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On the Fiscal Sustainability of Swiss Cantons Since 1905

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On the Fiscal Sustainability of Swiss Cantons Since 1905

Abstract

With an outstandingly long data set of Swiss cantonal public finances, we study whether this Swiss subnational level runs sustainable fiscal policies. Going back to the year 1905, we test for stationarity of cantonal public debt, revenue and spending and for cointegration between cantonal revenues and expenditures. Based on time series properties, we estimate individual fiscal reaction functions for each canton and for the panel of cantons as a whole. Using second generation panel-modelling and thus accounting for heterogeneity in cantonal fiscal policy, structural breaks and cross-sectional dependence among the cantons, our results show that the cantons run sustainable policies. Moreover, our results provide evidence that fiscal rules explain part of the heterogeneity in cantonal fiscal reactions to increased debt.

JEL-Codes: H620, H770, H720, C230.

Keywords: fiscal sustainability, fiscal institutions, Swiss Cantons.

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1. Introduction

Are subnational public finances sustainable or, put differently, do subnational jurisdictions conduct sound fiscal policies? What determines subnational public finances such that these jurisdictions avoid fiscal crises and bail-outs by other jurisdictions of the same federation? These questions have been addressed broadly in the literature on fiscal policy and public debt, in particular in studies on fiscal federalism (Rodden 2002, 2006, Hallerberg et al. 2007, Hallerberg and Wolff 2008). Such analyses have also played a prominent role in policy debates regarding reforms of fiscal federalism, the introduction and design of fiscal rules or no bail-out provisions (Baskaran and Feld 2010, Feld et al. 2018). While existing literature has studied determinants of fiscal policies extensively, also addressing fiscal adjustments to consolidate budgets (Alesina et al. 2019), the determinants of fiscal sustainability in its proper meaning are less frequently focused.

Moreover, the existence of fiscal sustainability has been empirically studied for several federations,¹ but evidence for the Swiss cantonal level is largely missing, despite the fact that the Swiss cantons are an interesting example for analyzing subnational fiscal sustainability for at least three reasons.² First, with 26 jurisdictions in total and a data availability that covers more than a century, the Swiss cantonal level offers a unique opportunity to investigate fiscal sustainability for a large set of jurisdictions over a long time period. Second, different to other federations, Swiss cantons possess wide-ranging fiscal competencies with regard to both, expenditures and revenues, leading to intensive fiscal competition (Feld and Kirchgässner 2001a, Martínez 2022, Baselgia and Martínez 2024). Third, Swiss cantons have differing sets of fiscal institutions which allow for investigating the effects of these institutions on fiscal policy (Feld and Kirchgässner 1999, Feld and Matsusaka 2003, Burret and Feld 2018a, b).

In this paper, we examine cantonal fiscal sustainability along two lines of the literature. First, we test for cointegration of cantonal revenues and expenditures, which would indicate that an accumulation of deficits is prevented (Hamilton and Flavin 1986). Second, we run fiscal reaction functions to check whether cantons counteracted increases in their debt to GDP ratios by adapting their future primary surpluses (Bohn 1996, 1998). In order to test these two aspects of fiscal sustainability, we compile an extraordinarily long data set of cantonal debt, revenues, expenditures and primary balances for 25 cantons³ going back to the year 1905. Given the large n and t dimensions of our panel, we are able to analyze cantonal fiscal sustainability in the long- and medium-run as well as for each canton individually and for the cantonal level as a whole. Our results show that fiscal policy of the Swiss cantons has been

¹ See Kitterer (2007), Claeys et al. (2008), Fincke and Greiner (2011), Potrafke and Reischmann (2015), Burret et al. (2016, 2017), Feld et al. (2020) for the German Länder; DeMello (2007) for Brazilian Provinces; Afonso and Rault (2008) and Berti et al. (2016) for EU member states; Bohn and Inman (1996) for the US states; Bohn (2007) for the US federal government.

² See Seawright and Gerring (2008) for a methodology to select cases. According to their classification, Switzerland can be considered a deviant case among federations, i.e., deviating from other federations regarding fiscal relations as some cross-case relationship. See Asatryan and Feld (2015) for some supporting evidence.

³ Switzerland has 26 cantons, but the canton of Jura was created by secession from Berne in 1979, such that data is available only since 1980. In order to conduct the analyses of fiscal sustainability properly, we decided to exclude Jura and thus obtain a balanced panel of the Swiss cantons over the whole time period.

sustainable overall, but with heterogenous fiscal reactions to increasing debt across time and cantons. Our estimations provide evidence that cantonal fiscal rules explain part of this heterogeneity.

Our contribution to the literature on fiscal sustainability is twofold. This paper is, to the best of our knowledge, the first that formally analyzes concepts of fiscal sustainability of the Swiss cantonal level empirically over such a long time period. Although Feld and Kirchgässner (1999, 2001b, 2008), Feld and Matsusaka (2003) and Burret and Feld (2018a) provide evidence as to what determines public debt and deficits at the Swiss subfederal levels, particularly focusing on institutional determinants like direct democracy and fiscal rules, they do not consider concepts of fiscal sustainability. Given the long time period covered in this paper, we are able to consider the introduction of debt brakes in the cantons of St. Gallen in 1929 and Fribourg in 1960 better than previous studies. Moreover, by applying and adjusting second-generation panel modelling methods to the Swiss cantonal level, we provide an econometric framework for future analyses of cantonal fiscal policies that fits the structural and institutional heterogeneity of Swiss cantons and shows new ways of analyzing fiscal policies in federations.

The remainder of this paper is organized as follows. Section 2 describes theoretical approaches to analyze fiscal sustainability. Previous findings on fiscal sustainability in Switzerland are discussed in section 3. Our econometric modelling is outlined in section 4. Canton-specific estimation results are reported in section 5, the results for the panel of cantons in section 6. Section 7 concludes.

2. Theoretical Approaches to Fiscal Sustainability

Although the approaches to empirically assess the sustainability of public finances differ, they all start with the intertemporal budget constraint (IBC) of the government. This constraint states that the outstanding debt to GDP ratio d_0 has to equal all future discounted primary surpluses plus the discounted future debt to GDP ratio (Bohn 2008):

$$d_0 = - \sum_{t=1}^{\infty} \left(\frac{1+y}{1+r} \right)^t p_t + \lim_{T \rightarrow \infty} \left(\frac{1+y}{1+r} \right)^T d_T \quad (1)$$

For the budget constraint to hold, two conditions are necessary. The first is depicted by the first expression on the right-hand-side of equation (1) and states that today's debt to GDP ratio d_0 has to equal all discounted future primary surpluses p_t , with y depicting the growth rate of real GDP and r the real interest rate. The second is the transversality or “no-Ponzi” condition and is stated by the second expression on the right-hand-side of equation (1). This condition requires that the discounted debt to GDP ratio d_T has to converge to zero if the number of years t approaches infinity. The empirical approaches to assess debt sustainability pick up these two theoretical conditions.

