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Yannick Bury, Lars P. Feld und Ekkehard A. Köhler

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Walter Eucken Institut
Goethestraße 10
79100 Freiburg
www.eucken.de
wei-freiburg@eucken.de

universität freiburg

Albert-Ludwigs-Universität Freiburg
Institut für Wirtschaftswissenschaften
Abteilung Wirtschaftspolitik und
Ordnungsökonomik

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Yannick Bury
Walter Eucken Institute
Goethestrasse 10
D-79100 Freiburg
bury@eucken.de

Lars P. Feld
Walter Eucken Institute
Albert Ludwigs University
Freiburg
Goethestrasse 10
D-79100 Freiburg
feld@eucken.de

Ekkehard A. Köhler
University of Siegen
ZöBiS
Kohlbettstraße 17
D-57068 Siegen
Ekkehard.Koehler@uni-siegen.de

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Abstract

With an outstandingly long data set of Swiss cantonal public finances we study whether the 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 which accounts 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 institutions can explain part of the heterogeneity in cantonal fiscal reactions to increased debt.

JEL Codes: H62, H77, H72, C23
Keywords: Fiscal Sustainability, Fiscal Institutions, Swiss Cantons

1. Introduction

Are subnational public finances sustainable? While this particular question has been empirically studied for several federations,[1] evidence for the Swiss cantonal level is missing so far. However, the Swiss cantons are an interesting example to analyze subnational fiscal sustainability for at least three reasons. First, with 26 jurisdictions in total and a data availability that covers more than a century, the Swiss subnational level offers a unique opportunity to investigate fiscal sustainability for a large set of jurisdictions over a long time period. Second, different to other subnational jurisdictions, the Swiss cantons possess wide-ranging fiscal competencies with regard to both, expenditures and revenues. Third, the Swiss cantons have differing sets of fiscal institutions which allows for investigating the effects of these institutions on the sustainability of fiscal policy.

In this paper, we examine cantonal fiscal sustainability along two lines of the theoretical and empirical 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 ratio by adapting their future primary surpluses (Bohn 1996, 1998). We compile an extraordinarily long data set of cantonal debt, revenues, expenditures and primary balances for 25 cantons, going back to the year 1905. Given the large n and t dimension of our panel, we are able to analyze cantonal fiscal sustainability in the long and medium run as well as individually for each canton and for the subnational level as a whole. Our results show that fiscal policy of the Swiss cantons has been sustainable overall. However, we find heterogenous fiscal reactions to increasing debt across time and across cantons. Our estimations provide evidence that a canton's fiscal institutions can 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 empirically studies concepts of fiscal sustainability of the Swiss cantonal level. Moreover, by applying and adjusting second-generation panel modelling methods to the Swiss subnational level, we provide an econometric framework for future analyses of cantonal fiscal policies that fits the structural and institutional heterogeneity of Swiss cantons.

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 modeling is discussed in section 4. Canton specific estimation results are reported in section 5, results for the panel of cantons are reported 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

[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 Laender; DeMello (2007) for Brazilian Provinces; Afonso and Rault (2008) and Berti et al. (2016) for EU states; Bohn and Inman (1996) for the US states; Bohn (2007) for the US federal government.

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):

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

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 states 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 test strategies that have been applied to test whether the transversality condition holds. Authors check either 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 come 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'Erasmo et al. 2016). The second category of estimation approaches picks up here. 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). Thus, the approach aims to test 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

As the intermediate (regional) tier of government, the Swiss federation consists out of 26 cantons that differ largely 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). With regard to 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.

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.[2] However, this result only weakly holds for the post-war period if they allow for a structural break after the Second World War. 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). She 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 based on the theoretical considerations outlined above.

4. Empirical Framework and Data

Given the theoretical considerations above, we follow Bohn (1998) and estimate fiscal reaction functions for the Swiss subnational level of cantons. Our baseline specification of the fiscal reaction function is

$$\begin{aligned} Primary\ Surplus_{i,t} = {} & \rho\ Public\ Debt_{i,t-1} + \beta\ Controls_{i,t} + \\ & Primary\ Surplus_{i,t-1} + \delta_i + u_{i,t}\ , \end{aligned} \tag{2}$$

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

[2] Although they also study time series characteristics of Swiss federal public finances, Feld and Schaltegger (2010) are not focusing on fiscal sustainability but on the role of finance ministers.

