiken/gesamtschweizerische-vermoegensstatistik-der-natuerlichen-person.html). 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 Swiss Federal Tax Administration publication 'Steuerbelastung in den Gemeinden', available online at https://www.estv.admin.ch/estv/de/home/allgemein/steuerstatistiken/fachinformationen/steuerbelastungen/steuerbelastung.html). 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 (2019) 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.

For *bequest taxes*, 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, 2014).

Cantonal *population* figures are taken from the Federal Statistical Office ('Bilanz der ständigen Wohnbevölkerung nach Kantonen', available online at https://www.bfs.admin.ch/bfs/de/home/statistiken/kataloge-datenbanken/tabellen.assetdetail.4782766.html).

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 cap-

ital 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.

Finally, 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 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.

B.2 Lucerne and Bern micro data

We obtained confidential anonymized individual records for the universe of taxpayers in the canton of Lucerne from the statistical office of the canton. In Switzerland, taxpayers are single individuals, married couples or couples in civil partnerships. The Lucerne data include 2,366,928 taxpayer-year observations, i.e. on average 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. 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.[53] 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

[53] 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.2.1.

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 6.3.7. 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 6. We are thus left with 6,602,269 taxpayer-year observations in the main analysis, i.e. on average 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%).

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.

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 ('Wertschriftenver-

mögen'), 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. We replace the top-coded observations with the mean values, which we obtained for each year and wealth component. For consistency, 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.2.1 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 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

Table B.2: Register events by canton

	Lucerne		Bern	
	Number	%	Number	%
(a) Entrants				
Unknown	12,993	10.56	25,027	9.43
Coming-of-age	43,793	35.59	103,154	38.89
Inmove Switzerland	43,846	35.63	72,642	27.39
Inmove abroad	8,217	6.68	19,374	7.30
Widowed woman	7,507	6.10	22,363	8.43
Separated woman	6,692	5.44	22,700	8.56
Total	123,048	100.00	265,260	100.00
(b) Exits				
Unknown	5,345	5.82	3,992	1.78
Death	24,898	27.09	79,534	36.51
Outmove Switzerland	37,835	41.17	72,069	33.08
Outmove abroad	8,426	9.17	22,026	10.11
Marriage woman	15,389	16.75	40,295	18.50
Total	91,893	100.00	217,846	100.00

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 B.2 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 B.2 shows that the shares of unexplained events is slightly higher in the Lucerne data. Much of our analysis in Section 6 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.2.2 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 B.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 B.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.3 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 Appendix Figure A.1). 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%.[54]

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 7 and B.3. 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 B.3.

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.[55] 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.

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

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

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

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 Appendix Figure A.1 and in the upper panel of Figure B.3.

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 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.4 Decomposition by wealth quantiles

Instead of decomposing the aggregate response across types of wealth as in Section 6.3, 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.[56]

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

$$\Delta W_{it}^{\text{stable}} = \Delta W_{it}^{\text{top 1\%}} + \Delta W_{it}^{\text{bottom 99\%}}, \tag{9}$$

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 Appendix Section B.2.2 for the calculation of wealth quantiles). We then again calculate the corresponding cumulative change $w_{it}^{\text{top 1\%}}$, analogously to equation (5), and report the difference between Lucerne and Bern.

Figure B.1 shows the results. It emerges clearly that taxable wealth grew faster post-2008 in Lucerne than in Bern, as in Section 6.2. The aggregate response of stable households amounted

[56] 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.

to 26.6 percentage points by 2015. Of these 26.6 percentage points, fully 22.2 percentage points were due to top-10% taxpayers, and 15.4 percentage points were driven by top-1% taxpayers. Top-1% taxpayers thus accounted for 58% of the aggregate response by stable households.

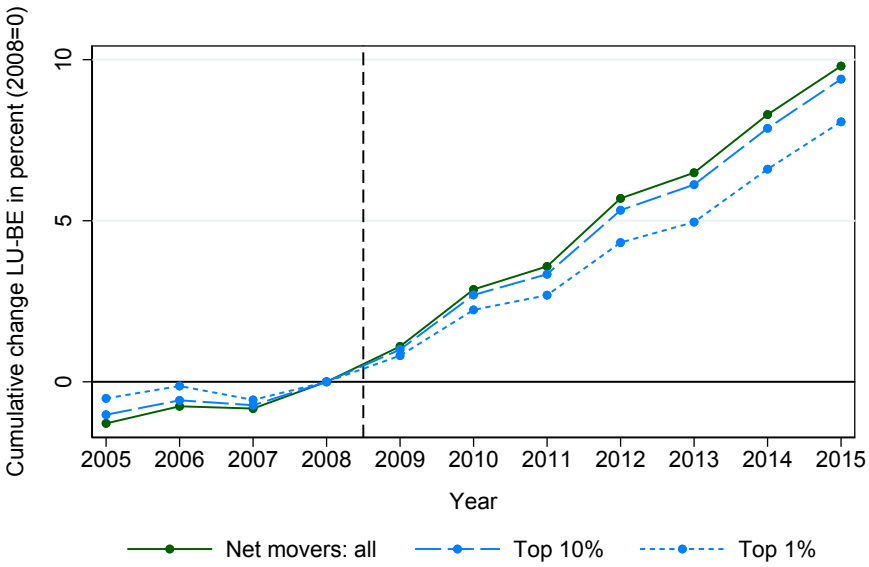
In Figure B.2, we analogously decompose the cumulative 9.8 percentage point effect from net migration into the top 10% and top 1% contributions. Among movers, the very wealthy dominate even more: fully 83% of the migration effect are accounted for by moves of taxpayers in the top 1% wealth bracket.

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 6.4).

Figure B.1: 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, 26.6 p.p. for differential wealth, 22.2 p.p. for the top-10%, and 15.4 p.p. for the top-1%. Separate graphs for Lucerne and Bern are shown in Figure B.9 of the Online Appendix.

Figure B.2: 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, 9.8 p.p. for wealth of all net movers, 9.4 p.p. for wealth of net movers in the top-10%, and 8.1 p.p. for wealth of net movers in the top-1%. Separate graphs for Lucerne and Bern are shown in Figure B.10 of the Online Appendix.