Following Feld et al. (2020), we separate the empirical approaches to debt sustainability into two categories, depending on which of the two conditions they refer to. The first category uses time-series properties to check whether the transversality condition is fulfilled. The idea behind this approach is that expenditures and revenues need to follow a concurrent path to avoid a continuous accumulation of

deficits and, thus, a continuous increase of the debt to GDP ratio. There are two empirical strategies that have been applied to test whether the transversality condition holds. Authors either check whether the debt to GDP ratio itself is stationary (Hamilton and Flavin 1986) or whether revenues and expenditures show a cointegration relation with a vector of $[-1; 1]$ (Trehan and Walsh 1988, 1991; Ahmed and Rogers 1995; Quintos 1995; Burret et al. 2016). While the stationarity of debt refers to the debt to GDP ratio directly, checking for a cointegration relation of revenues and expenditures requires that an increase in expenditures has to go along with the same increase in revenues, while a reduction in revenues has to be followed by a reduction of expenditures.

One critique of assessing sustainability based on the transversality condition and relying on time-series properties is that it is not relating deficits to the levels of outstanding debt (Feld et al. 2020; D’Erasmus et al. 2016). Thus, the second category of estimation approaches sets in. Instead of referring to the transversality condition, this approach refers to the intertemporal budget constraint, stating that outstanding debt has to equal future primary surpluses. Econometrically, this condition is tested by estimating fiscal reaction functions (Bohn 1996, 1998), i.e., testing directly whether the government increases primary surpluses to counteract preceding increases in the debt to GDP ratio.

3. Institutional Background and Previous Evidence on Fiscal Sustainability of Swiss Cantons

The Swiss federation consists of 26 cantons as the intermediate (regional) tier of government that largely differ in size. While the largest canton has 1.5 million inhabitants (Zurich), the smallest canton only has 16.000 inhabitants (Appenzell Inner-Rhodes). With 88.1 billion Swiss Francs in 2017, aggregate spending of the cantons distinctly exceeds that of the federal (68.0 billion Swiss Francs) and the municipal levels (48.8 billion Swiss Francs). Regarding cantonal budget shares, education, healthcare and social security are the most important spending categories of the cantons. In 2017, 65 percent of all cantonal expenditures were spent within these three categories. All cantons have their own constitution, executive, legislature and judiciary. Given this basic institutional setup, Swiss cantons possess high autonomy on spending and revenues (Feld and Kirchgässner 2005).

This is in contrast to other federations (e.g., Germany or Austria) where subnational jurisdictions have large autonomy on spending but no power to tax. As Dardanelli et al. (2019) conclude, such differences may first and simply be the result of antecedent conditions. The Swiss federation was founded before World War I during a time period with much more limited government. The German federation, in contrast, obtained its more modern shape after World War II with a rather developed welfare state. Moreover, Switzerland was borne out of a federal bargain (Dardanelli and Mueller 2019) and thus started from a lower level of centralization than Austria, Germany or India. Globalization and technological change, as driving forces of centralization identified by Dardanelli et al. (2019), affected European federations similarly such that the differences between the more and less centralized among them are less open to this explanation. European integration, although Switzerland is not a member of the EU, does not appear to have played a role either. However, as Dardanelli and Mueller (2019) point

out, the low degree of nationalization of the party system in Switzerland, the dominance of right-of-center parties in the executive after World War I and, in particular, direct democracy might have led to less centralization of Swiss federalism as compared to Germany or Austria (Feld et al. 2008). Dardanelli and Mueller (2019) also show that Swiss centralization occurred less in fiscal policies than in legislative terms. Still, both world wars contributed to fiscal centralization in the Swiss federations, e.g., regarding the establishment of its welfare state arrangements or of new powers to tax of the federal level.

While tests on fiscal sustainability have been applied for many countries and subnational jurisdictions, there are only few studies that systematically examine the fiscal sustainability of Switzerland. Borgmann and Raffelhüschen (2004) use a generational accounting approach and show that there is a sustainability gap of 56% of GDP, but overall sustainability may still be ensured. Closer to the theoretical reasoning outlined above, Kirchgässner and Prohl (2008) refer to the transversality condition and conduct time series analysis for the Swiss federal level. They test on cointegration between federal expenditures and revenues. Using long time series from 1900 to 2002, Kirchgässner and Prohl (2008) find sustainability for the whole period.⁴ However, this result only weakly holds for the post-war period if they allow for a structural break after the World War II. Their explanation for this puzzling result is that, while not having an effect on the whole period, high deficits during World War II and after the 1970s could drive the sub-periodical results. A similar approach is undertaken by Prohl (2010) who applies an error correction model to the same dataset, distinguishing between short- and long-term dynamics. She finds a long-run link between federal revenues and expenditures and, thus, long-run sustainability for the Swiss federal level.

While these studies focus on the federal level, to the best of our knowledge, our analysis is the first that empirically investigates fiscal sustainability of the Swiss subnational level comprehensively based on the theoretical considerations outlined above.⁵ In contrast, Blohm et al. (2022) consider the differences between cantonal cyclically-adjusted primary balances and the debt-stabilizing primary balances. They report 415 sustainable and 339 not sustainable canton-years for a sample of the 26 Swiss cantons between 1991 and 2019.

4. Empirical Framework and Data

Given the theoretical considerations in Section 2, we first test the transversality condition outlined in equation (1) and thus focus on the time series properties of public debt, primary balances, revenue and expenditure. In a second step, we follow Bohn (1998) and estimate fiscal reaction functions for the Swiss cantonal level. Our baseline specification of the fiscal reaction function is:

⁴ Although they also study time series characteristics of Swiss federal public finances, Feld and Schaltegger (2010) are not focusing on fiscal sustainability, but on revenue, spending, deficits and debt and the role of finance ministers.

⁵ Please note again that this assessment holds regarding fiscal sustainability, while there are several studies investigating cantonal or local public debt in Switzerland. See, e.g., Feld and Kirchgässner (1999, 2001b, 2001c, 2005, 2008), Feld et al. (2011) and Burret and Feld (2018a, b)

$$\begin{aligned} \text{Primary Surplus}_{i,t} = & \rho \text{Public Debt}_{i,t-1} + \beta \text{Controls}_{i,t} + \\ & \text{Primary Surplus}_{i,t-1} + \delta_i + u_{i,t}, \end{aligned} \quad (2)$$

where the dependent variable is the primary surplus of canton i in relation to GDP in year t . Our explanatory variable of interest is a canton's debt to GDP ratio of the previous year $t-1$. The coefficient ρ indicates whether cantonal budget balances have increased after an increase in a canton's debt to GDP ratio (Bohn 1998). If we cannot find a positive and significant reaction of the primary surplus after an increase in the previous year debt to GDP ratio the intertemporal budget constraint and thus the sustainability criteria outlined above are not fulfilled.

