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Functionality of fiscal rules in a low interest rate environment: New empirical results for Swiss cantons

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Functionality of Fiscal Rules in a Low Interest Rate Environment – New Empirical Results for Swiss Cantons

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Abstract

The trade-off between consistent (rule-based) and optimal fiscal policy became evident in the zero lower bound era. With such low interest rates, the argument goes, optimal fiscal policy required extending debt financed public investment spending. But while fiscal rules ensured consistency, they prevented this fiscal expansion. Using data of Swiss cantonal public finances between 1990 and 2019, we employ a bias corrected least squares dummy variable (LSDVC) model to investigate as to how fiscal rules affect fiscal policy in an environment with decreasing interest rates. Furthermore, we introduce the novel forecasted average treatment (FAT) approach into empirical public finance by exploiting the SNB's unexpected and substantial interest rate drop in 2015 following the termination of the Swiss Franc-Euro peg. The methodological novelty of the FAT approach lies in the investigation of an exogenous shock in absence of a control group. Our results show, first, that fiscal rules constrain public debt and expenditure, but do explicitly not constrain investment expenditure. Second, interest rate declines are mirrored by lower public debt and total public spending decline, the latter conditional on constraining fiscal rules. Third, we find varying reactions to the monetary policy shock in 2015 depending on rule stringency, but public investment is not systematically more constrained by strict rules.

JEL-Classification: E430; E620; H540; H630; H740.

Keywords: fiscal rules, zero-lower-bound, interest rate shock, public investment.

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1. Introduction

For several decades, whether and how fiscal rules restrain fiscal policy has been controversially discussed in politics and academia alike leading to manifold theoretical and empirical analyses. However, after the Global Financial Crisis (GFC), low interest rates became a second aspect that fostered the debate as to whether debt financing of public expenditure is an optimal fiscal policy. The two positions can be broadly assigned to two perspectives, a technical, macroeconomic perspective and an institutional design, political economics perspective. The first perspective argues that sustainable public debt levels can be modeled, and that not expanding (growth enhancing) public spending in a low interest rate period leaves money on the table. The second perspective argues that these technical optimizations are doomed to fail if they are not executed within a consistent, rule-based institutional framework. Yet, it remains an open question as to how the two key variables – fiscal rules and interest rates – interact with each other and how they affect fiscal policy decisions. This leads to our research question: *How do fiscal rules affect fiscal policy in a low interest rate environment?*

We contribute to the existing empirical literature on fiscal rule functionality in two distinct ways: First, we offer new insights on fiscal rules' functionality in a low interest rate environment. The connection between a rule that aims at constraining fiscal policy and an unusual monetary policy setting has not been made yet. Second, we contribute to the ongoing debate as to whether fiscal rules constrain public investment. This claim was articulated forcefully when interest rates were low, in policy debates and in academic discussions.

We begin in Section 2 with a literature review of the macroeconomic and political economics perspectives, leading to the derivation of six testable hypotheses. Next, we describe the data and descriptively analyze the most relevant variables in Section 3. The 26 Swiss cantons enjoy a high degree of autonomy which, among other things, authorizes them to implement their own fiscal rules with varying inter-cantonal degrees of constraint.

In Section 4 we use a bias corrected dynamic model (LSDVC) as baseline identification strategy. Additionally, we introduce the Forecasted Average Treatment (FAT) approach. This approach expands our investigations as it allows us to exploit an exogenous interest rate shock in the absence of a control group. The termination of the Swiss Franc-Euro peg on 15th January 2015 was accompanied by a sharp and unexpected interest rate cut. We exploit this exogenous interest rate variation by comparing the performance of the different cantons with different fiscal rule designs. The Swiss case provides for a homogenous macroeconomic, political, and legal environment which makes it particularly well-suited for the FAT approach.

In Section 5, we present our results for the LSDVC model and enrich these findings by adding the FAT results. Regarding both approaches, we find a consistent and robust constraining effect of fiscal rules on cantonal debt. The most stringent fiscal rules constrain total public expenditure, but not investment expenditures. The FAT approach extends these findings by showing that cantonal fiscal policy reacts differently to declining interest rates, conditional on fiscal constraints. Cantons with stricter fiscal rules reduce their debt levels and total expenditure while cantons with less credible fiscal constraints increase their spending when the interest rate level unexpectedly drops. Investment expenditures show no consistent pattern that would suggest a systematic constraint, neither in the dynamic regression model nor in the FAT approach. Fiscal rules have no extraordinary effect on public investment when interest rates decline. In Section 6, we report the robustness tests of our results and discuss limitations. Section 7 concludes.

2. Theory and Literature Review

The six hypotheses investigated empirically in this paper rest on two strings of theoretical literature: optimal fiscal policy from a macroeconomic perspective and political economics. We derive our hypotheses from both concepts and aim at connecting them with each other. The first one is *optimal fiscal policy* in different situations, e.g., in a low or a higher interest rate environment. The second is an emphasis on institutional realities and incentive problems, leading to a *deficit bias* and the theoretical rationale for implementing fiscal rules in the first place.

Optimal (fiscal) policy is characterized by its ability to adapt to changes in macroeconomic conditions. This necessitates access to a choice set of alternatives which policy-makers can (discretionally) choose from. Consistent, rule-based (fiscal) policy reduces the range of the choice set and usually complicates the attainment of first-best alternatives (Taylor, 1993; Alesina and Perotti, 1996). The discussion of this trade-off is well-established in monetary policy (e.g., Calvo, 1978; Ireland, 1999), but equally relevant for fiscal policy. In the zero lower bound era, the questions were raised whether perceived thresholds for sustainable public finances may have shifted and whether expanded public expenditure could support sustainable growth, among other things, by expanding public investment.

Optimal fiscal policy acknowledges that economies can grow out of their debt if growth of real GDP (g) is larger than the real interest rate (r). This is a feasible strategy if (i) the safe interest rate reflects true risk preferences, (ii) past observations of a beneficial relation between g and r allow for a reliable prediction of the future relation, and (iii) pessimistic outlooks from investors do not lead to self-fulfilling downward spirals (Lucas and Stokey, 1983; Summers, 2014;

Blanchard, 2019; Mehrotra and Sergeyev, 2021). Linking the third condition to the consequences of rising interest rates has been described theoretically by Dahan (1998), Bi (2012), Bi and Leeper (2013), and Lorenzoni and Werning (2019).¹ We want to test this theory in the reverse direction by asking whether decreasing interest rates have a decreasing effect on public debt and deficits.

Optimal fiscal policy may demand higher public expenditure to facilitate growth or to execute crucial public investment with long-term welfare enhancing effects (e.g., supporting energy transition, expanding and improving public education or digitalization in the public sector). Consistent fiscal policy, bounded by a fiscal rule, may not have the fiscal leeway to do this, even when the zero lower bound period offers uniquely cheap conditions for deficit spending (Blanchard and Giavazzi, 2004; Krogstrup and Wyplosz, 2006; Bom and Ligthart, 2014; Guer-guil et al., 2017; Furman and Summers, 2020; Ardanaz et al., 2021)

The technical/ macroeconomic view neglects that fiscal policy is negotiated and decided in a political arena. The preferences of politicians and bureaucrats may not be in line with an economic rationale causing all sorts of distortions and making the first-best solution unachievable. For a more realistic view, we connect the literature on optimal fiscal policy with the political economics literature which provides the rationale for the institutional design of fiscal rules referring to a *deficit bias*. This bias in political decision-making originates from three distinct mechanisms: *time inconsistency*, *common pool problems* and *moral hazard* (electoral cycles).²

Undesirable outcomes in fiscal policy arise from a *time inconsistency* problem (Kydland and Prescott, 1977; Barro and Gordon; 1983) according to which economic planning cannot lead to welfare maximizing outcomes as the planner (a government) acts in an environment of other rational agents who adapt their own expectations to the planner's actions. This means that an optimal fiscal policy cannot be achieved because, once this optimal policy is articulated, economic agents adapt their expectations and actions to this new policy leading to less-than-optimal results. Political agents thus aim at a long-term optimal (fiscal) policy but conduct short-term policies that distance them from the optimum. To form stable expectations over time, government actions need to be in line with certain rules, hence time-consistent rules make government actions predictable. Woodford (2001) and Blanchard (2019) stress the importance of

¹ The reverse effect of increased public debt leading to higher interest rates has also been investigated thoroughly (Tanzi and Lutz, 1991; Ardagna et al., 2007; Checherita-Westphal and Rother, 2012).

² Badinger and Reuter (2017) name five distinct problems which can be managed in a rule-based fiscal policy regime: *common pool theory*, *information asymmetry*, *short-sightedness*, *political competition*, and *outside pressure*. They can be summarized in the three mechanisms named here. See also Alesina and Passalacqua (2016) for a thorough literature survey.

stable expectations, and both emphasize that fiscal rules can avoid misguided expectations and bad equilibria.

The government budget is a scarce resource, and its inefficient overuse is a game-theoretic *common pool problem* (Weingast et al., 1981). Velasco (1999, 2000) uses a game-theoretic design to model the common pool problem for fiscal policy. He shows that government transfers exceed the welfare maximizing level such that public debt becomes excessively high over time. Government deficits are higher than the amount reasonable for tax smoothing purposes (Barro, 1979). Velasco emphasizes that this problem is caused by the strategic behavior of competing groups, and in this regard fiscal policy is comparable to the general common pool problem analyzed by Levhari and Mirman (1980) or Benhabib and Radner (1992).

The interaction between *electoral cycles* and economic policy decisions as proposed by Alesina (1987, 1989) focuses primarily on consequences for inflation and unemployment in a setting of political competition and opposing political ideology. Rogoff (1990) shifts the focus to the effects of electoral cycles on fiscal policy like taxation, transfers, and public consumption. In an electoral cycle, fiscal policy is expansionary before and contractionary after elections. However, an asymmetry occurs resulting in budget deficits and a higher debt stock across elections. Shi and Svensson (2006) built their own theoretical and empirical analysis on Rogoff's work. They emphasize that information availability for voters and restrictions on rent seeking by politicians affect the political budget cycle's magnitude. In this context, Shi and Svensson highlight the importance of a well-functioning institutional framework to mitigate moral hazard.