B.5 Additional graphs

Figure B.3: Top tax rates on wealth (upper panel) and income (bottom panel) in Lucerne and Bern

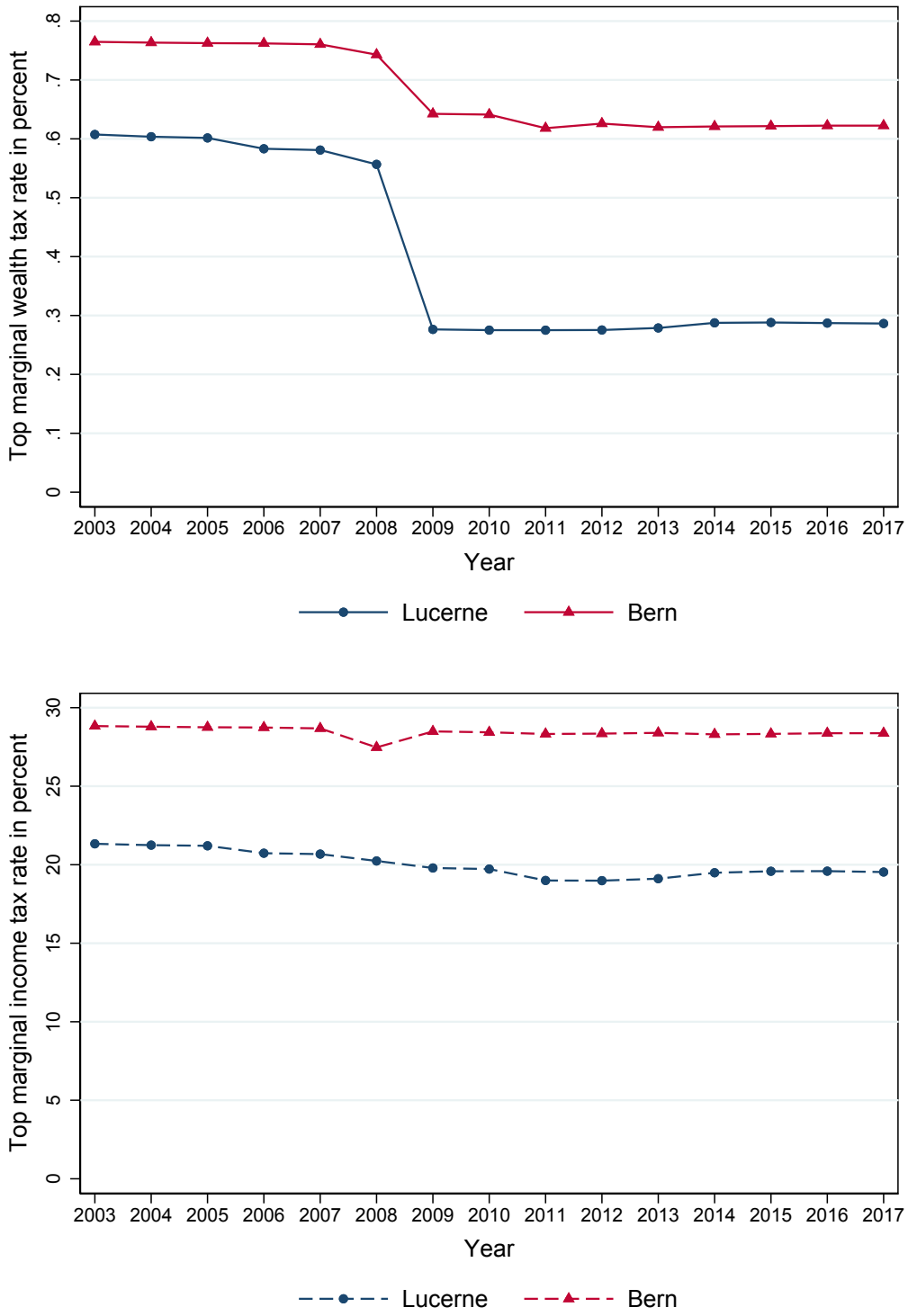
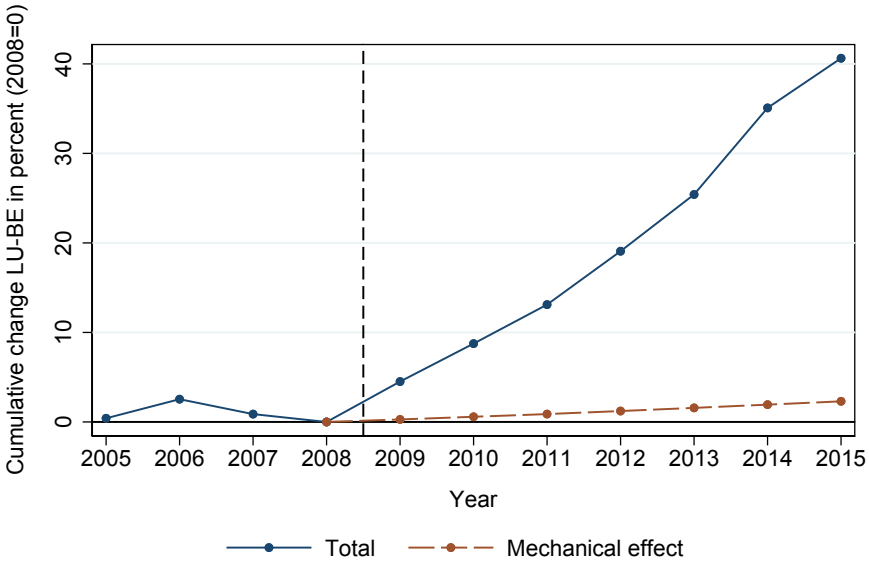
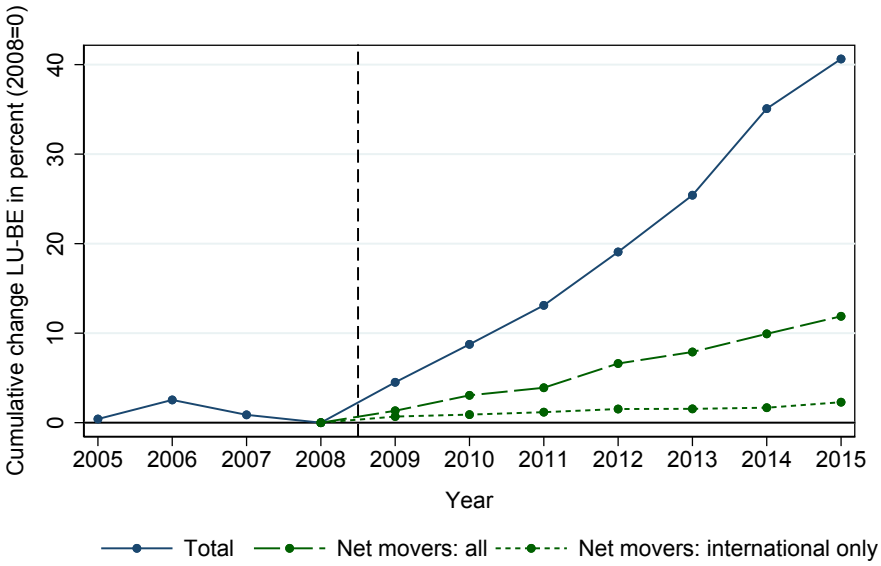


Figure B.4: Aggregate and mechanical effects



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, 40.6 p.p. for differential wealth and 2.3 p.p. for the mechanical effect.