Assessing fiscal sustainability by estimating fiscal reaction functions will not reject the overall fiscal sustainability of a jurisdiction if governments have to run deficits repeatedly in a multi-year downturn, as long as they run surpluses during the following phase of recovery and the observed time period is sufficiently long. Moreover, to assure that variations in the primary surplus are not driven by cyclical fluctuations and extraordinary expenditure events, we include variables to control for their temporary fluctuations. Following Bohn (2008), Mendoza and Ostry (2008) and Feld et al. (2020), our baseline controls for temporary fluctuations in the business cycle (YVAR) and government expenditure (GVAR) are taken from the closed solution of Barro's tax smoothing model (Barro 1981, 1986) and take the form

$$YVAR_{i,t} = \left(1 - \frac{Y_t}{Y_t^T}\right) * \frac{G_t^T}{Y_t} \quad (3a)$$

$$GVAR_{i,t} = \frac{(G_t - G_t^T)}{Y_t^T}, \quad (3b)$$

where Y_t indicates cantonal imputed GDP and G_t cantonal expenditures. Y_t^T and G_t^T indicate the respective trend variables. Trend variables are attained using a standard Hodrick-Prescott (1997) filter with a smoothing parameter of 100 (Feld et al. 2020). Given the definition of YVAR stated above, the variable indicates whether imputed GDP is *below* its trend value. We thus expect a negative sign of the YVAR coefficient. The GVAR variable is positive if expenditures are above their trend. We therefore expect a negative effect of GVAR on the primary surplus, too.

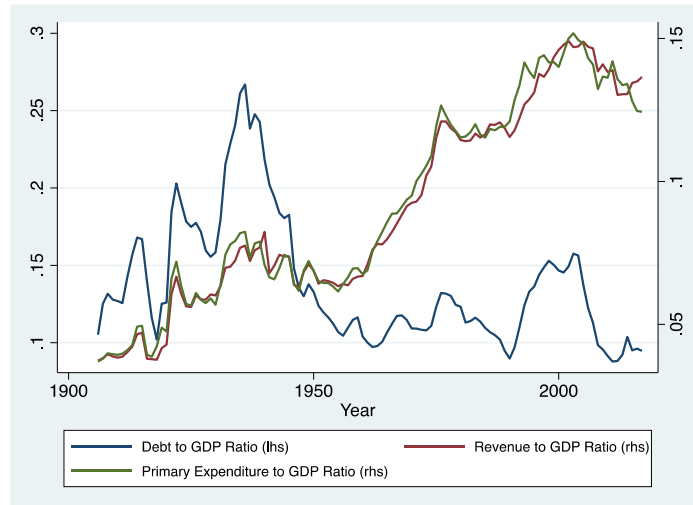
As fiscal policy is persistent (Claeys 2006), Feld et al. (2020) and Theofilakou and Stournaras (2012) argue that a lagged dependent variable should be included when FRF are estimated over a long period to control for unobserved persistence that would otherwise lead to an omitted variable bias. Therefore, we include a lagged dependent variable and estimate a dynamic model.

Further possible control variables are discussed in the literature on Swiss public debt. Among them are fiscal preferences, ideology, demography, culture (e.g., according to language differences), singular events like losses incurred by cantonal banks, a canton's decentralization level and other institutional differences. Unfortunately, these variables are not consistently available for the long time period on which we focus our sustainability analysis such that we have to leave them out of the analysis. It should be noticed that all information should be available to the early years of our sample to be included.

However, we are able to assess the stringency of fiscal rules for the longer time period. We use the fiscal rules index developed by Feld and Kirchgässner (2001b, 2001c, 2008) and updated by Burret and Feld (2018a, b). This four-scale index assigns one point for every de jure characteristic by focusing on the link between budgeting and execution, on the strictness of numerical constraints and on non-discretionary sanctions for accruing deficits. Extending the index to earlier periods than 1980 requires to assess the fiscal rules of the cantons of St. Gallen and Fribourg only, as their fiscal rules were the only ones introduced before 1980. Thus, we are the first to be able to properly assess the effect of fiscal rules on fiscal sustainability of Swiss cantons including the time variation for these two cantons as the third step of our sustainability analysis. We expect fiscal rules to improve fiscal sustainability.

Overall, our dataset comprises information for 25 of the 26 Swiss cantons over the period between 1905 and 2017.⁶ We collected data for cantonal debt to GDP ratios, revenues, expenditures and interest spending. Data for the post-war period comes from the Swiss Federal Statistical Office and the cantonal public finance reports. For the period between 1905 and 1945, we collected data from the finance departments and archives of each canton. Covering an outstandingly long n and t dimension, our panel data is in both dimensions much larger than that of most international studies of fiscal sustainability. Fiscal data for the aggregate of cantons is depicted in Figure 1.⁷

Figure 1: Cantonal Debt, Revenues and Expenditures relative to GDP 1905-2017



Source: Own depiction based on Swiss Federal Federal Statistics Office and Cantonal Archives.

5. Canton Specific Results

The literature indicates three sources why fiscal reaction functions are likely to differ across and within cantons. First, if observing a long t-dimension, structural breaks in the fiscal behavior of cantons are likely (Kirchgässner and Prohl 2008). Second, business and fiscal policy cycles differ between the

⁶ The canton of Jura seceded from the canton of Berne in 1979. We decided to leave it out of the whole analysis in order to use a balanced panel of Swiss cantons for the whole time period.

⁷ The time period in Figure 1 ends in 2017 in line with the overall data set that is used in the econometric analysis. The data set is not extended to more recent years as the update for fiscal rules is not available yet.

cantons (Burret and Feld 2018b). Third, fiscal preferences vary between and within cantons over time (Funk and Gathmann 2011, 2013).

Given the heterogeneity of cantons, we follow Feld et al. (2020) and start our empirical analysis by inspecting the time series properties and the fiscal reactions for individual cantons. First, we test for structural breaks in the cantonal debt, primary surplus, revenue and expenditure series. Applying the Andrews and Zivot (1992) test, we find a cluster of breaks during the Second World War: 14 cantons show a break in intercept and trend of their debt series, 8 cantons show a break in their revenue, expenditure and primary surplus series. We therefore allow for a structural break in the series at the end of the Second World War and conduct the estimation of fiscal reaction functions separately for the entire dataset and the post-war period. Consistent with the assessment by Dardanelli et al. (2019), the structural break indicates as to how the Second World War affected Swiss fiscal federalism.