An alternative effect of elections might result if an incumbent government can expect with a high probability that it will not be re-elected in an upcoming election. This incumbent has an incentive to increase public debt in order to bind the opposing challenger, that will probably form the new government, in order to force it to renege on its campaign promises thus raising the election outlook of the current government in a future election. Such a behavior of strategically incurred debt may have an ideological bias regarding right-wing or left-wing parties in power (Persson and Svensson, 1989; Alesina and Tabellini, 1990; Pettersson-Lidbom, 2001)

Based on these strings of theoretical literature on *optimal fiscal policy* and *deficit bias*, we derive our testable hypotheses. According to theory, fiscal constraints and low interest rates can have opposing and potentially interfering consequences on fiscal policy. We thus need to define our variables of interest carefully and address theoretically adverse effects in different hypotheses. This leads in total to six hypotheses to be tested empirically in the subsequent sections:

- *H₁: More stringent fiscal rules decrease public debt and/ or primary deficits.*
- *H₂: More stringent fiscal rules decrease public (total/ investment/ interest) expenditure.*
- *H₃: Low interest rates decrease public debt and/ or interest expenditures.*
- *H₄: Low interest rates increase primary deficit and/ or (total/ investment) expenditure.*
- *H₅: Given more stringent fiscal rules, public debt and/ or interest expenditure decrease more strongly after a negative interest rate shock.*
- *H₆: Given more stringent fiscal rules, primary deficit and/ or (total/ investment) expenditure increase less after a negative interest rate shock.*

The existing empirical literature we built on is huge. Deroose et al. (2006), Nerlich and Reuter (2013), Iara and Wolff (2014), Reuter (2015), Afonso and Guimarães (2015), and Bergman et al. (2016) investigate the effects of fiscal rules in European countries. While they consider improvements of fiscal rule design on the EU level, they find significant constraining effects on various fiscal variables. Thornton and Vasilakis (2017), Asatryan et al. (2018), Eyraud et al. (2018), Afonso and Jalles (2019), Caselli and Reynaud (2020), and Sawadogo (2020) report similar results for multinational datasets beyond the European context and for emerging markets as well. For the sub-national level Bayoumi and Eichengreen (1995) and Bohn and Inman (1996) find reduced deficits for U.S. states. Deng and Liu (2025) investigate the reducing effect of strict balanced budget rules on bond spreads, also for U.S. states. Grembi et al. (2016) show that relaxing fiscal rules increases deficits in Italian municipalities. Schaltegger (2002) connects literature on US budget rules with the Swiss case. Feld and Kirchgässner (1999, 2001a, b) and Feld and Matsusaka (2003) investigate the effect of different budgetary procedures on cantonal debt and public spending. Additional literature on the impact of Swiss fiscal rules on the cantonal and federal levels include Feld et al. (2017), Asatryan et al. (2018), Burret and Feld (2018a, b), Salvi et al. (2020), Feld et al. (2021) and Pfeil and Feld (2024). They have in common that while applying different empirical identification strategies they find a constraining effect of the respective fiscal rules, ensuring fiscal sustainability in multiple respects.

Kopits and Symansky (1998), Yared (2019), Brändle and Elsner (2024), and Potrafke (2025) summarize the existing empirical evidence and contextualize the relevant macroeconomic and political economics literature regarding the rules' *raison d'être* as well as the consequences of rule introduction. Heinemann et al. (2018) provide a meta-regression including 30 papers on fiscal rules' functionality. They show that fiscal rules have a constraining effect on public deficits and debt, but this effect vanishes with more sophisticated identification strategies. This supports the sustained demand for reliable empirical identification strategies. In order to meet this demand, we introduce a new methodological approach, i.e., the FAT approach, to analyze effects of policy changes in absence of a control group.

3. Data and Descriptive Statistics

3.1 Data

All fiscal data are provided by the Swiss Federal Finance Administration (FFA). All cantonal financial statements are standardized by the FS Model, a Swiss specific public accounting model that is inspired by the International Public Sector Accounting Standards (IPSAS). As such the fiscal dataset contains a *statement of financial position* (assets, debt and equity), a *statement of financial performance* (expenditure and revenue) and a *financing statement* (investment expenditure and investment revenue). Fiscal data in the FS model is available for all cantons from the year 1990 to 2021. We begin with a 30-year observation period (1990 to 2019) but later, to focus our analysis on the functionality of fiscal rules in a low interest rate environment, we narrow our observation period to the years 2011 to 2019.³

Fiscal variables

In Section 2 we formulated six hypotheses with regard to five variables of interest: (1) *debt*, (2) *primary deficit*, (3) *total expenditure*, (4) *investment expenditure*, and (5) *interest expenditure*. The overall contractionary effects of fiscal rules on fiscal policy and the expansionary effects of optimal policy in a low interest rate environment can cause opposing and potentially interfering effects on variables of interest. We therefore rely on inherent accounting identities to isolate different (expenditure) accounts with different expected coefficient signs. The definition of fiscal variables is based on definitions by the Harmonized Accounting Model for the Cantons and Communes (HAM2).

Investigating public investment empirically with administrative data potentially suffers from an unidentifiable time gap between, first, the (political) decision to invest, second, the payment for the investment, third, the activation of the new asset in the balance sheet, and fourth, the actual completion of the project. While we cannot address all four steps equally, we use different public finance accounts to cope with the issue. We begin with *investment expenditure* from the financing statement. Alternatively, we consider the *annual change in cantonal assets* in the robustness checks. The HAM2 differentiates assets between *administrative property* and *financial assets*.⁴ In our analysis, we focus on changes in administrative property and as a second-best alternative consider changes in capital assets. Table 1 summarizes the investment variables.

³ For the long observation period we cut off observations after the year 2019 to avoid COVID-related outliers, for the short observation period (zero lower bound era) we cut off observations prior 2011 to mitigate GFC-related distortions.

⁴ Financial assets are divided into *capital assets* and *current assets*.

Table 1: Descriptive statistics of public investment (in 1.000 CHF per capita), 1990 to 2019

	Obs.	Mean	Std. Dev.	Min	Max
Investment Exp.	780	1.14	0.75	0.20	5.50
Admin. property	754	0.17	1.05	-2.52	19.91
Capital assets	754	0.06	0.48	-2.95	3.69

Note: Public investment accounts in HAM2 standard.

Interest rate

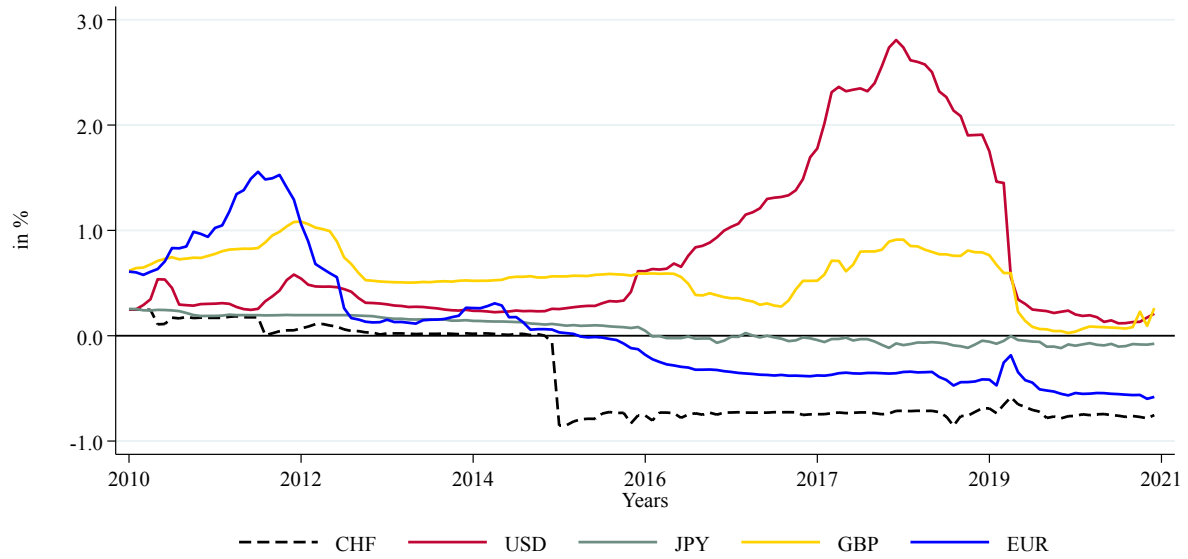
Data on interest rates in Switzerland is provided by the Swiss National Bank (SNB). Swiss monetary policy has mostly been in line with other major central banks of industrialized countries over the last three decades. Interest rates show a steady negative trend from 1990 to 2019 with two temporal trend reversals between 1999 and 2009 (Figure A-1 in the Appendix).

After the beginning of the GFC, central banks around the world, including the SNB, rigorously dropped interest rates. Between 2009 and 2016, central banks in industrialized countries kept their interest rate band relatively constant at a very low level.⁵ In early 2015, however, the SNB was the only bank in its peer group that once again dropped interest rates substantially (in total 84.38 basis points) due to the termination of the Swiss Franc-Euro peg on 15th January 2015 (Figure 1). This decision came unexpectedly for market participants and no prior expectation adaptation could be observed. In order to avoid an excessive currency appreciation of the Swiss Franc, the SNB decreased interest rates. With two interest rate changes in quick succession the SNB executed an additional strong interest rate change in the low interest rate period. The 84.38 basis points interest rate drop has been by far the sharpest interest rate decline in non-crisis years for at least 25 years. After this drop the interest rate remained on this low (even negative) level for the rest of our observation period.

This substantial interest rate drop in 2015 and its consequences for debt financing could have influenced cantonal treasuries' budget plans or their medium-term refinancing structure. We use this unexpected interest rate drop as exogenous variation when we focus explicitly on the low interest rate period between 2011 and 2019.

⁵ The *European Central Bank*, the *Bank of England* and the *Bank of Japan* even kept the interest rate low until inflation increased in early 2022. Only the *Federal Reserve* increased interest rates between late 2016 and the COVID-19 outbreak in 2020.

Figure 1: Policy rate and money market rate (2010 to 2021)



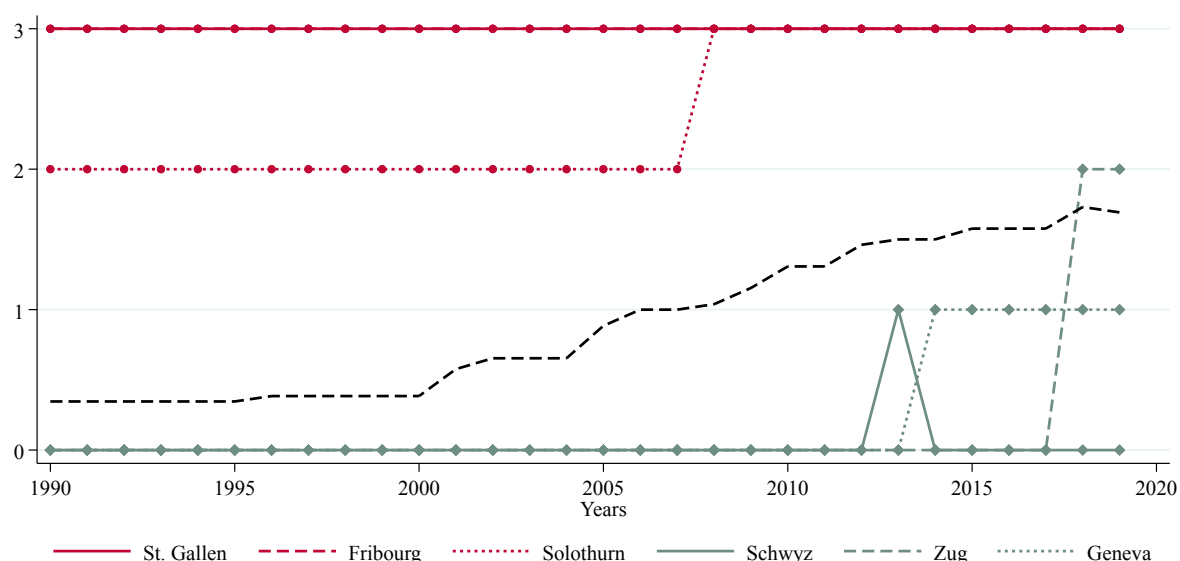
Notes: The graph displays the SNB policy rate and the respective interest rates for four currency areas. The unexpected and substantial interest rate drop due to the termination of the Euro-Swiss Franc-Peg in the year 2015 is clearly visible.

Fiscal rule index

All cantons but Appenzell Inner-Rhodes introduced fiscal rules between 1929 and 2007 (Weber, 2025). Cantonal fiscal rules are usually balanced budget rules, sometimes in combination with a debt ceiling rule. They are enacted autonomously by cantonal parliaments and/ or popular referenda. Cantonal fiscal rules are *not* mandatorily prescribed by the federal government. Thus, while all fiscal rules are systematically similar and conceptually homogenous, the actual fiscal rule design heterogeneously varies between cantons. Throughout the entire observation period, the canton of Schwyz has had rather loose fiscal rules, while Fribourg and St. Gallen adhered to strict rules. Rule stringencies for all other cantons are within that range and vary over time. Weber (2025) provides for a thorough analysis of the composition of cantonal fiscal rules.