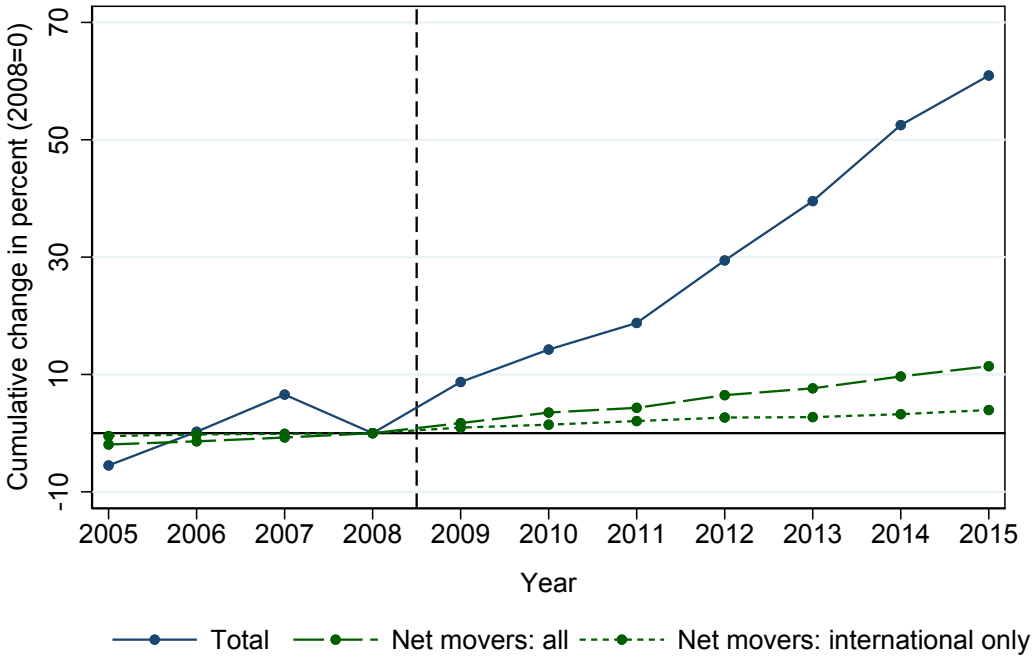
Figure B.5: Contribution of intra-national and international taxpayer mobility, including accumulation after arrival



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, 40.6 p.p. for differential wealth, 11.9 p.p. for wealth of all net movers, and 2.3 p.p. for wealth of international net movers only.

Figure B.6: 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

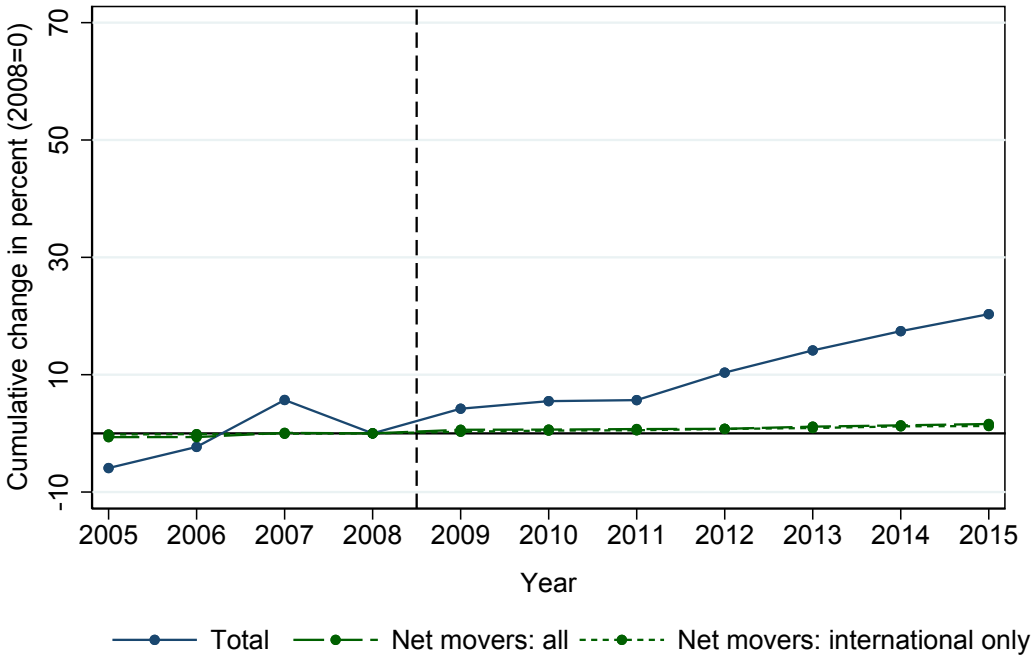
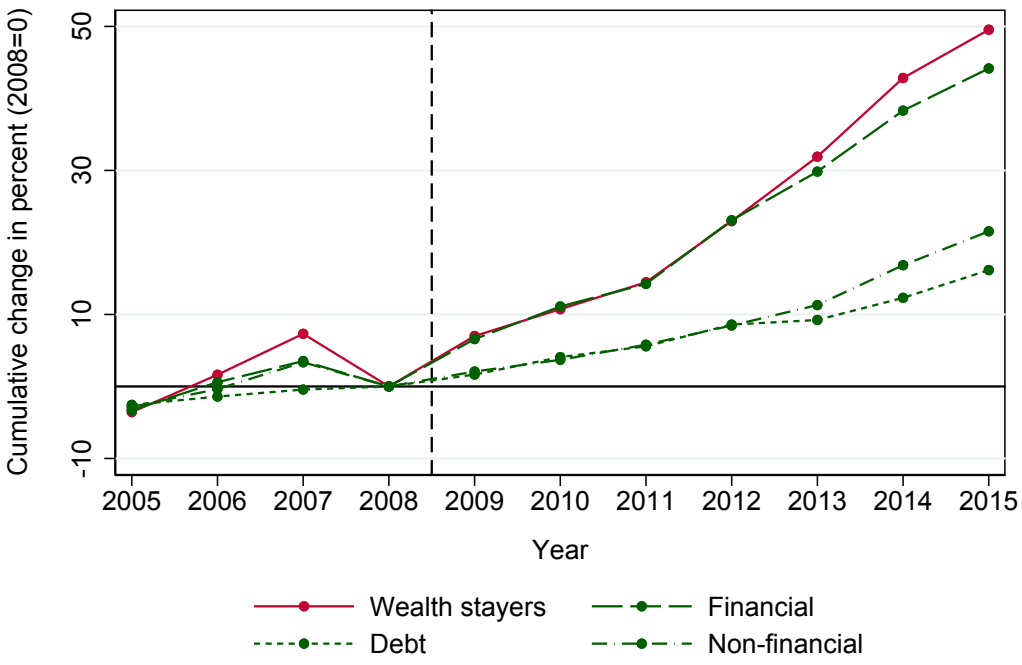