Second, we explore the time-series properties of the four series for each canton. Based on the transversality condition of the intertemporal budget constraint, we can use the time series properties to attain first evidence on the sustainability of cantonal public finances as well as on the heterogeneity of fiscal reactions. Results of the time series tests are reported in Table 1. Strict stationarity of the debt to GDP ratio can be rejected for most of the cantons. Only Zurich, Obwalden, Zug and Vaud show evidence for strictly stationary debt series and, thus, first evidence in favor of sustainable public finances. These four cantons have highly developed economic structures, leading to relatively high incomes and thus to a high revenue potential. All other cantons at least show a trend in the debt development or even strictly non-stationary series and, consequently, evidence for an accumulation of debt. Time-series evidence for primary surpluses paint a slightly better picture with 18 of the 25 cantons showing a stationary budget balance. Although the latter provides evidence for sustainable finances for most of the cantons, the mixed picture of the individual debt series indicates heterogeneity among the cantons.

Some of these results may be surprising. For example, the primary surplus may be stationary and public debt is not, as in the case of the canton of Berne. While, theoretically, public debt is the accumulation of deficits, it should be noted that stock-flow adjustments and the differences in accounting for both variables may lead to deviations between them. Similarly, trend stationary revenue and non-stationary spending in connection with stationary primary surpluses, like in the canton of Zurich, might surprise. Again, accounting differences, e.g., regarding interest expenditure, might play a role here. Please note that primary surpluses are calculated by subtracting interest expenditure.

Third, we estimate individual reaction functions for each canton and report the respective reaction coefficients ρ in Table 1. We find multiple slopes of cantonal fiscal reaction functions. The majority of the cantons shows differing, but positive and statistically significant reaction coefficients. However, those 10 cantons that already showed non-stationary debt series show non-positive or insignificant fiscal reactions for either the entire or the post-war period. That both primary surplus and debt are stationary and fiscal reactions negative might be the result of insufficient reactions of the primary surplus to public

debt. These results on the properties of canton-individual fiscal data confirm our suspicion of heterogenous fiscal reaction behavior among the cantons.

Table 1: Canton-Specific Results 1905-2017

Canton	Stationarity				Cointegration of Revenues and Expenditures (Johansen- Test)	Fiscal Reaction of the Primary Surplus on Debt	
	Debt	Primary Surplus	Revenue	Expenditure		1905-2017	1946-2017
ZH	✓	✓	✓*	X	✓	0.052**	0.076**
BE	X	✓	X	X	✓	0.006	0.050***
LU	n.a.	✓*	✓*	✓*	✓	0.019	0.043**
UR	X	✓	✓*	X	✓	-0.005	-0.019
SZ	X	✓	✓*	✓*	✓	0.047**	0.073*
OW	✓	✓	X	✓*	✓	0.046***	0.056***
NW	X	✓	X	X	✓	0.000	-0.021
GL	n.a.	✓	✓*	X	✓	-0.015	0.009
ZG	✓	✓	X	X	✓	0.040	0.064
FR	✓*	✓*	X	X	X	-0.020***	-0.012
SO	✓*	✓	✓*	✓*	✓	-0.023*	-0.004
BS	✓*	✓*	X	X	✓	-0.019	0.091***
BL	✓*	n.a.	✓*	n.a.	n.a.	0.065**	0.079**
SH	n.a.	✓	✓*	✓*	✓	-0.011	0.010
AR	X	✓	✓*	X	✓	0.051**	0.101*
AI	X	✓*	X	X	✓	0.028**	0.064***
SG	✓*	✓	X	X	✓	-0.012**	0.004
GR	X	n.a.	✓*	✓*	✓	-0.007	0.016*
AG	✓*	✓	✓*	✓*	✓	0.005	0.009
TG	X	✓	X	✓*	✓	0.008	0.079***
TI	X	✓	X	n.a.	n.a.	0.006	0.009
VD	✓	✓	X	✓*	✓	0.054***	0.057***
VS	✓*	✓*	X	✓*	✓	0.011	0.033
NE	X	✓	X	X	✓	-0.007	0.090***
GE	X	✓	X	X	✓	0.002	-0.003

Stationarity is tested by Augmented-Dickey-Fuller Tests, Phillips-Perron Tests and Kwiatkowski, Phillips, Schmidt and Shin Tests, each with and without linear time trends. ✓ if all tests indicate stationarity, X if any of the tests indicates non-stationarity, ✓* if tests indicate trend-stationarity, n.a. if mixed results. Johansen Test for cointegration reported without trend, with trend results for Cantons with trend-stationarity in variables show no cointegration. Cantonal abbreviations: Zurich (ZH), Bern (BE), Lucerne (LU), Uri (UR), Schwyz (SZ), Obwalden (OW), Nidwalden (NW), Glarus (GL), Zug (ZG), Fribourg (FR), Solothurn (SO), Basle City (BS), Basle County (BL), Schaffhausen (SH), Appenzell ER (AR), Appenzell IR (AI), St. Gallen (SG), Grisons (GR), Aargau (AG), Thurgau (TG), Ticino (TI), Vaud (VD), Valais (VS), Neuchatel (NE), Geneva (GE).

6. Results for the Subnational Level as a Whole

Aside inspecting cantonal sustainability individually, we are interested in analyzing sustainability of the Swiss cantonal level as a whole, thus amending the canton specific analysis by estimating fiscal reaction functions for the panel of 25 Swiss cantons. Besides the heterogeneity in cantonal individual fiscal reactions, common trends and events such as the oil price shocks of the 1970s or the economic downturn that hit the entire Swiss federation in the early 1990s could influence fiscal policy of all cantons simultaneously. Therefore, we have to incorporate possible cross-cantonal effects into our modelling.

6.1 Choosing the Panel Estimator

To account for heterogeneity and cross-cantonal effects in the choice of the estimator for the panel of cantons, we follow the procedure for the selection of panel estimators for fiscal reaction functions in heterogenous panels proposed by Burret et al. (2016) and Feld et al. (2020). Applying this procedure, we first test for cross sectional dependence (CD) of the error terms across the cantons by applying Pesaran's (2004) test for CD in panel data.

Results are reported in Table 2. We can reject the null-hypothesis of no CD for all variables for the entire and the post-war period at the 1% significance level, indicating that the errors are indeed correlated across cantons. Thus, we have to control for CD in our estimations. Moreover, we check whether the series are stationary in the panel as a whole. Stationarity of the series in the panel as a whole is crucial for subsequent estimations as otherwise unobserved additional factors could drive empirical results on cantonal fiscal reaction behavior.

We apply Pesaran's panel unit root test in the presence of cross-sectional dependence (Pesaran 2006) to check for panel stationarity. We conduct the test with and without including a time trend. Lag lengths are determined according to the Akaike information criterion after estimating canton specific VARs. Results are also reported in Table 2. The test indicates that all series are panel-stationary without including a time-trend. The only exception is the debt series for the post-war period, which appears to be integrated of order one for at least one canton. Our control variables appear to be stationary in both periods.