For this paper, the fiscal rule variable is based on Burret and Feld (2018a), who follow Feld and Kirchgässner (2001a). Since they consistently cover most of our observation period, as Burret and Feld (2018a) provide data for the years 1990 to 2011, we extend the fiscal rule variable and extrapolate it for changes in the rule design in order to avoid structural breaks (Weber, 2025). The four-scale index assigns one point for every affirmed *de jure* characteristic and equals zero otherwise. The three characteristics are: (1) *link between budgeting and execution process*, (2) *numerical constraints* and (3) *non-discretionary sanctions* for accruing deficits. Figure 2 displays the development of rule stringency for the six cantons with the highest and lowest index values during the observation period as well as the average constraining level over time.

Figure 2: Fiscal rule index for Swiss cantons (1990 – 2021)



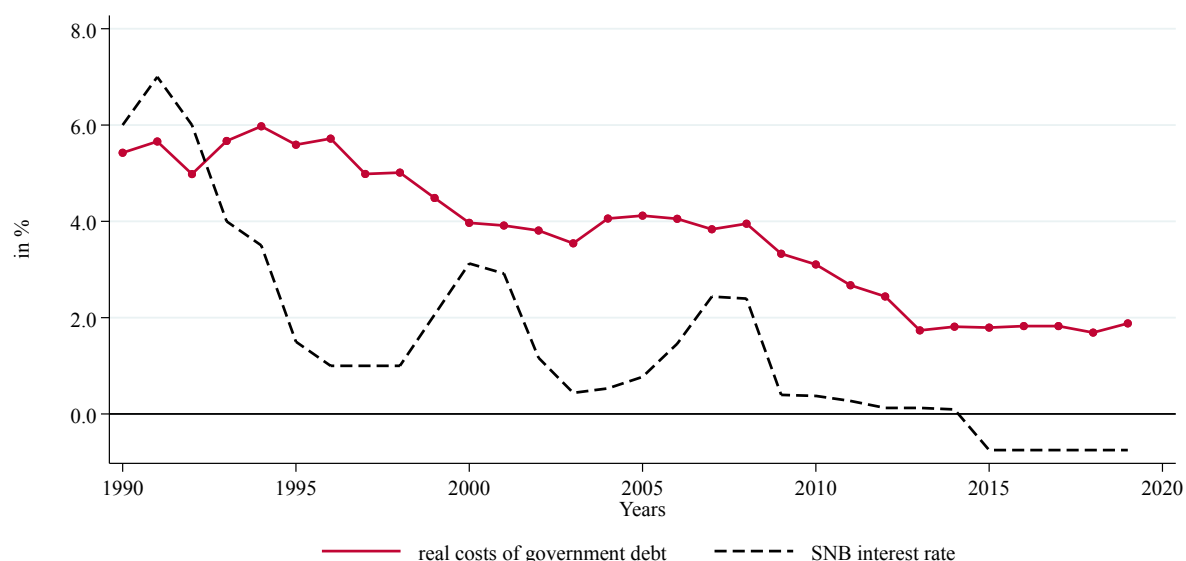
Notes: Black dashed line displays the trajectory of average rule stringency.

The fiscal rules in Fribourg and St. Gallen contain constraining elements on all three *de jure* characteristics for the entire observation period (blue solid line). Solothurn also meets all three characteristics from the year 2008 onwards (blue dashed line). Fiscal rules in Schwyz, Geneva and Zug have comparably low *de jure* constraining effects during the entire observation period. Appenzell Inner-Rhodes is the only canton with no fiscal rule for the entire observation period. The average index value across all cantons has a positive trajectory, with a consistent increase between 2000 and 2018 (black dashed line). The discrete index characteristics rationalize the formation of four sub-sample groups for a more nuanced analysis (Table A-1 in the Appendix). Additional control variables are presented in Table A-2 in the Appendix.

3.2 Descriptive Statistics

We first approach the effects of fiscal rule and interest rate variation on fiscal policy graphically. The cantons' average real costs of debt (interest expenditures divided by long-term liabilities) consistently decreased during our observation period (Figure 3, red line) with a particularly sharp drop in the aftermath of the GFC. While the average costs of debt were almost 6 % in the mid-1990s, they decreased to less than 2 % in the 2010s. This means, first, that debt financing costs improved for the public sector in Switzerland long before the negative interest rates occurred, and second, that our investigation of a sharp interest rate decline in the year 2015 happened in an environment of constantly decreasing interest rates.

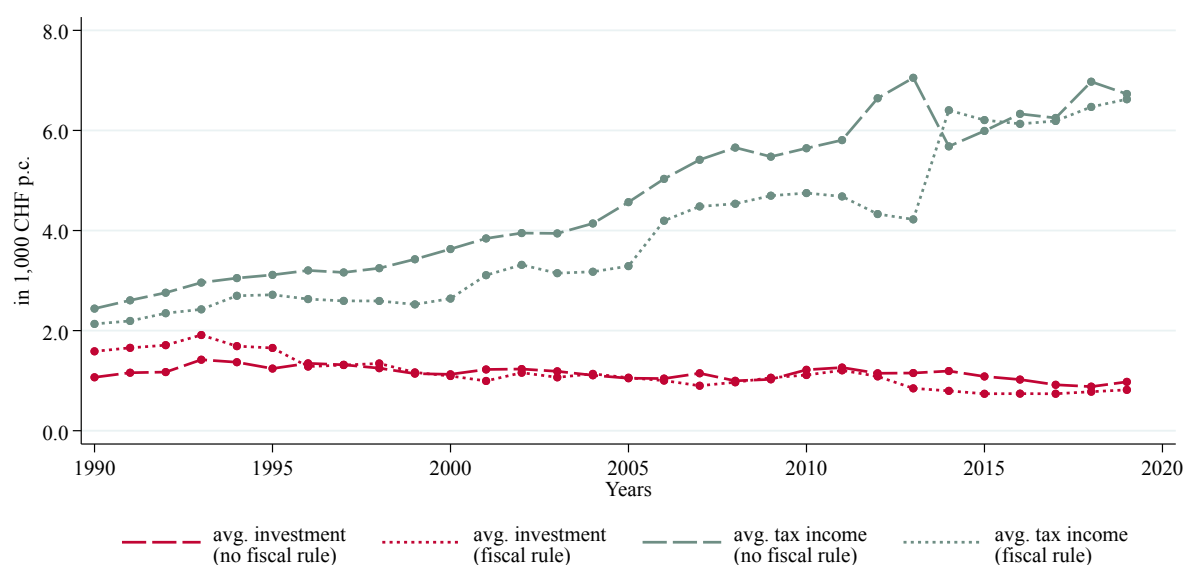
Figure 3: Refinancing costs of government debt (1990 – 2021)



Notes: Interest expenditures in percent of long term liabilities (red line) and SNB interest rate (black dotted line).

Figure 4 depicts the trajectory of average tax revenue (teal lines) and cantonal investment (red lines), conditional on whether the cantons had a fiscal rule in place or not. The group without fiscal rules contains all cantons with an index value of zero, all other cantons are averaged in the group with fiscal rules. In these descriptive statistics cantons can change the group when they enact/ suspend their fiscal constraints.⁶

Figure 4: Cantonal per capita tax revenue and investment (1990 to 2019)

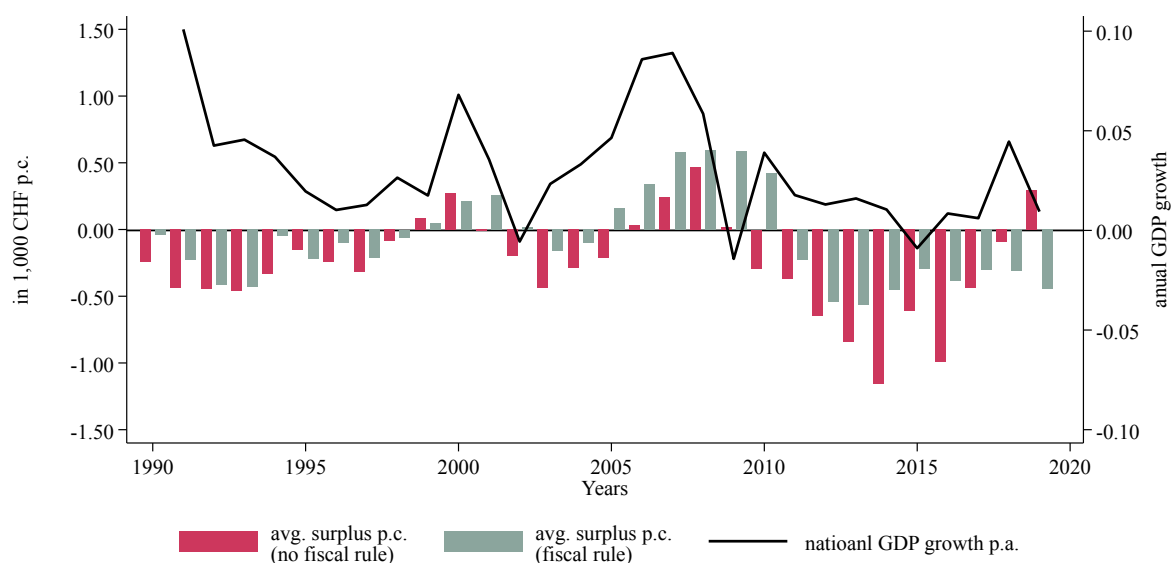


⁶ The sharp increase of average tax revenue for cantons with fiscal rules from the year 2013 to 2014 is caused by a group switch for the canton Geneva. A canton with high per capita tax revenue.

While per capita tax revenue rises consistently, public investment is relatively constant throughout the entire observation period.⁷ The trajectories are very similar for cantons with and without fiscal rules. We cannot identify different tax or investment policies in cantons with different fiscal constraints. Size and composition of the two groups vary substantially over time. While in the year 1990 only four cantons had fiscal rules in place, the number of cantons with rules rises over time. In the year 2019, 21 out of 26 cantons display an index value greater than zero. The ratio between cantonal tax revenue and public investment is not affected by these changes (Figure A-2 in the Appendix).

This increasing number of cantons with fiscal rules can also be depicted by the development of cantonal primary deficits, conditional on GDP growth (Figure 5). In the early 1990s, cantons usually generated a primary deficit, despite relatively high GDP growth rates. Over the years, and with more cantonal fiscal rules being enacted, a more nuanced picture evolves.

Figure 5: GDP growth and primary deficit (1990 to 2019)



While the establishment of fiscal rules does not erase automatic stabilizers in fiscal policy, fiscal rules seem to support more sustainable fiscal policy throughout the business cycle. In times with high GDP growth rates (black line, right axis) the primary surplus is larger in cantons with fiscal rules and during economic downturns the primary deficit is not as large as it is in cantons without fiscal rules. However, cantons with fiscal rules do not react systematically different to macroeconomic conditions compared to cantons without fiscal constraints.

⁷ All monetary variables in this paper are deflated to 2019 = 100.