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 large. 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 temporary fluctuations of both. 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

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

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

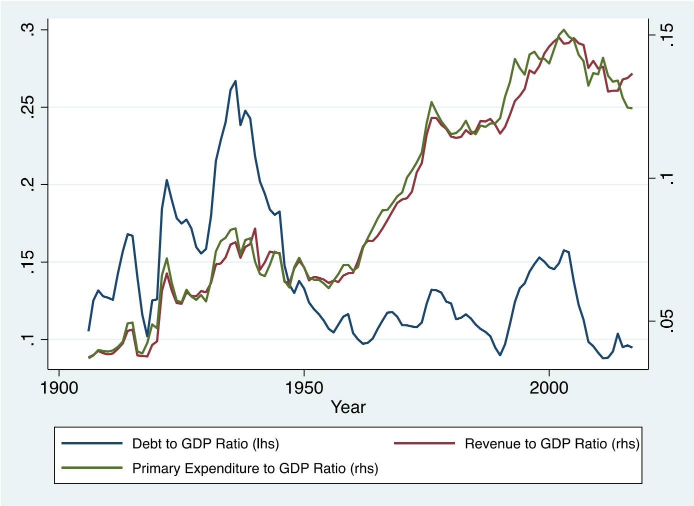
where Y_t indicates cantonal imputed GDP and G_t cantonal expenditures. Y_t^T and G_t^T indicate the respective trend variables. Trend variables are attained using a standard Hodrick-Prescott (1997) filter with a smoothing parameter of 100 (Feld et al. 2020). Given the definition of YVAR stated above, 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.

Our dataset comprises information for 25 of the 26 Swiss cantons over the period between 1905 and 2017.[3] 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.

[3] The canton of Jura seceded from the canton of Berne in 1979.

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 cantons (Burret and Feld 2018). 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. 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. All other cantons show at least 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.

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
NB	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).

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

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 sectoral 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 co-integration 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 co-integration 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 of the fiscal reaction function of the cantons as a whole are reported in Table 3. Estimations for the period from 1905 until 2017 are shown in Panel A. We find a significant 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***	0.014***	0.020***	0.025***	0.024***	0.041***
	(0.004)	(0.003)	(0.003)	(0.006)	(0.004)	(0.008)
YVAR	0.023	0.330	0.043	0.217	0.244	0.324
	(0.957)	(0.648)	(0.670)	(0.536)	(0.397)	(0.423)
GVAR	-0.980***	-0.760***	-0.787***	-0.628***	-0.575***	-0.588***
	(0.311)	(0.224)	(0.232)	(0.137)	(0.124)	(0.125)
Primary Surplus (t-1)		0.432***	0.411***		0.376***	0.329***
		(0.003)	(0.035)		(0.038)	(0.036)
Squared change of debt			-0.040			0.028
			(0.063)			(0.142)
CSA Lagged Debt	-0.009**	-0.010**	-0.014***	-0.024	-0.017	-0.029*
	(0.005)	(0.004)	(0.005)	(0.019)	(0.013)	(0.016)
CSA YVAR	0.104	-0.208	-0.259	-0.041	-0.931	0.120
	(0.388)	(0.261)	(0.308)	(0.199)	(1.822)	(0.190)
CSA GVAR	0.371***	0.307***	0.298***	0.117**	0.107***	0.111***
	(0.121)	(0.105)	(0.109)	(0.052)	(0.040)	(0.040)
CSA Primary Surplus (t-1)		-0.441***	-0.419***		-0.393***	-0.344***
		(0.073)	(0.072)		(0.116)	(0.111)
CSA Squared change of debt			0.010			-0.074
			(0.037)			(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. 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 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 2008, 2007; Schaltegger 2002; Burret and Feld 2018).

To ensure that cantons do not accumulate deficits, cantonal finance ministers agreed in 1981 on the principle to run balanced budgets. To codify this agreement, most cantons introduced fiscal rules afterwards. The first two cantons that introduced a fiscal rule were St. Gallen (1929) and Fribourg (1960). 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 (2001, 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 Burret and Feld (2018) 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 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***	0.028***
	(0.003)	(0.005)
YVAR	0.535	0.136
	(0.671)	(0.431)
GVAR	-0.773***	-0.559***
	(0.222)	(0.119)
Primary Surplus (t-1)	0.392***	0.317***
	(0.038)	(0.037)
Fiscal Rule Index	0.002**	0.002*
	(0.001)	(0.001)
CSA Lagged Debt	-0.014***	-0.032*
	(0.005)	(0.018)
CSA YVAR	-0.285	-0.276
	(0.262)	(2.061)
CSA GVAR	0.319***	0.102**
	(0.107)	(0.040)
CSA Primary Surplus (t-1)	-0.399***	0.969***
	(0.071)	(0.134)
CSA Fiscal Rule Index	-0.002*	-0.002
	(0.001)	(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 budged constraint, the literature on fiscal sustainability derives 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 the panel. We compiled an extraordinarily long dataset for all 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 heterogenous 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, an 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 heterogenous 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.