Third, we test for a cointegration relation between expenditures and revenues and between the primary surplus and the lagged debt to GDP ratio to gain insights as to the long-run dynamics of cantonal fiscal reactions. A cointegration relation would indicate a systematic long-term link between the two variables and, thus, evidence in favor of fiscal sustainability in the long-run (Burret et al. 2016). We apply Westerlund's (2007) error correction based panel cointegration test.

Table 2: Panel Time Series Evidence

Variable	Cross Sectional Independence		Non-Stationarity (without time trend)		Non-Stationarity (with time trend)		Westerlund ECM Cointegration Test	
	1905-2017	1946-2017	1905-2017	1946-2017	1905-2017	1946-2017	1905-2017	1946-2017
Revenues	165.36 (0.000)	126.10 (0.000)	-2.430 (0.000)	-2.380 (0.001)	-2.531 (0.151)	-2.383 (0.400)	Gt -4.648 (0.000) Ga -41.962 (0.000)	Gt -3.696 (0.000) Ga -26.325 (0.000)
Expenditures	164.54 (0.000)	124.49 (0.000)	-2.511 (0.000)	-2.382 (0.000)	-2.598 (0.076)	-2.528 (0.137)	Pt -23.139 (0.000) Pa -72.457 (0.000)	Pt -17.318 (0.000) Pa -27.938 (0.000)
Primary Surplus	57.67 (0.000)	37.56 (0.000)	-4.468 (0.000)	-3.199 (0.000)	-4.043 (0.000)	-3.227 (0.000)	Gt -0.257 (1.000) Ga -0.368 (1.000)	Gt 0.016 (1.000) Ga 0.140 (1.000)
Lagged Debt	70.93 (0.000)	29.12 (0.000)	-2.242 (0.007)	-1.42 (0.902)	-2.404 (0.396)	-1.894 (0.995)	Pt -1.847 (0.727) Pa -0.590 (0.775)	Pt -0.830 (0.930) Pa -0.243 (0.912)
YVAR	176.97 (0.000)	138.16 (0.000)	-4.455 (0.000)	-3.817 (0.000)	-4.546 (0.000)	-3.792 (0.000)		
GVAR	81.24 (0.000)	40.04 (0.000)	-6.042 (0.000)	-5.221 (0.000)	-6.194 (0.000)	-5.251 (0.000)		

Notes: P-Values reported in parentheses. Cross dependence tested with the Pesaran (2004) test which has the null hypothesis of cross-sectional independence. Stationarity is tested with the Pesaran unit root test that has the null hypothesis of non-stationarity. Cointegration relations are tested applying the Westerlund error correction panel cointegration test that has the null hypothesis of series being not cointegrated.

While we find cointegration between expenditures and revenues we find no relation between the primary surplus and the debt to GDP ratio. Thus, there is mixed evidence in the long- and short-run dynamics of cantonal fiscal reactions. To incorporate these data properties into our modelling, we follow Feld et al. (2020) and use Pesaran's Common Correlated Effects Mean Group (CCEMG) estimator (Pesaran 2006) for our panel estimations of cantonal fiscal reaction functions. The CCEMG-estimator amends for every canton i all variables with the cross-sectional means of the $N-i$ other cantons as further explanatory variables. The mean group itself then reflects the average effect of all individual cantonal estimates, yielding the estimate for the reaction of the primary surplus after an increase in the debt to GDP ratio for the panel of all cantons.

Based on the data properties inspected above, the CCEMG-estimator is well-suited for our case for four reasons. First, the panel estimate is drawn from 25 individual estimates of each canton's fiscal reaction functions. Conceptually, this procedure is equivalent to a fixed effects estimation. Thus, the CCEMG-estimator accounts for multiple slopes of cantonal fiscal reaction functions by controlling for time-invariant canton-individual unobservables. Second, by amending all canton-individual estimates with the $N-i$ cross-cantonal means, the CCEMG-estimator accounts for *time-variant* unobserved common factors and, thus, for cross-cantonal correlations such as the oil price shock in the 1970s or the economic downturn in Switzerland in the 1990s. Third, simultaneously controlling for time-invariant unobservables for all individual cantons and for time-variant unobservables for the panel as a whole accounts for differing long- and short-run dynamics of cantonal fiscal reactions. Fourth, controlling for the canton-specific deviations from the cross-cantonal mean of each variable lowers potential problems that could stem from non-stationary time series.

6.2 Results for the Panel of Cantons

Panel estimation results for the fiscal reaction function of the cantons as a whole are reported in Table 3. Estimates for the period from 1905 until 2017 are shown in Panel A. We find a significantly positive reaction of cantonal fiscal policies on an increase in the cantonal debt to GDP ratio. Thus, the Swiss subnational level as a whole fulfills the intertemporal budget constraint by increasing primary surpluses after experiencing an increase in debt to GDP ratios. In column 2, we amend the static model with a lagged dependent variable. The lagged primary surplus is statistically and economically highly significant which confirms that cantonal fiscal policies are persistent. In column 3, we follow Bohn (2008) and include the squared deviation of the debt to GDP ratio from its mean to account for non-linearities in the debt development of a canton. While the non-linear debt variable shows no significant effect on the primary surplus, the magnitude of the fiscal reaction coefficient increases. Following our results on structural breaks in the time series, we estimate the fiscal reaction function separately for the post-war period (Panel B of Table 1).

Table 3: Common-Correlated-Effects Mean Group (CCEMG) Estimation of Fiscal Reaction Functions

	Panel A: 1905-2017			Panel B: 1946-2017		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged Debt	0.012*** (0.004)	0.014*** (0.003)	0.020*** (0.003)	0.025*** (0.006)	0.024*** (0.004)	0.041*** (0.008)
YVAR	0.023 (0.957)	0.330 (0.648)	0.043 (0.670)	0.217 (0.536)	0.244 (0.397)	0.324 (0.423)
GVAR	-0.980*** (0.311)	-0.760*** (0.224)	-0.787*** (0.232)	-0.628*** (0.137)	-0.575*** (0.124)	-0.588*** (0.125)
Primary Surplus (t-1)		0.432*** (0.003)	0.411*** (0.035)		0.376*** (0.038)	0.329*** (0.036)
Squared change of debt			-0.040 (0.063)			0.028 (0.142)
CSA Lagged Debt	-0.009** (0.005)	-0.010** (0.004)	-0.014*** (0.005)	-0.024 (0.019)	-0.017 (0.013)	-0.029* (0.016)
CSA YVAR	0.104 (0.388)	-0.208 (0.261)	-0.259 (0.308)	-0.041 (0.199)	-0.931 (1.822)	0.120 (0.190)
CSA GVAR	0.371*** (0.121)	0.307*** (0.105)	0.298*** (0.109)	0.117** (0.052)	0.107*** (0.040)	0.111*** (0.040)
CSA Primary Surplus (t-1)		-0.441*** (0.073)	-0.419*** (0.072)		-0.393*** (0.116)	-0.344*** (0.111)
CSA Squared change of debt			0.010 (0.037)			-0.074 (0.188)
Cantons	25	25	25	25	25	25
Years	112	112	112	72	72	72
N	2,800	2,800	2,800	1,800	1,800	1,800

Notes: Dependent variable: Primary Surplus relative to imputed cantonal GDP. Effects are estimated with Pesaran's (2006) CCEMG estimator that controls for cross-sectional-dependence and time variant unobservables with heterogenous impact across panels. We use the Stata routine xtmg.