4. Methodology

To examine the effects of fiscal rules and decreasing interest rates on fiscal policy outcomes, we adopt a two-part strategy. First, we assess our variables of interest in a panel estimation with cantonal and year fixed effects (two-way fixed effects, TWFE), similar to previous research (Burret and Feld, 2018a, b). We use annual data for all 26 Swiss cantons and begin with a 30-year observation period (1990 to 2019) that is later shortened to the zero lower bound era (2011 to 2019). While the panel regression gives us a good idea about the average trajectory of fiscal policy when fiscal constraints are (on average) tightening and interest rates decrease, it falls short of separating the two effects convincingly. In a second step, we therefore introduce the Forecasted Average Treatment (FAT) approach to investigate the effect of an unexpected interest rate drop on fiscal policy, conditional on different degrees of rule stringency.

4.1 Dynamic Model with Bias-Corrected Least Square Dummy Variable Estimator

Fiscal policy decisions are inherently dynamic, with past decisions contributing to shaping present choices. This is particularly true for the budgeting process. Consequently, to accurately capture this temporal influence, we include a lagged dependent variable in our model. The bias-corrected least square dummy variable estimator (LSDVC) addresses the inconsistencies introduced by the lagged dependent variable (Nickell, 1981) and has been shown to be efficient when N is relatively small (Judson and Owen, 1999). The regression specification is:

$$(1) \quad Y_{it}^k = \beta_0 Y_{it-1}^k + \beta_1 \text{Fiscal Rule}_{it}^j + \beta_2 \text{Interest}_{it} + \partial \text{Controls}_{it} + \sigma_i + \mu_t + \varepsilon_{it},$$

with the indices i and t referring to cantons and years, respectively. The index k denotes a fiscal policy outcome variables (*debt*, *primary deficit*, *(total) expenditure*, *interest expenditure*, or *investment*). Y_{it-1}^k represents the lagged dependent variable, it addresses persistency in fiscal policy. All specifications include common controls from the respective literature (e.g., Feld and Kirchgässner, 2008; Burret and Feld, 2018a; Berset and Schelker, 2020): *net transfers*, *tax potential*, *unemployment rate*, *population*, *age structure*, and *fiscal policy preferences* (Table A-2 in the Appendix) plus cantonal (σ_i) and time (μ_t) fixed effects, so that comparisons are within canton-year cells. The controls *net transfers* and *tax potential* are considered as share of GDP; population is used on a log scale. As we expect the errors to be correlated within a canton, we cluster the standard errors at the cantonal level, as it is common practice (Burret and Feld, 2018b, Lüchinger and Schaltegger, 2013). This regression specification allows us to test hypotheses one to four.

Next, we include an interaction term between the SNB policy rate and the fiscal rule variable. This allows us to detect a possibly heterogeneous effect of decreasing interest rates, contingent upon fiscal rule stringency. This specification addresses our fifth and sixth hypotheses. The regression specification is determined by:

$$(2) \quad Y_{it}^k = \beta_0 Y_{it-1}^k + \beta_1 \text{Fiscal Rule}_{it}^j \times \text{Interest}_{it} + \partial \text{Controls}_{it} + \sigma_i + \mu_t + \varepsilon_{it}.$$

For this specification, we group the cantons into four groups, based on their fiscal rule stringency. The three discrete rule characteristics (Feld and Kirchgässner, 2001b) which constitute the index determine the four groups. We hold these groups fixed, in order to address the potential reverse causality or simultaneity that could arise. Also, due to the restricted N in our sample (N = 26 cantons), grouping the variables could improve the power of the regression. Table A-1 in the Appendix sorts all 26 cantons in their respective group.

4.2 Forecasted Treatment Effects

The motivation for extending this analysis by the novel Forecasted Average Treatment (FAT) analysis is twofold. First, we seek to extend our results from the LSDVC model with respect to heterogenous effects (due to different fiscal rule designs) of decreasing interest rates. In the following, we will first elaborate as to why achieving this goal is difficult with well-established econometric alternatives, and with TWFE estimations in particular. Second, we want to gain better understanding of the fiscal reactions to a sudden, unexpected interest rate shock. For both goals FAT is a complement rather than a substitute to the LSDVC approach.

Given the exogenous and unexpected interest rate variation in January 2015 and the different fiscal rule designs in Swiss cantons, it is not far-fetched to aim for a quasi-experimental design. However, a closer examination of well-established causal inference methods reveals that identifying treatment effects in this context is not as straightforward as it may seem. In the following, we discuss the four most concerning issues with relying solely on TWFE estimations and we elaborate why other well-established alternatives also fall short in the case at hand.

First, the absence of a clear control group is the most pressing issue. All cantons (except Appenzell Inner-Rhodes) have some sort of fiscal rule, and all cantons are subject to the SNB's monetary policy shock. We try to circumvent this issue in equation (2) by separating cantons according to their rule stringency. Considering appropriate covariates to ensure unconfoundedness or using these covariates in a propensity score matching to compose a better suited control group suffers from uncertainty problems.⁸

⁸ Botosaru et al. (2023) discuss in this regard Hirano and Imbens (2001) and Kitagawa and Muris (2016).

Second, Chernozhukov et al. (2013), de Chaisemartin and D'Haultfœuille (2020) or Callaway and Sant'Anna (2021) highlight that TWFE models are often biased when treatment effects are heterogeneous, and the results are difficult to interpret. This, however, is exactly what we are interested in: the heterogeneous reaction of different cantons (with different fiscal rules) to a universally experienced interest rate shock.

Third, applying TWFE is associated with variance reduction. Several outcome variables either suffer from similar variance problems or follow monotonous trends, complicating inference (Mummolo and Peterson, 2018). This is exacerbated when working with highly aggregated data, where small variations may get lost.

Fourth, TWFE estimations rely on a strict exogeneity assumption (Imai and Kim, 2019, 2021, Imai et al. 2023),⁹ which is often unrealistic in applied settings. They furthermore only consider within-unit variation, preventing the inclusion of time-invariant variation. Some approaches try to address this limitation, such as *mixed effects models* or the *fixed effect vector decomposition* (see Plümper and Troeger, 2007, 2011, and the substantial criticism of this approach by Greene, 2011 and Breusch et al., 2011). A more common alternative are the *hybrid models*, which combine fixed and random effects (Allison, 2009 and Schunck and Perales, 2017). This model has a poor fit to our data.

More generally and beyond TWFE estimations, heterogeneity among cantons questions the validity of the parallel trend assumption, a critical precondition for many causal inference models (Roth, 2022). To address this issue, alternative methods attempt to relax the parallel-trend assumption, but they still rely on the existence of a valid control group – a condition that is not fulfilled for the case at hand.

Instrumental variables (IV) regressions are usually well-established solutions to situations as sketched above. Caselli and Reynaud (2020) introduce an IV for causal inference of the effect of fiscal rules on public finances. They model theoretically and prove empirically that the chance for rule introduction in one country increases if its neighboring countries introduced fiscal rules. The effect of neighboring decisions on national policy is rationalized by physical distance, bilateral trade flows, cultural, social or historical connections. It is at this point an open question whether these connections are equally valid and persistent on the sub-national level and whether negative spillovers (e.g., due to a fiscal equalization scheme) mitigate the

⁹ Imai and Kim (2019, 2021) show that for the TWFE model to be able to adjust for the two types of unobserved confounders (time- and unit-specific) it relies on the assumption of linear additive effects.

nexus of inter-cantonal connections and rule implementation.¹⁰ These concerns can be addressed by a thorough theoretical and empirical analysis on validity and exogeneity of this IV-approach for Swiss cantons. This, however, is beyond the scope of this paper since we also want to delve into the effects of fiscal rules on public investment after a sudden interest rate shock.¹¹ We aim at an extension of the results from the LSDVC model not an alternative.

To exploit the monetary policy shock in absence of any valid control group we propose with the FAT approach a novel econometric method introduced by Botosaru et al. (2023). The basic idea of this approach is to use available observations from the pre-treatment period to model a forecast beyond the point of treatment. These forecasts can then be compared with actual post-treatment observations. In contrast to many alternatives discussed above, the treatment effect we aim at isolating is *not* a regression coefficient but the difference between a forecast and the actual observation. If the exogenous treatment could not have been anticipated, the forecasts are only estimated with observations without any treatment distortions, thereby functioning as proper counterfactuals for the post-treatment observations. The FAT approach estimates its own, canton-specific counterfactuals, thereby allowing for heterogenous effects.

Forecasted counterfactuals can be applied for heterogeneous treatment effects that provide consistent and asymptotically normal FAT effects. In addition to its validity under heterogeneous treatment effects, the FAT approach does not require strong structural assumptions on the data generating process. The FAT approach estimates the average treatment effect on the treated (ATT) using canton-specific pre-treatment time series.¹² The FAT effect estimator is formally defined as follows:

$$(3) \quad \widehat{FAT}_h := \frac{1}{n} \sum_{i=1}^n [y_{i\tau+h} - \hat{y}_{i\tau+h}(0)],$$

where $\hat{y}_{i\tau+h}(0)$ represents the forecast for the canton-specific counterfactual at period $\tau + h$. The treatment year is denoted by τ and h is the post-treatment period. The forecast is obtained through basis function regressions with pre-treatment observation.¹³ The counterfactual forecast is defined as

¹⁰ If canton A introduces strict fiscal constraints canton B may interpret this as an assurance that funds from the equalizations scheme are secure for the foreseeable future and relax its own constraints.

¹¹ The lack of a thorough theoretical and empirical investigation of sub-national properties is also the reason for excluding better known synthetic control method alternatives. In the case at hand all units within Switzerland are equally treated. If we want to operationalize synthetic control methods, we must rely on sub-national jurisdiction from outside of Switzerland. However, this might be difficult due to the political, cultural or institutional differences.

¹² Since all cantons are treated by the interest rate shock, the ATT equals the average treatment effect (ATE).

¹³ FAT is consistent and asymptotically normal for short pre-treatment panels.

$$(4) \quad \hat{y}_{i\tau+h}^{(q_i, R_i)} := \sum_{k=0}^{q_i} \hat{c}_{ik}^{(q_i, R_i)} b_k(\tau + h),$$

where R_i denotes the pre-treatment period used in the forecast, defined as $R_i \in \{q_i + 1, \dots, \tau\}$, q_i is the order of the polynomial, and k the sequence number of basis function regressions, for the pre-treatment outcomes denoted by $\{b_k(t)\}_{k=0}^{q_i}$. For each canton i , the forecast is estimated via *canton-specific regressions* of pre-treatment outcomes on the basis functions:

$$(5) \quad \hat{c}_i^{(q_i, R_i)} := \underset{c \in \mathbb{R}^{q_i+1}}{\operatorname{argmin}} \sum_{t \in T_i} (y_{it} - \sum_{k=0}^{q_i} c_k b_k(t))^2,$$

where $c_i = (c_{i0}, \dots, c_{iq_i})$ is a $q_i + 1$ vector of canton-specific coefficients.

Since the true order is unknown, we are faced with a bias-variance trade-off where a large polynomial degree ensures unbiasedness but increases variance at the same time. We follow the recommendation of Botosaru et al. (2023) and set the estimation window to $R_i = q_i + 1$. The number of pre-treatment periods thus increases with a higher polynomial degree.

While the FAT approach allows for heterogenous effects on different cantons, it assumes no unforecastable common shocks after treatment. Swiss cantons are ideal for this identification strategy because, besides autonomously defined fiscal rules, all cantons operate within a common economic, legal and political environment. This makes the application to the Swiss cantons more compelling than other samples, e.g., an international setting. To minimize confounders, we narrow our sample to the years 2011 to 2019, avoiding distortions from the 2008 financial crisis and the COVID-19 pandemic. In our observation period, aside from the significant shock in 2015, only small changes in the SNB policy rate occurred (see Figure 1 in Section 2). We set τ to 2019, allowing for a long post-treatment period. The FAT approach ensures unbiased forecasts with short pre-treatment time series (2011 to 2014).