Figure B.7: Evolution of asset types: Cumulative change in wealth of stayers relative to year 2008 with components with components of wealth decomposed into financial assets and debt in Lucerne and Bern separately displayed.

(a) Lucerne



(b) Bern

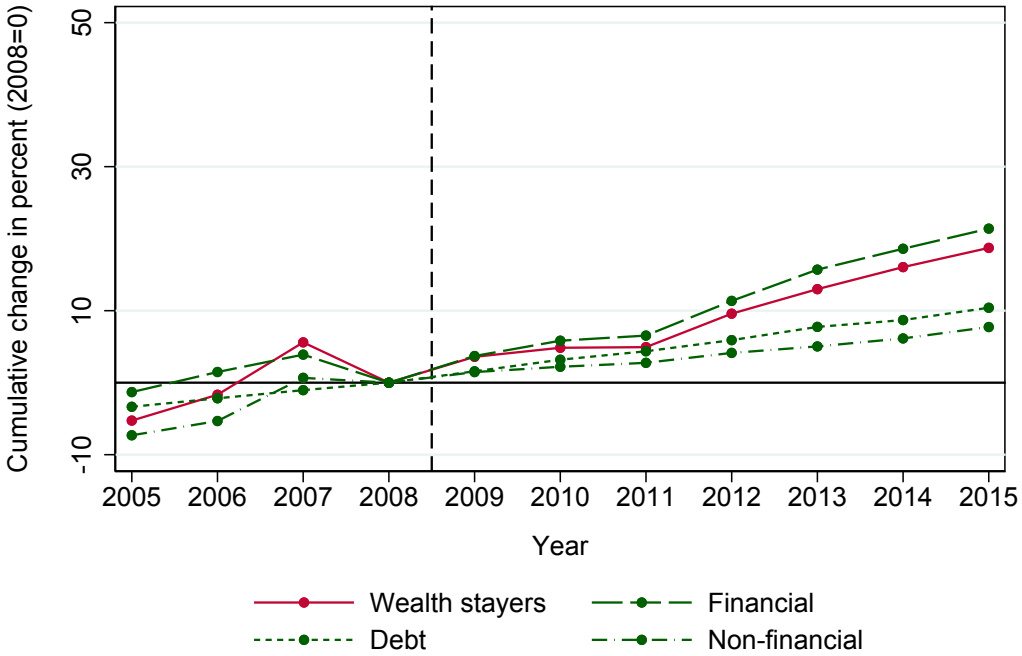
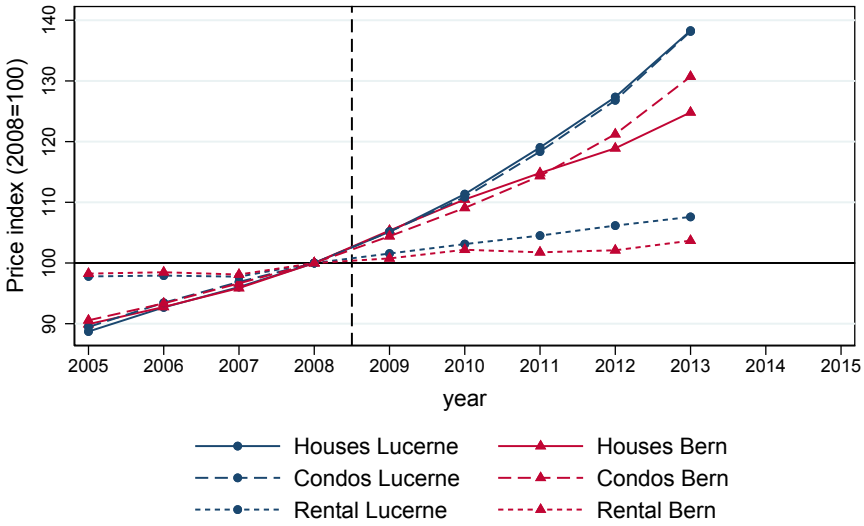


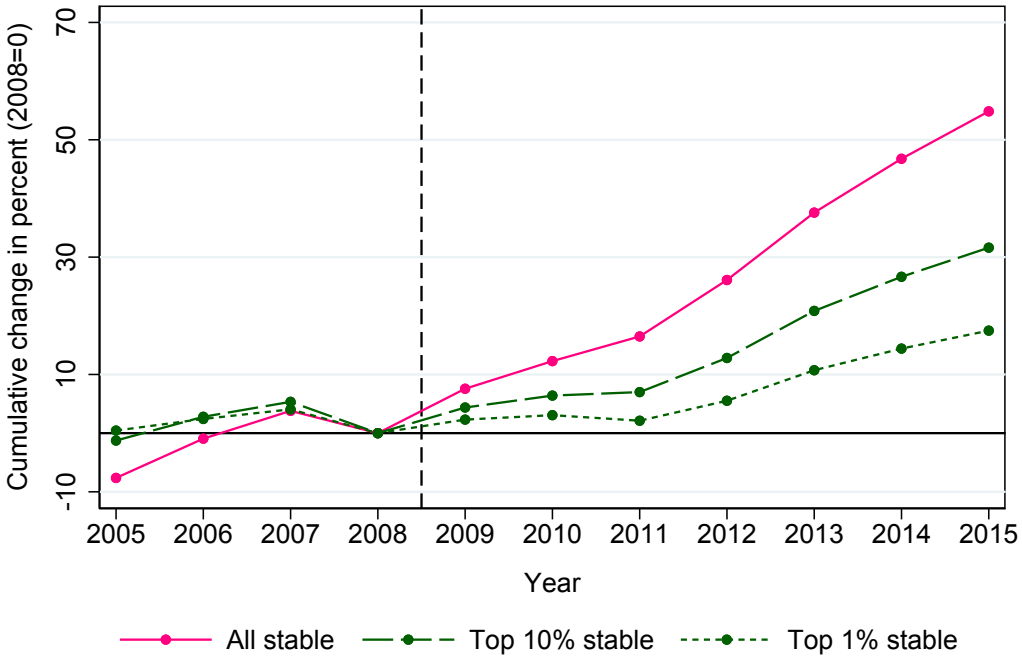
Figure B.8: Evolution of housing prices, Lucerne and Bern