For the post-war period the fiscal reaction coefficients continue to show a positive and statistically significant reaction behavior of cantonal fiscal policy in all specifications and confirm the sustainability verdict of the estimates of the entire period. Note, however, that the reaction coefficients are higher in the post-war panel compared to the long period panel. Thus, fiscal reactions to an increase in the debt to GDP ratio were stronger in the second half of the twentieth century. This result is in line with the results of Kirchgässner and Prohl (2008) for the Swiss federal level who find that fiscal reactions were dampened during the war periods. Again, this supports the considerations by Dardanelli et al. (2019) regarding the effects of wars on federalism. Moreover, the mean coefficient for fluctuations in public expenditures and the lagged primary surplus all show contradicting effects to the canton individual variables. These results provide evidence that confirms non-uniform fiscal policies of the cantons and, thus, the need to use the CCEMG estimator that controls for these cross-sectional effects.

6.3 Do Fiscal Rules Explain Fiscal Reactions?

Given these non-uniform fiscal policies, the question arises as to which factors are driving the heterogeneity of cantonal fiscal policies. Existing evidence shows that, among the various sets of cantonal fiscal institutions, especially fiscal rules are influencing local budget balances (Feld and Kirchgässner 2001b, 2001c, 2005, 2008; Schaltegger 2002; Burret and Feld 2018a, b).

To ensure that cantons do not accumulate deficits, cantonal finance ministers agreed in 1981⁸ on the principle to run balanced budgets. To codify this agreement, most cantons introduced fiscal rules afterwards. Two cantons had introduced a fiscal rule much earlier, i.e., the cantons of St. Gallen (1929) and Fribourg (1960) such that the decision of 1981 is belatedly following the lead of those two cantons. Today, all cantons except five (Appenzell Inner-Rhodes, Schaffhausen, Schwyz, Ticino and Zug) have introduced fiscal rules at various points in time either in their constitution or in their budget law. There are numerous empirical studies that provide evidence that the introduction of a fiscal rule improves the budget balance of a canton. Feld and Kirchgässner (2001b, 2001c, 2008) show that the introduction of a fiscal rule leads to lower deficits and debt levels. They find that the deficit-reducing effect primarily evolves through increased revenues.

Given this evidence, we include the fiscal rule index of Feld and Kirchgässner (2008) and Burret and Feld (2018a, b) as additional control variable that could influence the primary surplus. Results are reported in Table 4. For the period between 1905 and 2017, we find a positive and significant effect of fiscal rules on cantonal primary surpluses (Panel A). However, all other estimation results remain unchanged. This changes if we curtail our panel to the post war period (Panel B). Focusing on the post war period, the cross sectional mean of the lagged dependent variable now shows a positive and significant effect on the primary surplus if we control for cantonal fiscal rules. Thus, controlling for

⁸ Please note that the cantons of St. Gallen and Fribourg somehow served as role models for the decision of cantonal finance ministers in their efforts to harmonize budget laws in Switzerland. Earlier harmonization efforts did not lead to a clearcut legal conclusion.

fiscal rules, we find evidence in favor of uniform fiscal reactions to an increase in the debt to GDP ratio among the cantons. This provides evidence that the heterogeneity of cantonal fiscal reactions to an increased debt to GDP ratio, indicated by our results without including fiscal rules, can partly be explained by the differences in cantonal fiscal rules.

Table 4: (CCEMG) Estimation of Fiscal Reaction Functions Including Fiscal Rules

	Panel A: 1905-2017	Panel B: 1946-2017
	(1)	(2)
Lagged Debt	0.015*** (0.003)	0.028*** (0.005)
YVAR	0.535 (0.671)	0.136 (0.431)
GVAR	-0.773*** (0.222)	-0.559*** (0.119)
Primary Surplus (t-1)	0.392*** (0.038)	0.317*** (0.037)
Fiscal Rule Index	0.002** (0.001)	0.002* (0.001)
CSA Lagged Debt	-0.014*** (0.005)	-0.032* (0.018)
CSA YVAR	-0.285 (0.262)	-0.276 (2.061)
CSA GVAR	0.319*** (0.107)	0.102** (0.040)
CSA Primary Surplus (t-1)	-0.399*** (0.071)	0.969*** (0.134)
CSA Fiscal Rule Index	-0.002* (0.001)	-0.002 (0.002)
Cantons	25	25
Years	112	72
N	2,800	1,800

Notes: Dependent variable: Primary Surplus relative to imputed cantonal GDP. Effects are estimated with Pesaran's (2006) CCEMG estimator that controls for cross-sectional-dependence and time variant unobservables with heterogenous impact across panels. We use the Stata routine xtmg.

7. Conclusion

Starting from the intertemporal budget constraint, the literature on fiscal sustainability offers two empirical test strategies to empirically assess the soundness of a jurisdiction's public finances. The first approach goes back to Hamilton and Flavin (1986) and inspects the time series properties of a jurisdiction's debt stock, (primary) budget balance as well as revenues and expenditure series. If revenues and expenditures are cointegrated (and thus, the budget balance appears to be stationary) an accumulation of debt can be prevented. While this approach ignores the level of debt, the second approach derived by Bohn (1995, 1998) aims at inspecting how the government reacts to an increase in the level of debt. By estimating fiscal reaction functions, it can be checked whether a jurisdiction reacted by increases in the level of its debt to GDP ratio by increasing its primary balances.

In this paper, we apply both empirical approaches to the Swiss cantonal level individually as well as in a panel. We compiled an extraordinarily long dataset for 25 Swiss cantons, going back to the year

1905. Our canton specific results show that most cantons meet the sustainability criteria of the time series approach, while estimating fiscal reaction functions yields a rather mixed picture. We incorporate these heterogeneous canton specific results into our panel estimation on the fiscal sustainability of the entire set of cantons, using second generation panel modelling which accounts for structural breaks and time varying cross-sectional dependence.