While FAT is well-suited for our setting, it has some limitations we need to be aware of when interpreting the results: First, time-varying fiscal rule stringency is not accommodated, as the method does not allow for group changes.¹⁴ Second, although the interest rate remains stable for quite some time before and after the 2015 interest rate shock, the pre-treatment period has already very low interest rates (Figure 3 in Section 2). Thus, the interest rate shock 2015 is not a conventional reduction in costs of capital as the central bank interest rate even turns negative due to the shock.

¹⁴ There are fiscal rule changes in 15 out of 26 cantons during our observation period (2011 to 2019). However, only five cantons change groups by more than one step and cross the median.

5. Results

5.1 Dynamic Model with Bias-Corrected Least Square Dummy Variable Estimator

We first investigate both explanatory variables, *interest rates* and *fiscal rules*, individually in the dynamic model (Table 2 and 3) in order to begin with an individual test for every corresponding null hypothesis of our hypotheses H_1 to H_4 . Thereafter, we consider both variables of interest simultaneously in the same estimation in Table 4. In all baseline estimations the dependent variables and the respective coefficients are considered in 1,000 CHF per capita (debt is considered as log debt per capita). For the observation period 1990 to 2019 the average population in a canton is almost 300.000 people.

We find a highly significant and consistently negative effect of fiscal rule stringency on cantonal debt (Table 2). Cantons with strict constraints have less debt per capita compared to those with rather loose fiscal rules. The joint significance test indicates significance at the 1% level across various fiscal rule variable specifications (columns (1), (6), and (11)).¹⁵

Fiscal rules have no statistically significant effect on primary deficits. However, when we disentangle the accounting identity of deficit, we find a weakly significant negative effect of fiscal rules on total expenditures (column (3) and (8)). The effect is only statistically significantly different from zero for the continuous index variable but not for the median split. A more detailed analysis with the factor variable (column (6) to (10)) reveals that the effect is primarily driven by cantons with the strictest fiscal rules (jointly significant at a 1%-level). We cannot confirm this effect for investment or interest expenditures. Fiscal rules have no statistically significant effect on investment spending in any specification.

With these results we draw the following conclusions:

- R_1 : *More stringent fiscal rules reduce public debt.*
- R_2 : *More stringent fiscal rules have no statistically significant effect on primary deficits.*
- R_3 : *More stringent fiscal rules reduce public expenditure.*
- R_4 : *More stringent fiscal rules have no statistically significant effect on public investment.*
- R_5 : *More stringent fiscal rules have no statistically significant effect on interest expenditure.*

¹⁵ We report the results for the fiscal rule index variable in three distinct ways. We consider the index as *continuous variable* (column 1 to 5), *factor variable* (column 6 to 10) and as a dummy variable which equals 1 if rule stringency is above the *median index* value and 0 otherwise (column 11 to 15). Interaction terms between interest rates and fiscal rule stringency are only feasible with the index factor variable and median split.

Table 2: Results, dynamic model and individual effect estimation for fiscal rules

	(1) Debt	(2) Primary Deficit	(3) Exp.	(4) Investment Exp.	(5) Interest Exp.	(6) Debt	(7) Primary Deficit	(8) Exp.	(9) Investment Exp.	(10) Interest Exp.	(11) Debt	(12) Primary Deficit	(13) Exp.	(14) Investment Exp.	(15) Interest Exp.
fiscal rule (continuous)	-0.0252** (0.0106)	-0.0140 (0.0415)	-0.0801* (0.0418)	-0.00494 (0.0206)	-0.00241 (0.00277)										
low rule stringency						-0.0859*** (0.0269)	-0.0246 (0.117)	0.0491 (0.124)	0.000170 (0.0572)	-0.0188*** (0.00729)					
medium rule stringency						-0.0496* (0.0256)	-0.0303 (0.103)	-0.0963 (0.107)	0.0125 (0.0521)	-0.00349 (0.00680)					
strong rule stringency						-0.0827*** (0.0293)	-0.0387 (0.117)	-0.346*** (0.113)	-0.0526 (0.0562)	-0.0107 (0.00769)					
fiscal rule (median split)											-0.0637*** (0.0238)	-0.0291 (0.0947)	-0.0649 (0.101)	0.00263 (0.0480)	-0.00897 (0.00624)
lagged dependent variable	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	754	754	754	754	754	754	754	754	754	754	754	754	754	754	754
Number of cantons	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Joint Significance Chi2-test	5.68	0.11	3.68	0.06	0.76	13.24	0.12	15.41	2.31	10.12	7.17	0.09	0.41	0.00	2.06
Prob > chi2	0.0172	0.7360	0.0551	0.8110	0.3850	0.0042	0.9890	0.0015	0.5110	0.0176	0.0074	0.7590	0.5210	0.9560	0.1510

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Effect of fiscal rules on fiscal parameters, dynamic model, estimated with a bias-corrected LSDV estimator, fiscal variable per capita, observation period: 1990 to 2019.

To get a better understanding of both variables of interest, we proceed with an investigation of interest rates. Interest rate variation correlates positively with cantonal debt and negatively with total expenditure. Unsurprisingly, interest expenditure reacts significantly to changes in the monetary policy interest rate. Decreasing interest rates come with lower levels of debt and more public expenditure. We do, however, not observe any significant effect of interest rate variation on cantonal investment (Table 3).

Table 3: Results, dynamic model and individual effect estimation for interest rates

	(1) Debt	(2) Primary Deficit	(3) Exp.	(4) Invest- ment Exp.	(5) Interest Exp.
SNB interest rate	0.0258*** (0.00682)	-0.0279 (0.0259)	-0.115*** (0.0290)	0.0150 (0.0135)	0.00915*** (0.00245)
lagged dependent variable	yes	yes	yes	yes	yes
controls	yes	yes	yes	yes	yes
Observations	754	754	754	754	754
Number of cantons	26	26	26	26	26

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Effect of interest rate variation on fiscal parameters, dynamic model, estimated with a bias-corrected LSDV estimator, fiscal variable per capita, observation period: 1990 to 2019.

The results for different expenditure variables and the opposite results for total expenditure and interest expenditure are in line with our theoretical considerations: When interest rates decrease, the cantonal government has more fiscal room to maneuver, and this leads to higher total expenditures in other areas. It is noteworthy that in this analysis only cantonal investments do not seem to be affected by changes in the interest rate to a statistically significant degree.

The results of the effect of interest rate variation on fiscal policy can be summarized as follows:

- R_6 : Decreasing interest rates lead to lower public debt.
- R_7 : Decreasing interest rates have no statistically significant effect on primary deficits.
- R_8 : Decreasing interest rates lead to higher total expenditure.
- R_9 : Decreasing interest rates have no statistically significant effect on public investment.
- R_{10} : Decreasing interest rates lead to lower interest expenditures.

Table 4: Results, dynamic model and simultaneous effect estimation for fiscal rules interest rates

	(1) Debt	(2) Primary Deficit	(3) Exp.	(4) Investment Exp.	(5) Interest Exp.	(6) Debt	(7) Primary Deficit	(8) Exp.	(9) Investment Exp.	(10) Interest Exp.	(11) Debt	(12) Primary Deficit	(13) Exp.	(14) Investment Exp.	(15) Interest Exp.
SNB interest rate	0.0183* (0.0103)	-0.0823* (0.0434)	-0.177*** (0.0438)	-0.00334 (0.0216)	0.00817** (0.00349)	0.0167** (0.00748)	-0.0310 (0.0298)	-0.137*** (0.0331)	0.0124 (0.0151)	0.00752*** (0.00267)	0.0164 (0.0105)	-0.0828* (0.0434)	-0.163*** (0.0448)	-0.00223 (0.0217)	0.00772** (0.00349)
fiscal rule (continuous)	-0.0252** (0.0106)	-0.0140 (0.0415)	-0.0801* (0.0418)	-0.00494 (0.0206)	-0.00241 (0.00277)										
low rule stringency						-0.0859*** (0.0269)	-0.0246 (0.117)	0.0491 (0.124)	0.000170 (0.0572)	-0.0188*** (0.00729)					
medium rule stringency						-0.0496* (0.0256)	-0.0303 (0.103)	-0.0963 (0.107)	0.0125 (0.0521)	-0.00349 (0.00680)					
strong rule stringency						-0.0827*** (0.0293)	-0.0387 (0.117)	-0.346*** (0.113)	-0.0526 (0.0562)	-0.0107 (0.00769)					
fiscal rule (median split)											-0.0637*** (0.0238)	-0.0291 (0.0947)	-0.0649 (0.101)	0.00263 (0.0480)	-0.00897 (0.00624)
lagged dependent variable	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	754	754	754	754	754	754	754	754	754	754	754	754	754	754	754
Number of cantons	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Joint Significance Chi2-test	5.68	0.11	3.68	0.06	0.76	13.24	0.12	15.41	2.31	10.12					
Prob > chi2	0.0172	0.7360	0.0551	0.8110	0.3850	0.0042	0.9890	0.0015	0.5110	0.0176					

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Effect of interest rate variation and fiscal rules on fiscal parameters, dynamic model, estimated with a bias-corrected LSDV estimator, fiscal variable per capita, observation period: 1990 to 2019.

The results for both explanatory variables remain valid when we consider both variables simultaneously in one estimation (Table 4). The only exceptions are that the interest rate coefficient is no longer significantly different from zero when we estimate debt with a median split fiscal rule variable and there are some indications for a weakly significantly negative interaction between interest rate variation and primary deficit. The latter is plausible, given the expansion of total expenditure when interest rates decrease. The coefficient is roughly twice as larger for total expenditure than it is for primary deficits.

Finally, we investigate the conjoint effects of interest rates and fiscal rule stringency. To do this in a dynamic model framework, we need to incorporate interaction terms between interest rate and fiscal rule stringency (eq. (2)). With the bias-corrected time and canton fixed effects the results conform to generalized difference-in-differences results. The interaction terms, however, provide no new information. If anything, we find some indication that for interest expenditures the interest rate effect is lower in cantons with stricter fiscal rules, compared to cantons with loose fiscal rules (column (5) and (10) in Table A-3 in the Appendix). This is in line with theoretical expectations.

All results remain robust for the independent variables reported in Table 4 but there are no other systematic and significant findings for the additional interaction terms. The non-findings are reported in Table A-3 in the Appendix. Given these results, and the lack of a profound analysis of the zero lower bound era and the functionality of fiscal rules in this environment, we specifically address these issues with the following FAT identification strategy.