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 38.3% for houses in Lucerne, 24.8% for houses in Bern, 38.2% for condominiums in Lucerne, 30.7% for condominiums in Bern, 7.6% for rental prices in Lucerne, and 3.7% for rental prices in Bern.

Figure B.9: 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

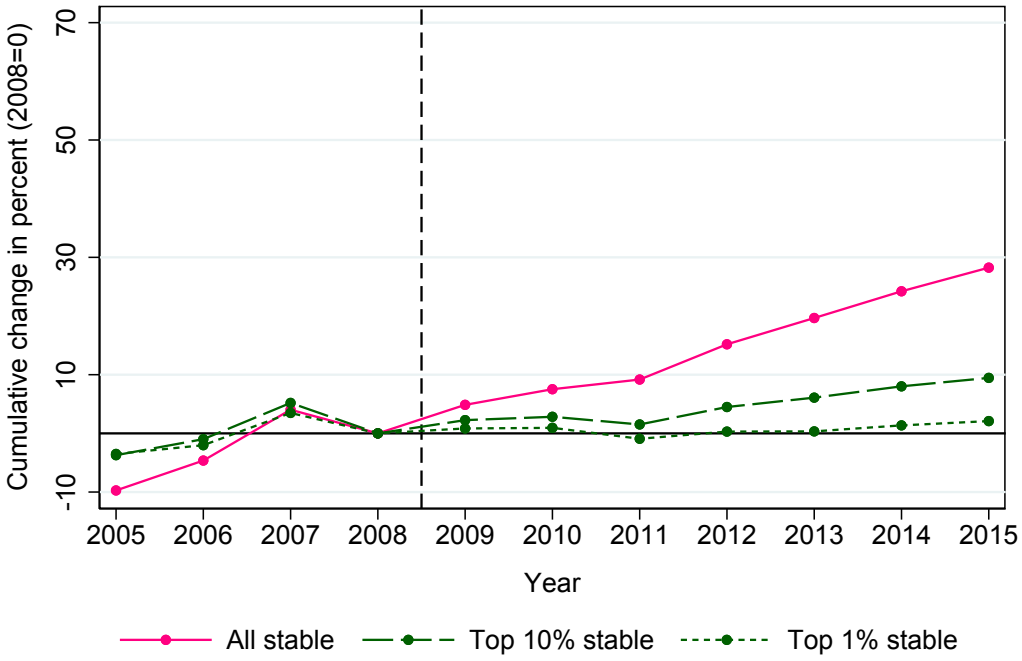
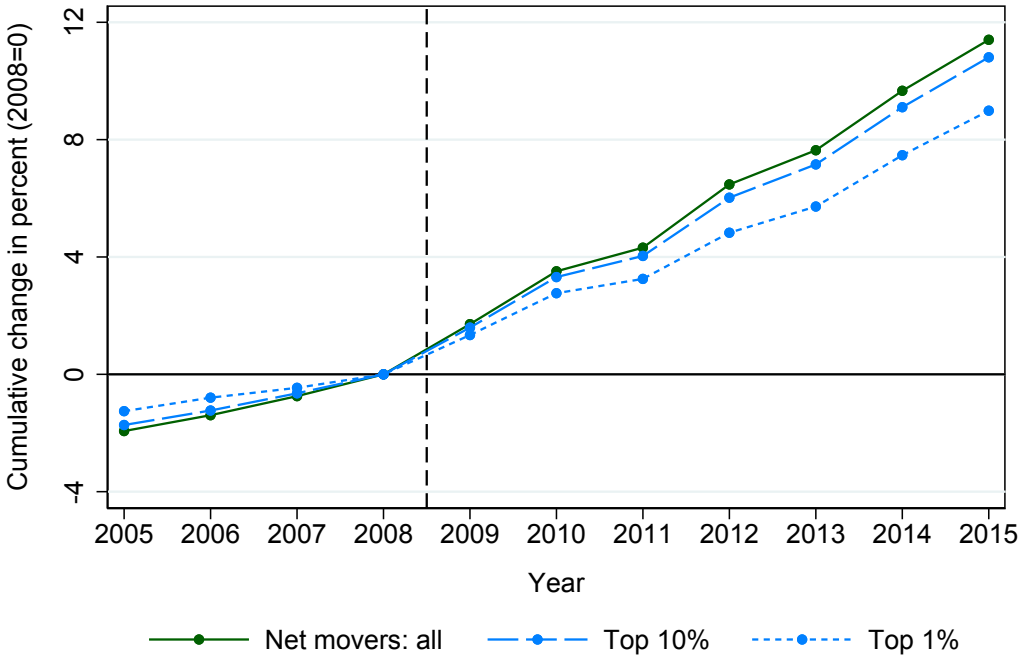


Figure B.10: Evolution of wealth of movers: Cumulative change in wealth of movers relative to year 2008 with top 10% and top 1% separately displayed in Lucerne and Bern.