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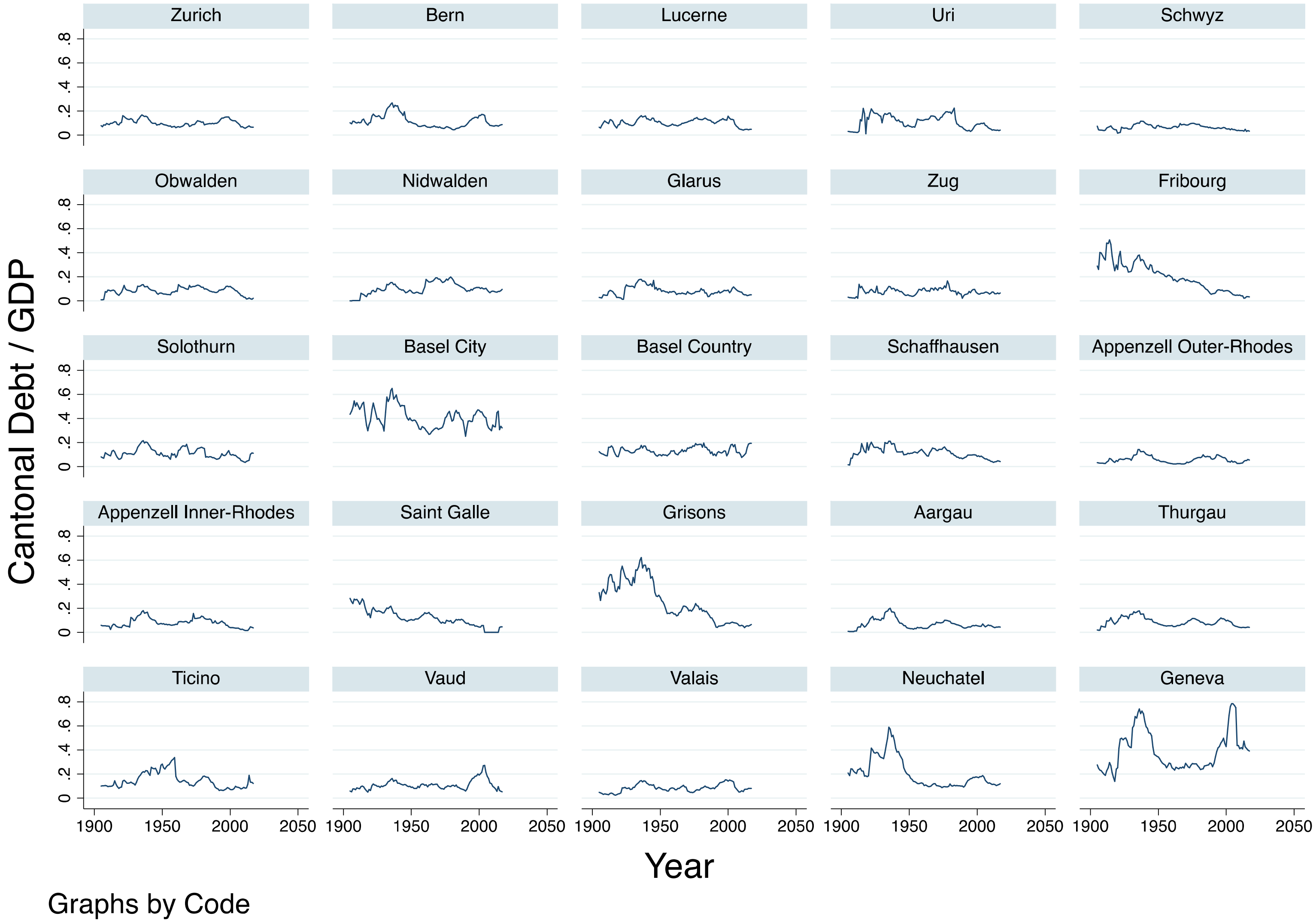