5.2 Forecasted Treatment Effects

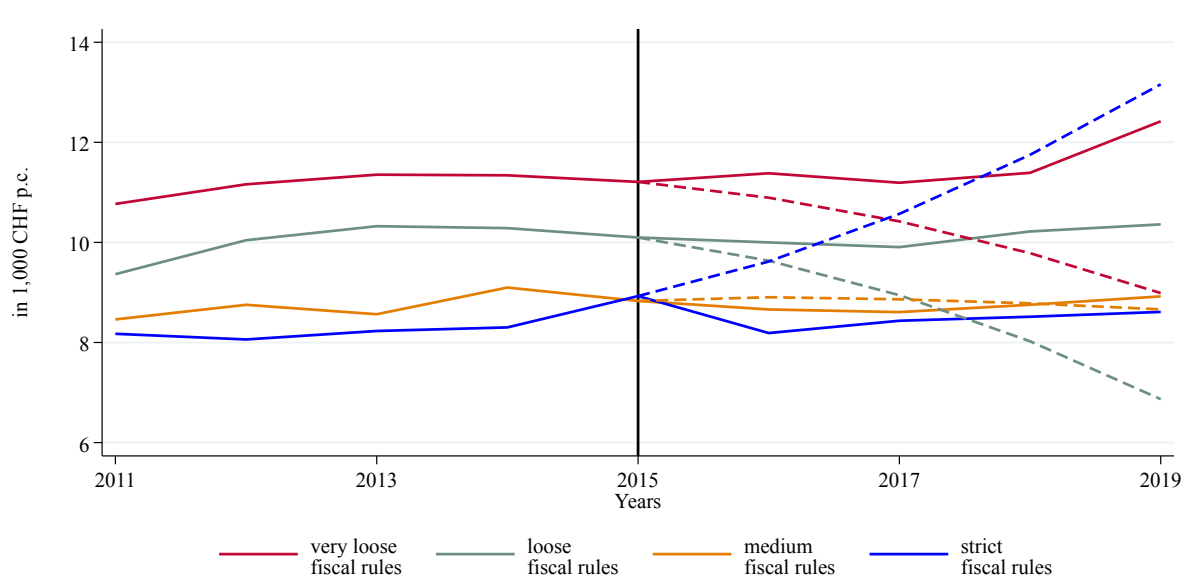
The implementation of the FAT approach offers a nuanced investigation of the impact of a negative monetary policy shock on cantonal fiscal policy across varying levels of fiscal rule stringency. By categorizing cantons into distinct groups based on the constraining power of their fiscal rules (Table A-1 in the Appendix), we can discern differential effects on our variables of interest.

In contrast to the dynamic model with TWFE that controls for time-invariant unobserved heterogeneity, FAT delves into the heterogeneity of treatment effects, providing insights as how cantons respond to an interest rate shock contingent on their fiscal rule framework. With this approach, FAT is better suited to test hypotheses five and six. We use the total expenditure results to visualize the substance of FAT in Figure 6 and 7 and highlight its applicability for fiscal policy evaluation.

The dashed lines represent the trajectory of forecasted cantonal spending in absence of the exogenous monetary policy shock. The solid lines represent the actual observations (average total

expenditure in each group). Following the interest rate shock, denoted by the vertical black line at year 2015, cantons with very loose fiscal rules (red lines)¹⁶ keep spending higher than forecasted (the solid line is above the dashed line), the deviation between forecasted and actual observations increases over time. Cantons with loose fiscal rules (teal lines),¹⁷ follow a similar pattern. Cantons with medium fiscal rules (orange lines)¹⁸ are, according to the FAT analysis, not substantially affected by the interest rate shock. Their total expenditures proceed as forecasted. Cantons with very strict fiscal rules (blue lines)¹⁹ keep expenditures well below the forecast.

Figure 6: FAT total expenditure for cantons grouped by index value, line graph



Notes: The vertical line represents the unexpected interest rate shock on 15th January 2015. The four colored lines represent four groups of cantons, sorted according to their rule stringency at the beginning of the observation period with red averaging observations for cantons with the least stringent fiscal rules, teal and orange medium strict fiscal rules and blue averaging observations for cantons with the most stringent fiscal rules. The dashed lines visualize forecasts; solid lines depict actual observations.

Figure 7 captures the average treatment effect over the entire post-treatment period within a group. The bars illustrate the total differences between dashed and solid lines in Figure 6. A positive bar indicates that actual observations are on average higher than forecasts in this group over the entire post-treatment period. After the unexpected and substantial monetary policy shock on 15th January 2015 cantons with very loose and loose fiscal rules keep their total expenditure in the period 2016

¹⁶ Cantons with very loose fiscal rules are Uri, Schwyz, Zug, Basel-City, Schaffhausen, Appenzell I.Rh., Thurgau, Tessin, Geneva, Jura (see Table A-1 in the Appendix).

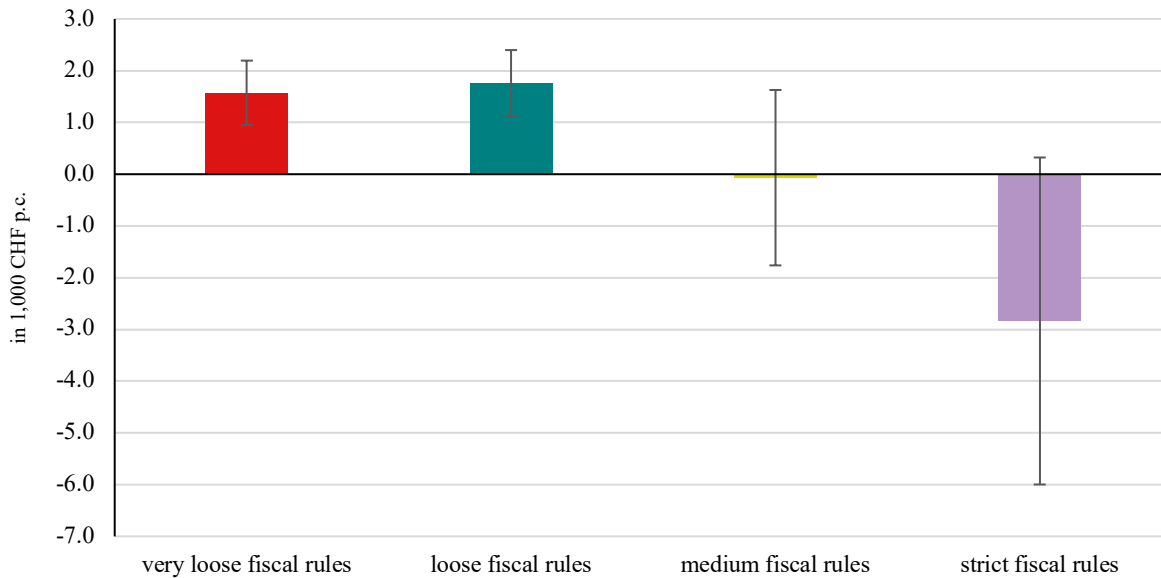
¹⁷ Cantons with loose fiscal rules are Appenzell O.Rh., Grisons, Vaud (see Table A-1).

¹⁸ Cantons with medium fiscal rules are Zurich, Berne, Lucerne, Obwalden, Basel-Country, Aargau, Valais, Neuchâtel (see Table A-1).

¹⁹ Cantons with the strictest fiscal rules are Nidwalden, Glarus, Fribourg, Solothurn, St. Gallen (see Table A-1).

to 2019 significantly higher than forecasted while cantons with medium strict and strict fiscal rules showed responses which are not significantly different from zero.

Figure 7: FAT total expenditure for cantons grouped by index value, bar graph



Notes: The four bars visualize the average difference between forecasts and actual observations over the entire post-treatment period (2016 to 2019). The 95% confidence intervals (thin, black, vertical lines) are derived from Newey-West corrected standard errors.

The heterogeneous results between different groups suggest that cantons react differently to a negative monetary policy shock, depending on the fiscal rule's constraining power. It also suggests that stringent fiscal rules do not only enforce a stronger commitment to debt reduction but also constrain spending. Notably, the convex trajectory of the dashed blue line is caused by a mildly convex trajectory in pre-treatment average observations and may result from the composition within the fiscal rule group. Cantons with strict fiscal rules potentially lack a clear trend or are influenced by stronger effects from outliers.

The results visualized above are derived from a second polynomial degree forecast function ($q_i = 2$). To ensure that our choice of polynomial degree balances accuracy and precision, we follow the approach outlined in Botosaru et al. (2023). Lower polynomial orders may introduce bias if the counterfactual trends exhibit higher-order curvature, while (too) high orders risk overfitting and increased variance. Given this trade-off, the degree $q_i = 2$ is chosen as our primary specification, as it captures nonlinearity while maintaining robust estimates. The results for $q_i = 3$ serve as a robustness check to test whether our results remain consistent when allowing for more flexible counterfactual trends.

The main results beyond total expenditure are presented in Table 5.²⁰ Identical to the LSDVC results, all dependent variables are expressed in 1,000 CHF per capita, ensuring comparability. As visualized above, the coefficients need to be interpreted as deviations from forecasts. They are, in contrast to the results for the dynamic model, *not* regression coefficients describing the effect of changes in the independent variables of interest.

Table 5: FAT for cantons grouped by index

Index	(1) Debt	(2) Primary Deficit	(3) Expenditure	(4) Investment Expenditure	(5) Interest Expenditure
Very loose fiscal rules	-0.4566 (0.484)	1.5335*** (0.4577)	1.5743*** (0.3172)	-0.4983 (0.4336)	0.0064 (0.0162)
Loose fiscal rules	-0.9416 (0.6728)	0.1822 (0.3854)	1.7529*** (0.33)	-2.5607*** (0.4371)	0.0095 (0.0074)
Medium fiscal rules	-0.0469 (0.577)	1.4867 (1.0301)	-0.0672 (0.8649)	0.4934*** (0.1556)	-0.0372*** (0.014)
Strict fiscal rules	-3.9593*** (1.1915)	-2.6036 (1.5991)	-2.8371* (1.6124)	0.0707 (0.0671)	-0.0077*** (0.003)

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Corresponding standard errors for the polynomial-regression FAT of degree 2, observation period: 2012 to 2019. We report Newey-West corrected standard errors.

Beyond the results for total expenditure analyzed in Figure 6 and 7, the interest rate cut causes a significant reduction in debt for cantons with strict fiscal rules (Table 5, column (1)). Cantons with less strict constraints show no statistically significant effect. To put this finding in fiscal policy terms, the 84 basis point interest rate drop that coincided with the termination of the Swiss Franc-Euro peg on 15th January 2015 led to a debt level 3,959 CHF per capita lower than forecasted in cantons with strict fiscal rules (for an average canton of this group: 1,15 billion CHF).²¹ This, in combination with the findings for total expenditure, strongly suggests that cantons with constraining fiscal rules used the interest rate drop to further consolidate their fiscal policy.

The statistically significantly positive difference for primary deficits in cantons with very loose fiscal rules (column (2)) indicates that the actual primary deficits are higher than its forecast. Using the negative interest rate shock to increase public spending and deficits is thereby particularly pronounced in cantons with very loose fiscal rules.

²⁰ All FAT results are visualized in Figure A-3 in the Appendix.

²¹ The result, however, must be interpreted with caution. As visualized above the forecasting properties in the group with very strict fiscal rules tend to exaggerate future developments based on pre-treatment observations. Therefore, the average treatment effect can be affected by both, the properties of the forecast function and the true reaction to the exogenous variation.

The results are inconclusive for investment expenditure (column (4)). One could argue that only in cantons with loose fiscal rules investment expenditures are significantly lower than forecasted and this effect turns (significantly) positive when the rule is only a bit more constraining. However, this interpretation is in contradiction to the hypothesis that governments expand public investment when interest rates decline, unless they are constraint by a fiscal rule. Our results suggest the exact opposite. The non-results for very loose and strict fiscal rules also question this interpretation. It is implausible that this fiscal rule effect would only occur for the two middle groups but vanishes when fiscal rules are more or less constraining. The results for interest expenditures (column (5)) are trivial. It seems natural that after a negative interest rate shock interest expenditures are lower than forecasted. The difference between forecasted and actual observation is, however, only significantly different from zero for cantons with rather strict fiscal rules.