(a) Lucerne



(b) Bern

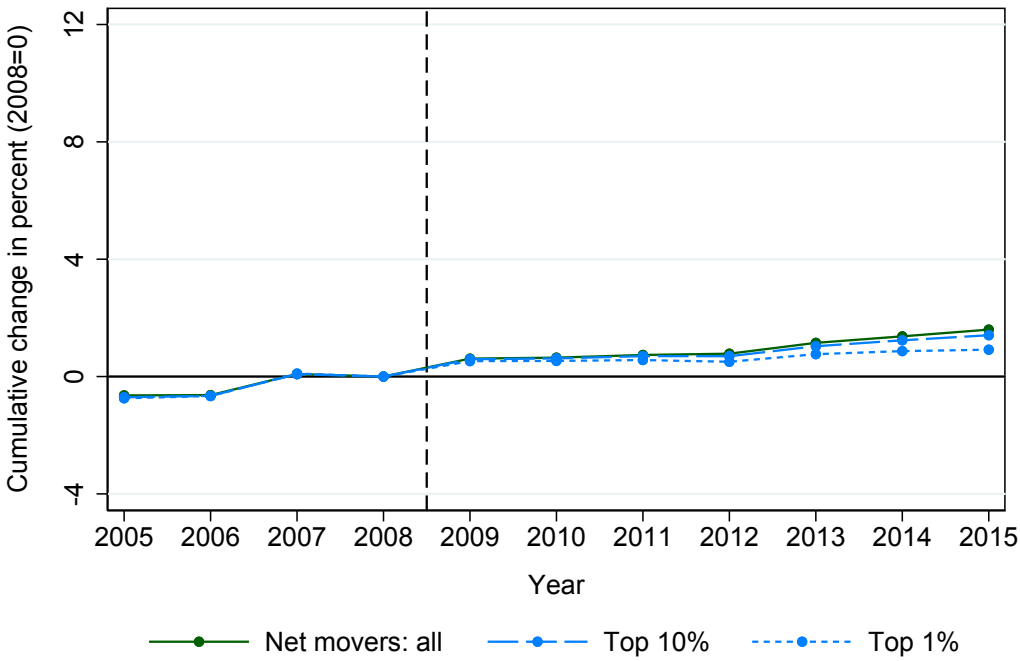
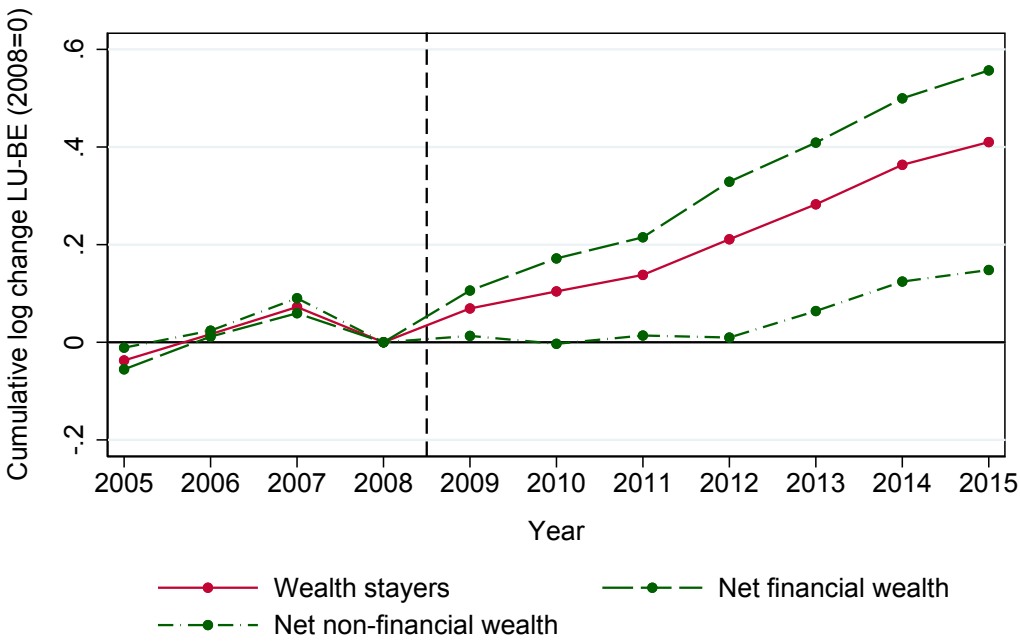


Figure B.11: Evolution of cumulative log wealth by component: Cumulative change in net financial wealth (net of 6% of debt), and net non-financial wealth (net of 94% of debt) of stayers. Top panel displays evolution in Lucerne and bottom panel displays evolution in Bern.

(a) Lucerne



(b) Bern

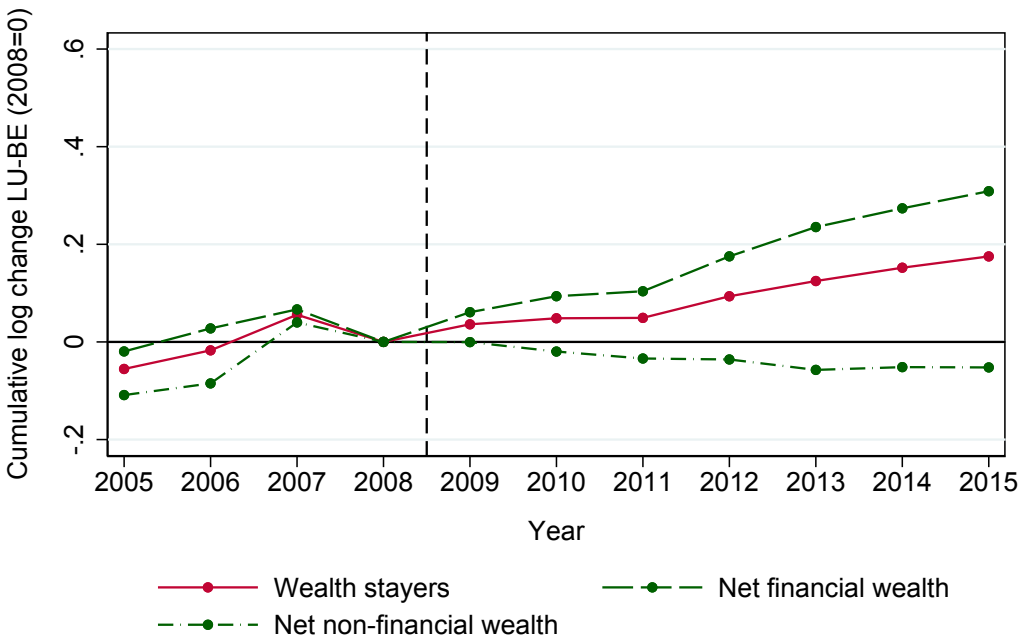
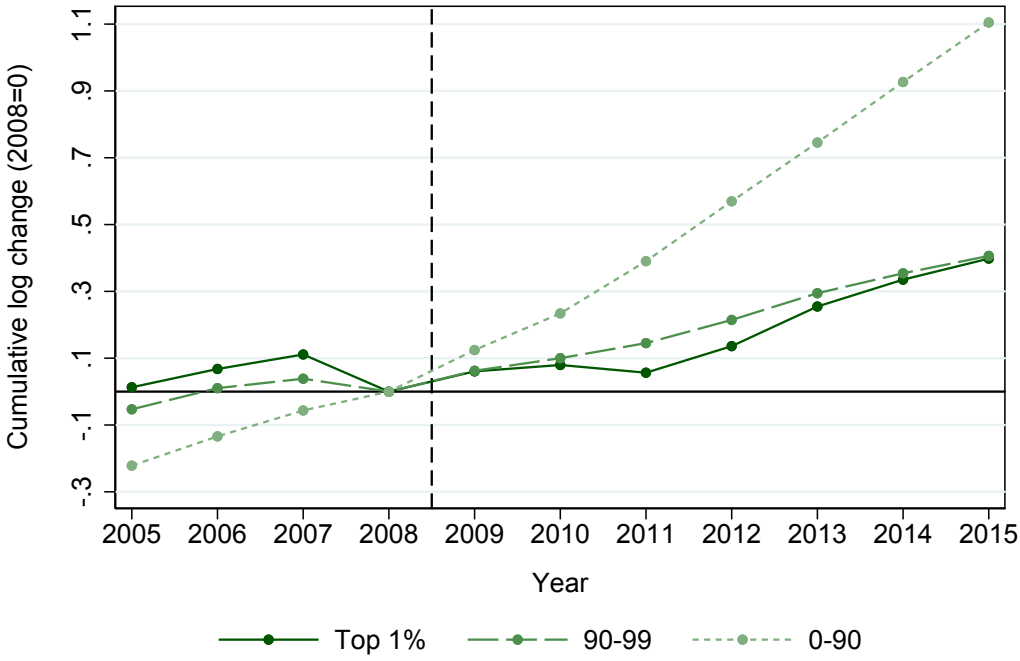