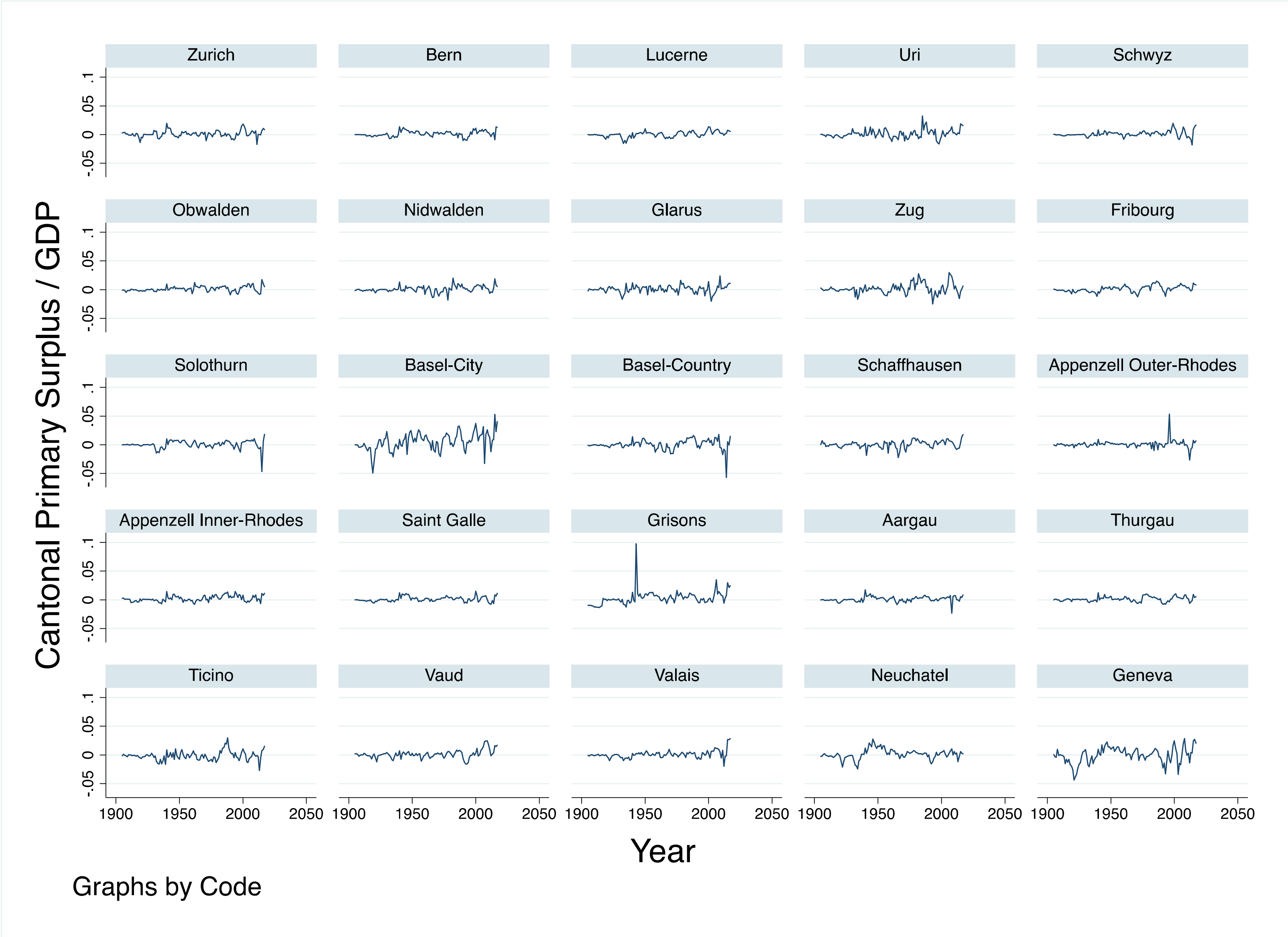
Appendix: Canton Specific Graphs