The panel estimation results for both empirical approaches reveal that the Swiss cantonal level as a whole ran sustainable fiscal policies. However, and in line with previous findings for the Swiss federal level, we find that fiscal reactions to increased debt were stronger in the second half of the 20th century. Besides this heterogeneity in fiscal reactions across time, our results also indicate heterogeneous fiscal reactions among the cantons. One possible explanation for this heterogeneity across time and among the cantons are the varying sets of fiscal institutions among the cantons. Our results provide evidence in favor of this hypothesis by indicating that the existence and the design of cantonal fiscal rules explains some of the heterogeneity in fiscal reactions among the cantons.

Given these findings, the question whether further institutional factors of the Swiss cantons could affect the sustainability of cantonal finances provides scope for future research. One particular candidate in this respect is the particular design of Swiss fiscal federalism. In contrast to federations like Germany or Austria, tax and spending autonomy are closely aligned in Swiss federalism, thus more strongly living up to the liability principle in fiscal affairs. The liability principle is further strengthened by a no bail-out culture that was reinforced by the Leukerbad ruling of the Swiss Federal Supreme Court in 2003 according to which the canton of Wallis was not required to bail-out the creditors of Leukerbad during its fiscal crisis. Following this decision, the joint liability of cantons and its local jurisdiction that was implicitly assumed by financial markets became separated again in investors' expectations leading to lower interest rates of the cantons (Feld et al. 2017).

Although it is always difficult to transpose functioning institutional arrangements in one country to another one, the Swiss experience with its fiscal federalism may have implications for other federations, like Germany with its stronger extent of joint and several liability of the *Laender*. It may also have implications for the future of the European Union (EU) (Feld et al. 2018), if the EU further moves towards a federation. The congruence of spending and revenue competencies, accompanied by strict no bail-out rules, is constituting for Swiss fiscal federalism. It needs to be respected in the cases mentioned.