Figure B.12: Evolution of cumulative log wealth at the top: Cumulative change in wealth of 'stable households' in percentiles 0-90, 90-99, and 99-100. Top panel displays evolution in Lucerne and bottom panel displays evolution in Bern.

(a) Lucerne



(b) Bern

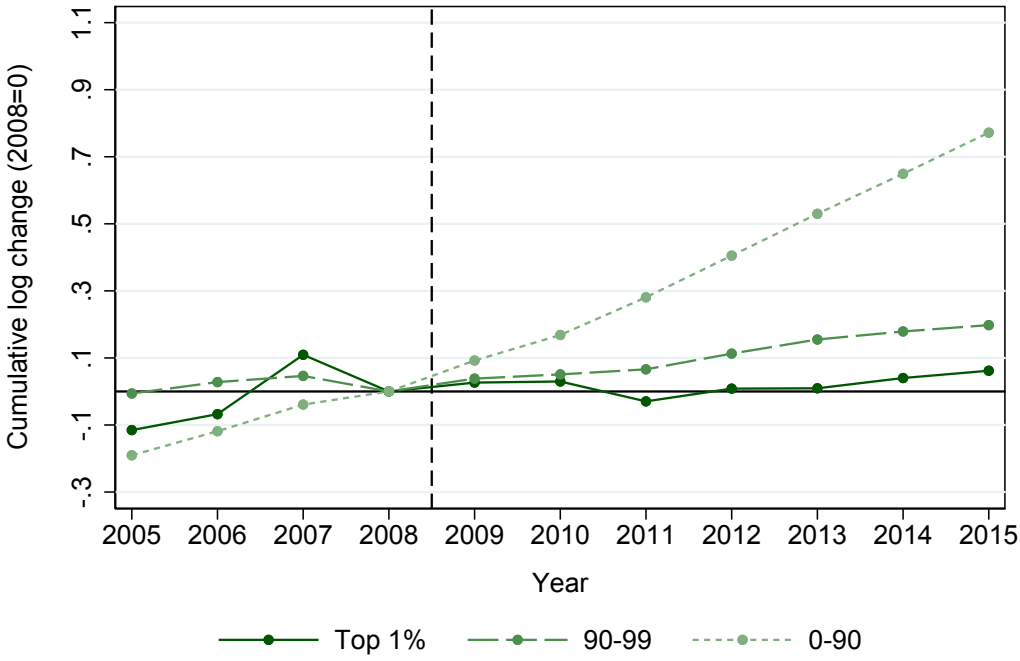
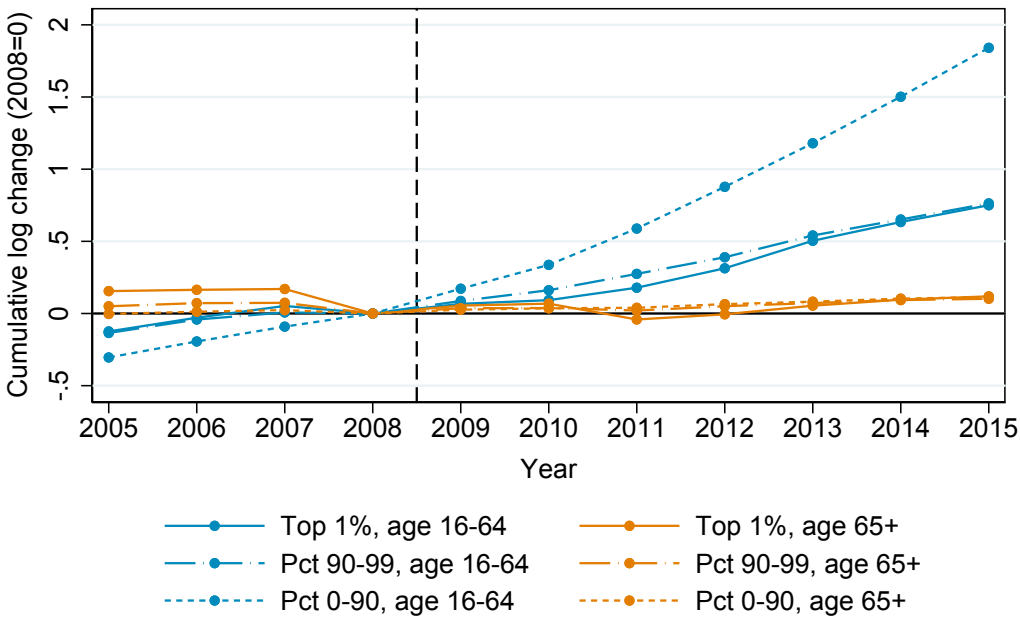


Figure B.13: Evolution of cumulative log wealth at the top by age group: Cumulative change in wealth of 'stable households' in percentiles 0-90, 90-99, and 99-100 by older/younger than 65 in 2008. Top panel displays evolution in Lucerne and bottom panel displays evolution in Bern.