Zurich
Bern
Lucerne
Uri
Schwyz
Obwalden
Nidwalden
Glarus
Zug
Fribourg
Solothurn
Basel-City
Basel-Country
Schaffhausen
Appenzell Outer-Rhodes
Appenzell Inner-Rhodes
Saint Galle
Grisons
Aargau
Thurgau
Ticino
Vaud
Valais
Neuchatel
Geneva
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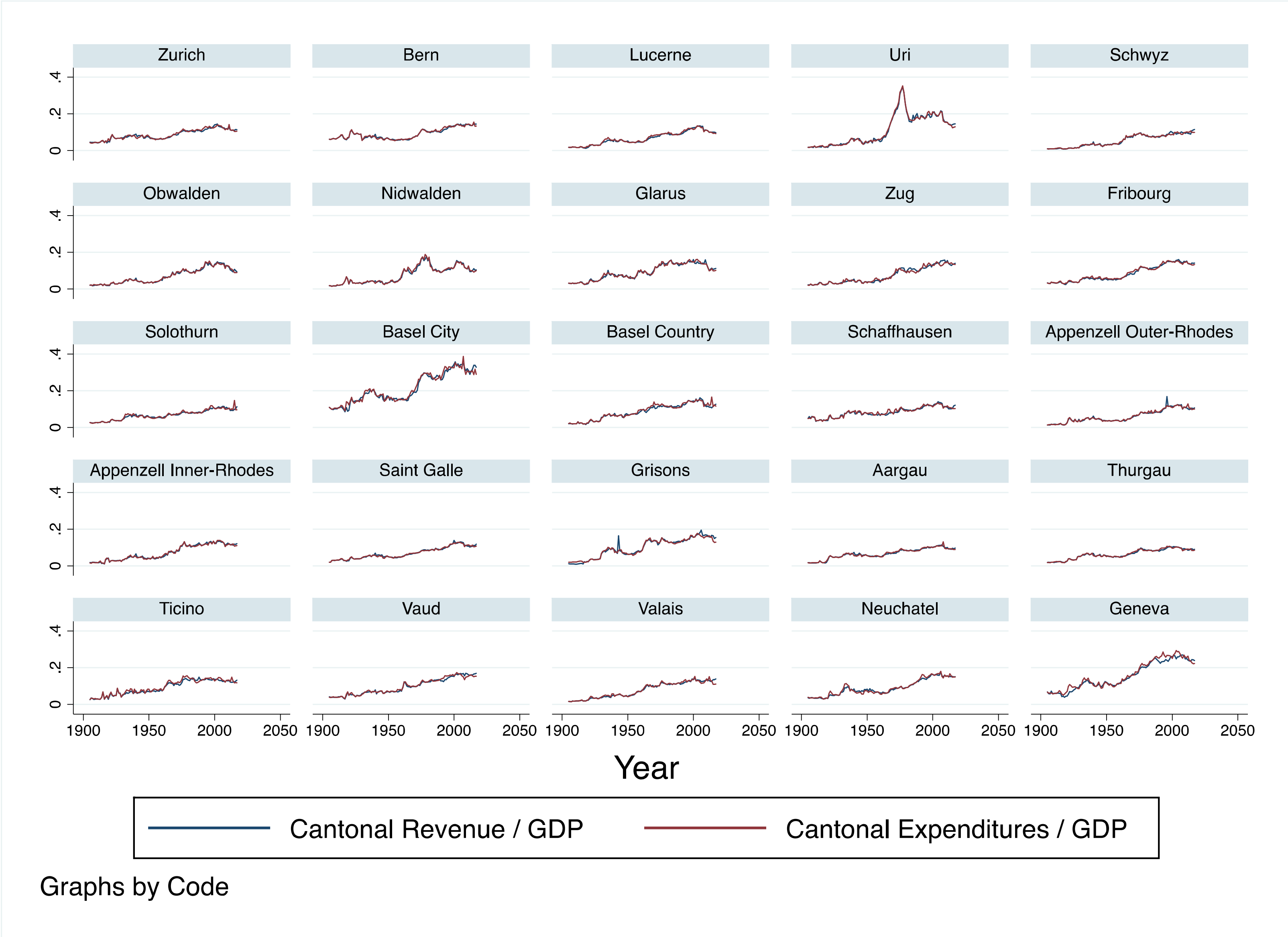
1900 1950 2000 2050
Cantonal Primary Surplus / GDP
Year
Graphs by Code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Fribourg
Solothurn
Basel City
Basel Country
Schaffhausen
Appenzell Outer-Rhodes
Appenzell Inner-Rhodes
Saint Galle
Grisons
Aargau
Thurgau
Ticino
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Valais
Neuchatel
Geneva
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1900
1950
2000
2050
Year
Cantonal Revenue / GDP
Cantonal Expenditures / GDP
Graphs by Code

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