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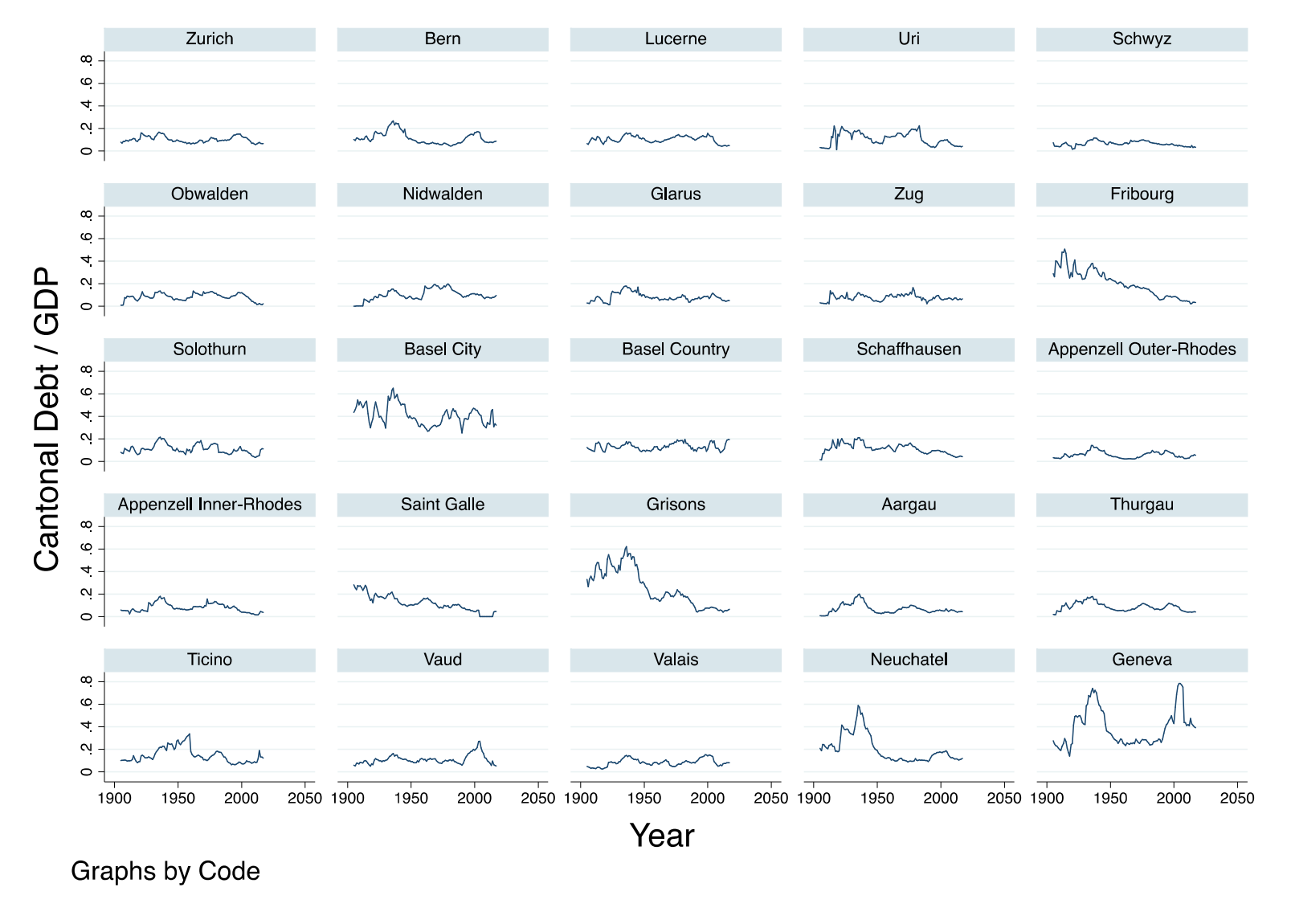
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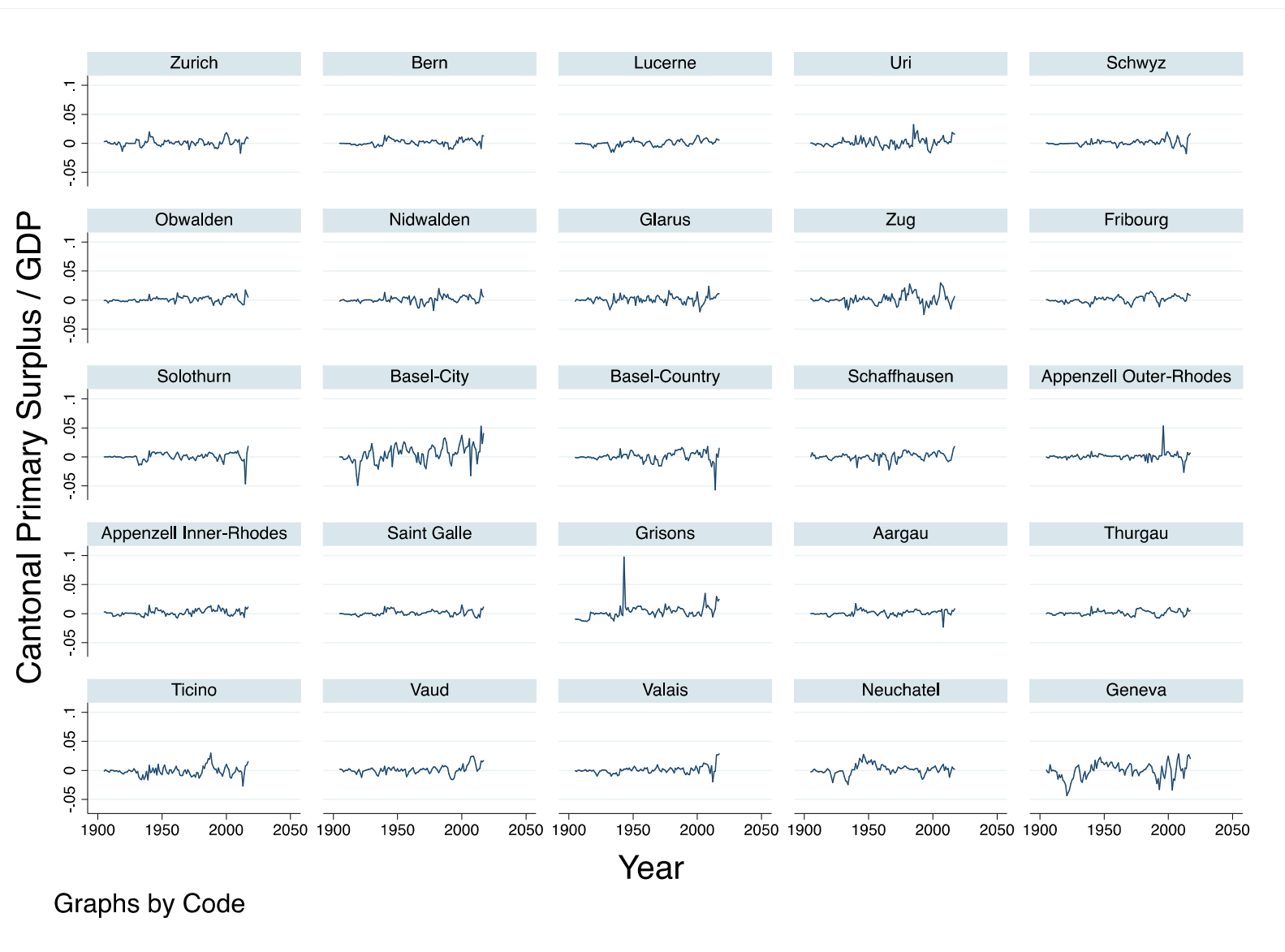
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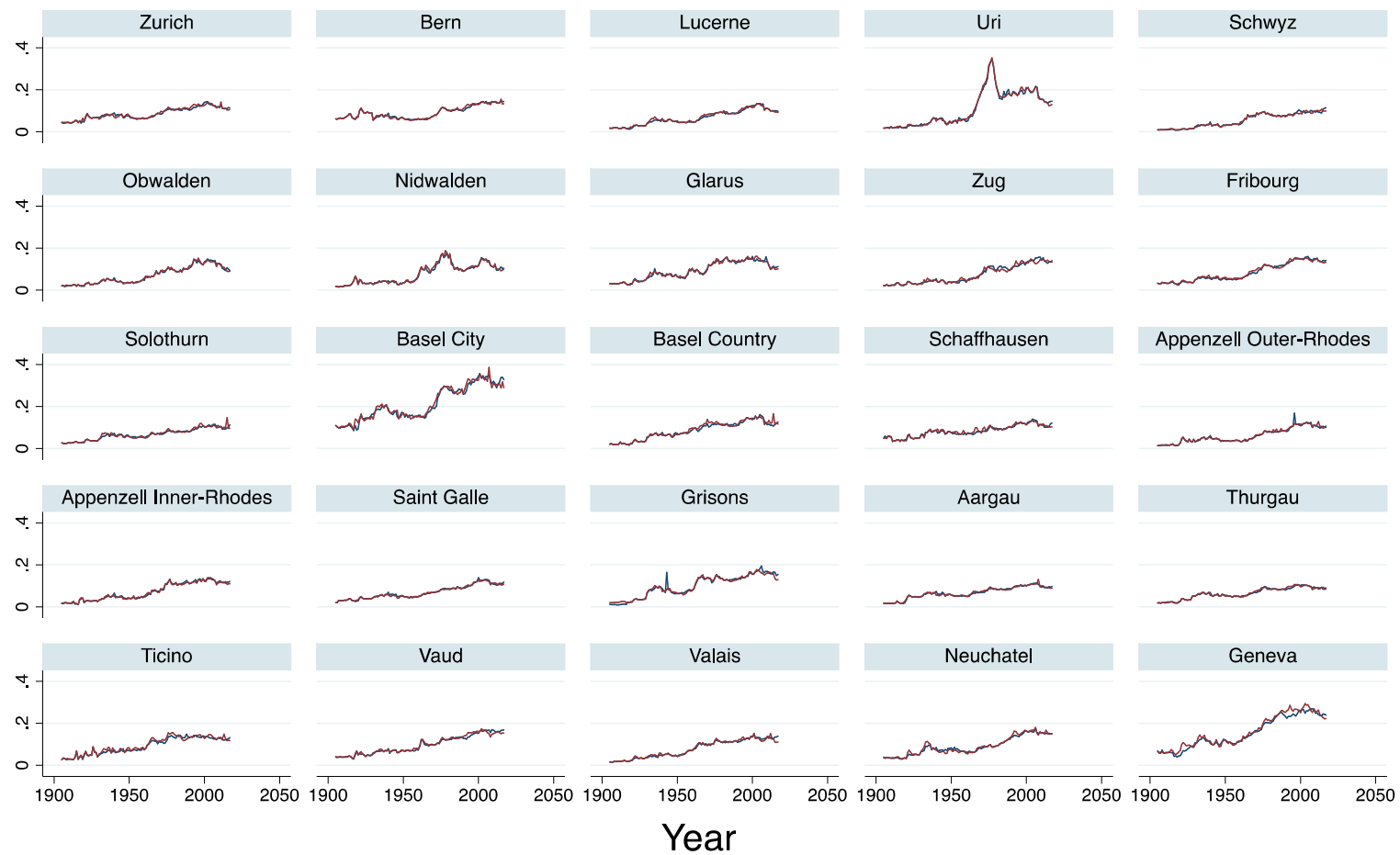
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Appendix: Canton Specific Graphs







Graphs by Code