(a) Lucerne



(b) Bern

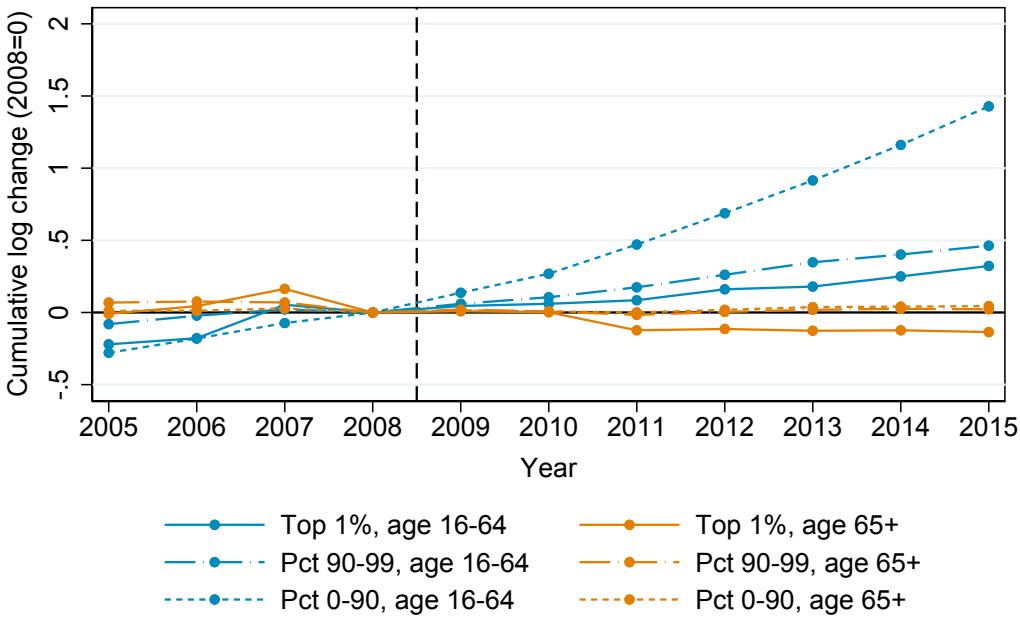
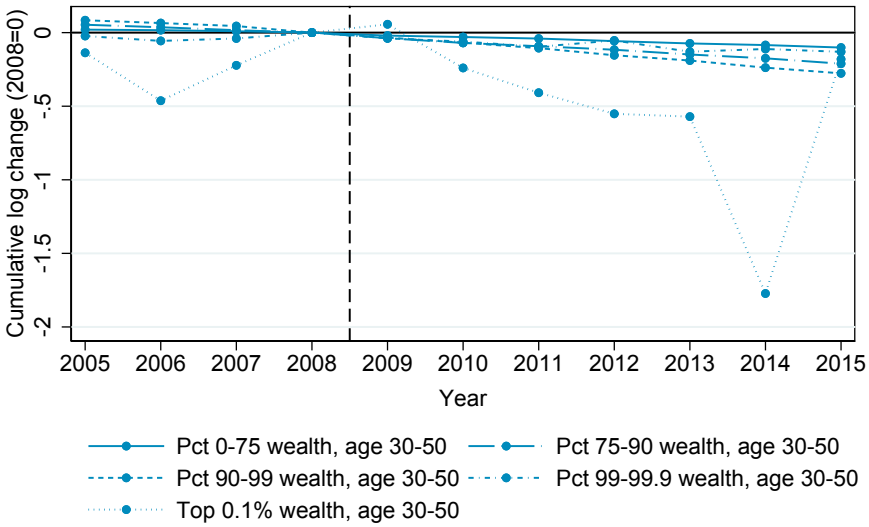
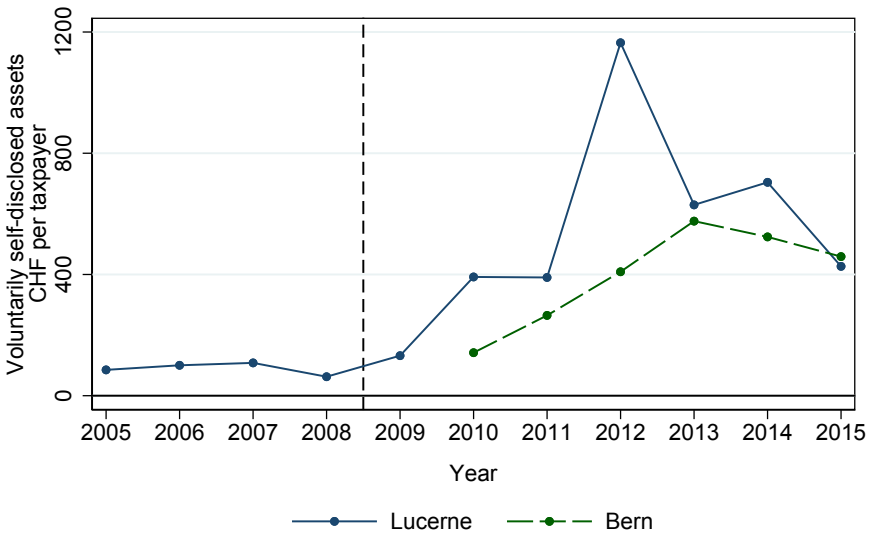


Figure B.14: Evolution of earnings of stable households by wealth quantile



Notes: The graph shows cumulative differential log changes in earnings of Lucerne relative to Bern for taxpayers who are stables and between age 30-50 in 2008, the year before the tax reduction. It shows this evolution separately for households in the top 0.1%, percentiles 99-99.9, 90-99, 75-90 and 0-75 of the wealth distribution in 2008. In contrast, wealth in Figure B.1, we display patterns for each wealth quantile separately rather than add them up. The 2015 values of the depicted series are, respectively, -0.101 for percentiles 0-75, -0.211 for percentiles 75-90, -0.276 for percentiles 90-99, -0.130 for percentiles 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.

Figure B.15: 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.