While standard errors and p-values are reported (in Table 5 in parentheses under the coefficients), they should be interpreted with caution.²² The limited number of observations affects their validity. Botosaru et al. (2023) emphasize that the FAT model focuses on forecasting treatment effects rather than hypothesis testing in the conventional sense. The complexity of counterfactual estimation, coupled with the minimal variability in the data, further complicates statistical inference. To address these issues, we employ robustness checks, varying polynomial order and observation period to assess the robustness of our findings across different assumptions and data specifications.

With the FAT approach, we are not only introducing a new empirical tool to fiscal policy evaluation, but we also aim to test our hypotheses five and six derived in Section 2. With respect to the latter the results presented here can be summarized as follows:

- *R₁₁: Given a negative interest rate shock, cantons with more constraining fiscal rules reduce their debt level more than expected.*
- *R₁₂: Given a negative interest rate shock, very loose fiscal rules facilitate increasing primary deficits.*
- *R₁₃: Given a negative interest rate shock, very loose and loose fiscal rules facilitate increasing public expenditure.*
- *R₁₄: Given a negative interest rate shock, cantons with more constraining fiscal rules reduce their total expenditures more than expected (weakly statistically significant).*
- *R₁₅: Given a negative interest rate shock, fiscal rules have no systematic effect on investment expenditures.*

²² We compute standard errors using the Newey-West estimator to ensure that the variances remain robust to both heteroskedasticity and autocorrelation, using a lag of 2. Statistical inference remains valid under weak dependence assumptions, aligning with the central limit theorem conditions outlined in Botosaru et al. (2023). Standard errors are aggregated over years following the principles of variance decomposition.

5.3 Comparing FAT and LSDVC results

In order to compare the FAT results presented in this section with the results from the dynamic model with TWFE, we need to consider the different implications of significant coefficients carefully. As explained above, a regression coefficient in the dynamic model is different from a FAT coefficient because the latter describes the difference between forecasted and actual observations. In a structural decreasing interest rate environment (1990 to 2021), a *positive* coefficient in the dynamic model indicates an also decreasing dependent variable. *Negative* coefficients in FAT estimations (2012 to 2019) show that this decline is amplified after the interest rate shock in early 2015. This means that opposite signs in both estimations do not contradict but rather complement each other.

The dynamic model assumes homogenous treatment effects, while FAT allows each canton's counterfactual to evolve independently based on its historical fiscal trends. If cantons with strict fiscal rules were systematically reducing expenditures regardless of monetary conditions, FAT would pick up on this behavior as a natural evolution. However, if an external shock influenced all cantons post-2015, FAT would interpret any deviation from pre-treatment trends as part of the treatment effect. The dynamic model controlling for macroeconomic trends through year fixed effects, captures common shocks that affect all cantons uniformly, thus absorbing the effect.

Another important consideration is that the dynamic model allows for standard hypothesis testing with conventional standard errors and p-values, whereas FAT relies on forecasting-based counterfactuals, making statistical inference more complex. Ultimately, these methodological differences highlight the complementary nature of both approaches. The dynamic model with unit and time fixed effects provides for a structured estimation of how cantonal fiscal outcomes respond to monetary policy shocks relative to other cantons depending on their fiscal rules stringency, while FAT offers a perspective based on deviations from expected fiscal behaviour.

The effects of low (decreasing) interest rates and fiscal rules on cantonal debt complement each other nicely by both identification strategies. Decreasing interest rates correlate with decreasing debt levels and this effect is particularly persistent in cantons with constraining fiscal rules (dynamic model). These effects are confirmed for cantons with constraining fiscal rules by lower actual debt levels than forecasted (FAT approach).

In the dynamic model (total) expenditure is negatively affected by interest rate variation and interest expenditure is positively affected. Fiscal rules have only a constraining effect on (total) expenditure. Enhancing these findings by FAT considerations reveals that only cantons with less

constraining fiscal rules react to a drop of the interest rate level with fiscal expansion. This is in line with the negative coefficient sign for the SNB interest rate variable in the dynamic LSDVC model. The result that only strict fiscal rules constrain public expenditure is confirmed by FAT (weakly significant).

Both identification strategies provide no clear and consistent evidence for an effect of interest rate variation and fiscal rule stringency on public investment. With respect to primary deficits only the FAT approach yields very similar effect sizes and significance levels for primary deficits and expenditure for cantons with loose fiscal rules. For both variables of interest, the actual observation is about 1.500 CHF per capita larger and significantly different from the forecast.

6. Robustness Checks

Swiss cantons are characterized by very sound fiscal conditions. This introduces challenges to the two variables of interest. First, fiscal soundness of the cantons raises the question as to whether they are genuinely constrained by fiscal rules. Fiscal conditions could be so strong that cantons never approach legally binding limits, and cantonal politics are effectively not constrained. A similar argument arises for interest rates. If the level of debt is very low, debt financing costs may not impact fiscal policies. The reputation of fiscal prudence could allow cantons a privileged treatment as creditors perceive them as safe havens. Third, with respect to public investment as one of our variables of interest, it is questionable (a) whether all public expenditures declared as investment actually are investment, (b) how large the demand for additional investment actually is, given that Switzerland generally benefits from very good infrastructure quality, and (c) whether investment can best be identified in a flow variable like expenditure, given the time lags between making the decision to invest and the actual payment for the investment. All these issues are addressed in the following robustness tests.

Substituting interest rate with real interest costs

We propose two alternatives to address the issue of (too) sound fiscal conditions. First, we substitute the variable *interest rate* with two plausible alternatives: (a) *canton-specific costs of debt* derived in Section 3.2 (Figure 3) and (b) $(debt/population) * interest\ rate$. The first alternative accounts for canton-specific interest expenditures and both alternatives consider canton-specific levels of debt, therefore addressing the varying importance of interest rate changes between cantons. We can only use these explanatory variables to analyze primary deficits and different expenditure

variables because debt estimations would suffer from an endogeneity problem. For the same reason we cannot use canton-specific costs of debt to estimate interest expenditures.

The results do not change substantially when we substitute the SNB interest rate by interest rate weighted with cantonal debt (Table 6, second row). The effect sizes and significance levels are lower than in Table 3, but the overall results remain robust. *Canton-specific costs of debt* are no feasible alternative to the main results. This variable has no significant effect on total expenditure and is not applicable for explaining interest expenditure variation. Due to this limited explanatory value, we only use interest rate weighted cantonal debt for a full analysis (results reported in Table A-4 in the Appendix). All significant findings from the baseline estimation reported in Table 4 can be replicated. Canton specific interest costs do not consistently provide significant results for interaction terms. This supports our findings from Table A-3.²³

Table 6: Robustness check, substitute central bank interest rate with cantonal costs of debt

	(1) Primary Deficit		(2) (total) Exp.		(3) Investment Exp.		(4) Interest Exp.	
Interest expenditure/ Long-term debt	-0.005** (0.0023)		-0.0013 (0.0023)		-0.00086 (0.0011)			
Interest rate * SNB interest rate		-0.0076* (0.00393)		-0.0072* (0.00417)		4.30e-05 (0.00194)		0.0021*** (0.000226)
lagged dependent variable	yes	yes	yes	yes	yes	yes	yes	yes
controls	yes	yes	yes	yes	yes	yes	yes	yes
Observations	754	754	754	754	754	754	754	754
Number of cantons	26	26	26	26	26	26	26	26

Notes: Effect of canton-specific costs of debt variation on fiscal parameters, dynamic model, estimated with a bias-corrected LSDV estimator, fiscal variable per capita, observation period: 1990 to 2019. Debt estimations are not conducted due to endogeneity.

With this substitution, we also address another concern which arises from using one national interest rate for all 26 cantons in the baseline specification of the dynamic model. Using one observation for all 26 units means that changes in the interest rate should be fully captured by time fixed effects, leading to an omitted interest rate variable. However, to display a coefficient for the interest rate variable in the baseline results, we omit time fixed effects for one year instead. The issue is less critical for the costs of debt variable because it has between-unit variation.

²³ We refrain from reporting any results for interaction terms since the respective results have already been weak in the baseline estimation and the robustness check results add no additional value.

Estimation with fiscal variables as share of GDP

The second alternative to account for sound fiscal conditions properly is a more pronounced consideration of debt sustainability, usually assessed by considering fiscal variables as share of GDP. Because employing GDP ratios is common practice in the related literature, we include this robustness check in our analysis as well. We recalibrate our model by expressing all fiscal variables as share of GDP.²⁴

When we estimate the dynamic model with fiscal variables as share of GDP, the results are puzzling (Table A-5). Fiscal rules still have a consistent and statistically significant constraining effect on cantonal debt. The same holds true for the negative interest rate effect on (total expenditure) but the significant findings for other variables of interest are difficult to interpret. First, variation in interest rate correlates negatively with investment and interest expenditures. This is implausible for interest expenditure, and it makes it difficult to explain the significant positive effect on primary deficits. Secondly, the significant positive effect of most stringent fiscal rules on primary deficits is not plausible either (Table A-5, column (7)). The results of this robustness check need to be considered carefully due to a potentially insufficient cantonal GDP approximation.

Alternative measures for public investment

Given the theoretical possibility that cantons may relabel public consumption as investment expenditure (Burret and Feld, 2018b) and due to the different stages of an investment project (decision to invest, payment, activation of the new asset in the balance sheet, and completion), we want to ensure that our respective results hold when using alternative investment variables. We therefore substitute the dependent variable *investment expenditure* by the two alternatives of annual asset variation from Section 3.1 (Table 1): annual change in *administrative property* and *capital assets*.

Alternative measures for cantonal investment policy are not systematically affected by fiscal rules (Table A-6 in the Appendix). Neither *administrative property* nor *capital asset* variation are consistently constrained by fiscal rules. The only exception is a significant negative impact of the most stringent fiscal rules on capital asset variation. The effect of the SNB interest rate is not consistently significantly different from zero in all specifications. The lagged dependent variable is in all cases insignificant indicating a bad fit of the dynamic model for this specification.

²⁴ The FSO provides *cantonal GDP* from the year 2008 onwards. To estimate cantonal GDP, we calculate a canton's share in Swiss productivity by dividing its tax potential by the sum of tax potentials for all cantons and then multiply this fraction by national GDP. Cantonal tax potential is derived by dividing cantonal tax revenue for property tax (private households and corporations alike) and corporate income tax by the respective canton-specific tax multiplier.

Variation in polynomial orders and forecast windows

Lastly, we apply two different robustness checks on the novel FAT approach. We explore the effects of using different polynomial orders and conduct a placebo estimation using an alternative observation period without any exogenous variation.

We begin with a sensitivity analysis by varying the polynomial orders and thereby the forecast window. Specifically, we examine the results for $q_i = 3$. Increasing q_i from 2 to 3 results in a corresponding increase in the pre-treatment period from three to four years (now the pre-treatment period is 2011 instead of 2012 to 2014).

The results are shown in Table 7. They reveal worrying sensitivity when using the FAT approach with annual data. The loss of significance for total expenditure and primary deficits for cantons with very loose fiscal rules is particularly concerning in this regard. The robust and large findings for the treatment effect on debt in cantons with strict fiscal rules and investment expenditure in cantons with loose fiscal rules (Table 7, column (1) and (4)) highlight the concern that these findings may be caused by unrealistic forecasts. New significant findings for debt, primary deficits, and investment expenditure are difficult to interpret due to the respective non-findings in the baseline estimation. This fluctuation indicates that increasing the polynomial order introduces greater variability. Higher flexibility in trend estimation captures different patterns, though the results remain highly sensitive to specification.

Table 7: Robustness check, polynomial-regression FAT of degree 3

Index	(1) Debt	(2) Primary Deficit	(3) Expenditure	(4) Investment Expenditure	(5) Interest Expenditure
Very loose fiscal rules	1.7500 (1.7586)	1.2636 (1.5876)	1.0693 (1.1759)	-1.1062 (1.4657)	0.0689* (0.0354)
Loose fiscal rules	4.9240*** (1.5137)	-8.4518*** (1.4707)	0.2581 (0.42)	-10.8695*** (2.2479)	-0.1742** (0.0698)
Medium fiscal rules	-0.0545 (1.4385)	6.8000* (4.0411)	2.5263 (3.6004)	1.0442** (0.4485)	-0.1475*** (0.0307)
Strict fiscal rules	-10.5883*** (3.0163)	-6.5828* (3.5826)	-4.7111 (3.7748)	2.1947*** (0.6803)	0.0010 (0.0213)

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

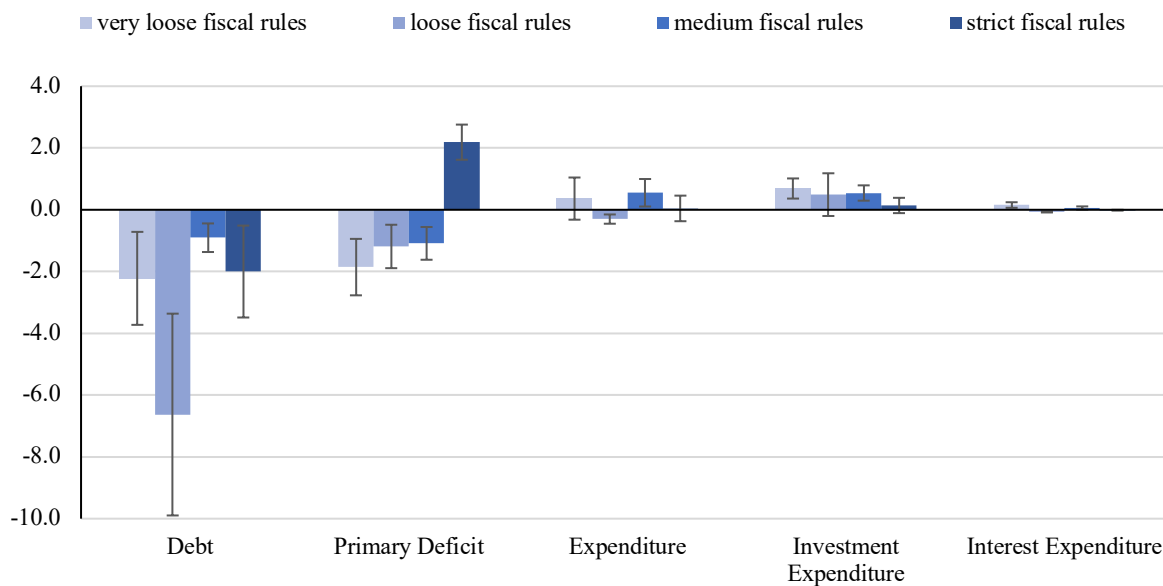
Notes: FAT for cantons grouped by index with corresponding standard errors, observation period: 2011 to 2019. We report Newey-West corrected standard errors.

Next, we conducted a placebo test to further assess the robustness of our model. Conducting a placebo estimation involves assessing our model's performance within an observation period devoid of any significant external shocks, such as a negative interest rate shock. This exercise aims

at ensuring the robustness of our methodology by confirming that our model's predictions align with observable outcomes when no shock is present.

For this test, we select the period from 2000 to 2007, designating 2003 as the placebo treatment year. Conducting a placebo test presents challenges, particularly in identifying a period devoid of external shocks. We select this period due to relatively little changes in cantonal fiscal rules and stable macroeconomic conditions. Figure 8 illustrates the results, presented as bar charts.

Figure 8: Robustness check, FAT placebo test



Notes: Treatment period 2000 to 2007, with 2003 as year of placebo treatment, and $q_i = 2$. FAT for grouped cantons. The 95% confidence intervals are derived from Newey-West corrected standard errors.

The significant findings for debt and primary deficits across different fiscal rule stringency groups support our concern from above that the FAT approach yields inaccurate results when using annual data with limited but expressive variation over time. Figure A-4 in the Appendix visualize this problem by comparing line graphs for debt and expenditure forecasts. Public expenditure evolves consistently over time. The forecast captures this consistent trajectory and, in absence of an exogenous variation, forecasted and actual observations are in the post-placebo-treatment period very close. Debt on the other hand encounters minor changes in the average marginal effect in the pre-treatment period. These marginal changes define the basis function regressions and are carried forward in the forecast. Unrealistic but algebraically plausible forecasts drive the results reported for debt and primary deficit in Figure 8. Taking both FAT robustness checks together we conclude that the FAT approach is a valuable tool to investigate heterogenous effects in absence of a control group but has to be applied carefully and under consideration of data properties in the pre-treatment period. Annual data may not be ideal.

7. Conclusion

This paper aims at answering the research question: *How do fiscal rules affect fiscal policy in a low interest rate environment?*, contributing to and finding common ground between two strands of literature. The theory on optimal (fiscal) policy decisions argues that consistent (rule-based) policy neglects the most appropriate alternatives in a given macroeconomic and monetary policy setting. For instance, fiscal rules constrain fiscal expansion after a negative monetary policy shock when gathering new public debt is cheap and the demand for public investments is high. The political economics literature warns that technically optimal results will not be implemented in practice because political processes and bureaucratic procedures are executed by rational individuals and their own goals may differ from optimal macroeconomic advice. Therefore, fiscal policy can only be long-term welfare-enhancing in a rule-based, consistent, institutional framework.

Our dataset covers all 26 cantons and up to 30 years of observation. We begin with a dynamic model with a bias-corrected least square dummy variable estimator. With the novel forecasted average treatment (FAT) approach we propose a new identification strategy to empirical fiscal policy evaluations. This approach allows us to test whether cantons react differently to interest rate shocks, conditional on their fiscal rule constraint. The FAT approach is applicable in absence of a control group and, as we show in the paper, it is a useful extension to the well-established but criticized econometric toolbox in public finance.

Both estimation strategies yield consistent results. Decreasing interest rates have a negative effect on public debt and interest expenditures, which is further reinforced by a constraining effect of fiscal rules on public debt. For the effect of interest rates on (total) expenditures the dynamic model finds a general expenditure increasing effect of decreasing interest rates. The FAT approach reveals more details that this finding is only persistent for cantons with loose fiscal rules. There is suggestive evidence that after a negative monetary policy shock, (total) expenditures are below the forecast in cantons with strong fiscal rules.

We find no consistent and robust effect of interest rate variation or fiscal constraints on primary deficits. Only for cantons with the loosest fiscal rules the FAT approach offers evidence for a deficit increasing policy after the interest rate shock. The effect size is very similar to the corresponding expenditure effect. The only limited evidence is surprising given robust effects on cantonal debt. A more thorough consideration of revenue accounts may help to clarify these relationships.

Across all specifications, we do not find any evidence for a negative effect of fiscal rules on public investment in a decreasing interest rate environment. Neither in the long-term (1990 to 2019) nor after the substantial interest rate drop in 2015 any evidence indicates that fiscal rules hampered the use of low-cost debt financing to expand public investment. The answer to our research question is that fiscal rules affect fiscal policy in a low interest rate environment but only by reinforcing fiscal consolidation without negatively impacting public investment.

The results for the dynamic LSDVC model are robust against a battery of robustness checks. We address concerns regarding heterogeneity in cantonal fiscal situations and identification problems in administrative data. The FAT results are sensitive for varying polynomial degrees, and a placebo test only partially supports the exogeneity in our variation. Annual data may not be ideal for the FAT approach as minor variation in the marginal properties of the average pre-treatment trajectories has large consequences on the forecasts. Therefore, the FAT results are only robust conditional on pre-treatment data properties. The results are robust for public expenditure and investment but the results for debt and primary deficits have to be interpreted carefully. Still, the consistency between FAT and the dynamic model results supports the FAT approach as a valuable extension of the econometric alternatives in empirical public finance.

For future research we identify three interesting paths. First, the existing literature may benefit from empirical work with disaggregated data. This is particularly relevant for public finance accounts and fiscal rule indexes. Highly aggregated data mask variation over time and between cantons. In this regard a nuanced analysis of the development of fiscal revenue in a low interest rate environment might be promising. Second, following our example here, other novel identification strategies could be fine-tuned to become applicable for sub-national fiscal policy and the Swiss case in particular. Caselli and Reynaud (2020) offer an interesting IV approach to analyze fiscal constraint. To make it applicable for the case at hand, first, the IV's validity and exogeneity need to be theoretically and empirically validated and, second, potential results should be put in perspective of other empirical studies that cover an observation period with multiple rule introductions (e.g. Burret and Feld, 2018 a, b). The observation period in this paper is not ideal for this exercise. Third, after a successful implementation of the FAT approach to empirical public finance in this paper, its cases of application can be further expanded. The COVID-19 pandemic can potentially function as a practical exogenous shock. It remains however crucial to consider pre-treatment data properties carefully and that no unforecastable common shocks appeared after the treatment. Many common economic variables were affected by other macroeconomic shocks short after the pandemic.

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Appendix

Figure A-1: Policy rate and money market rate in Switzerland (1990 – 2020)

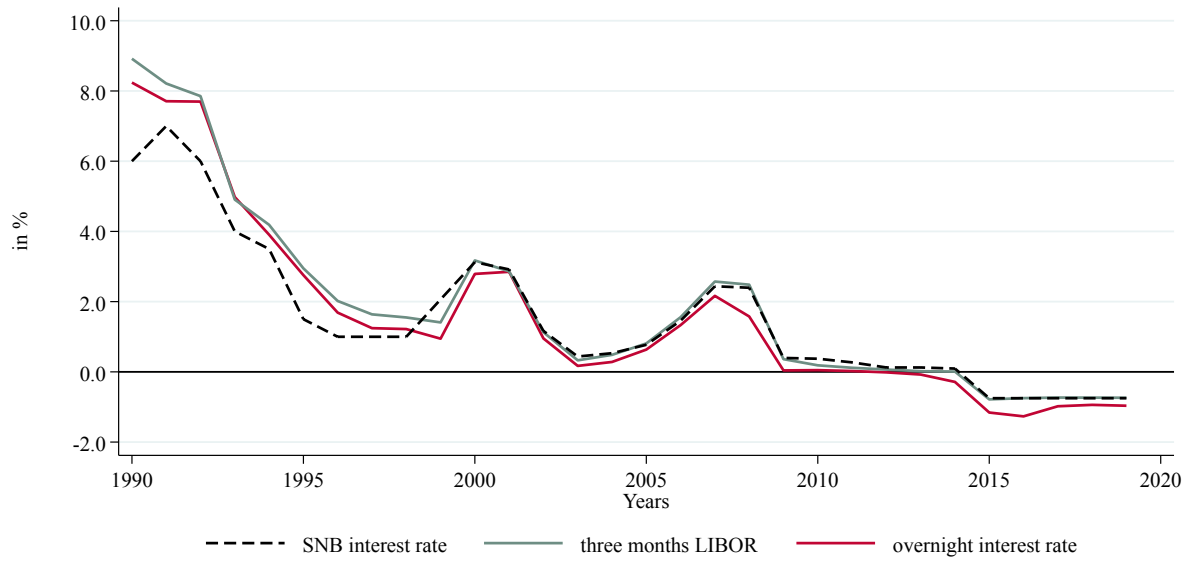


Figure A-2: Public Investment relative to cantonal tax revenue

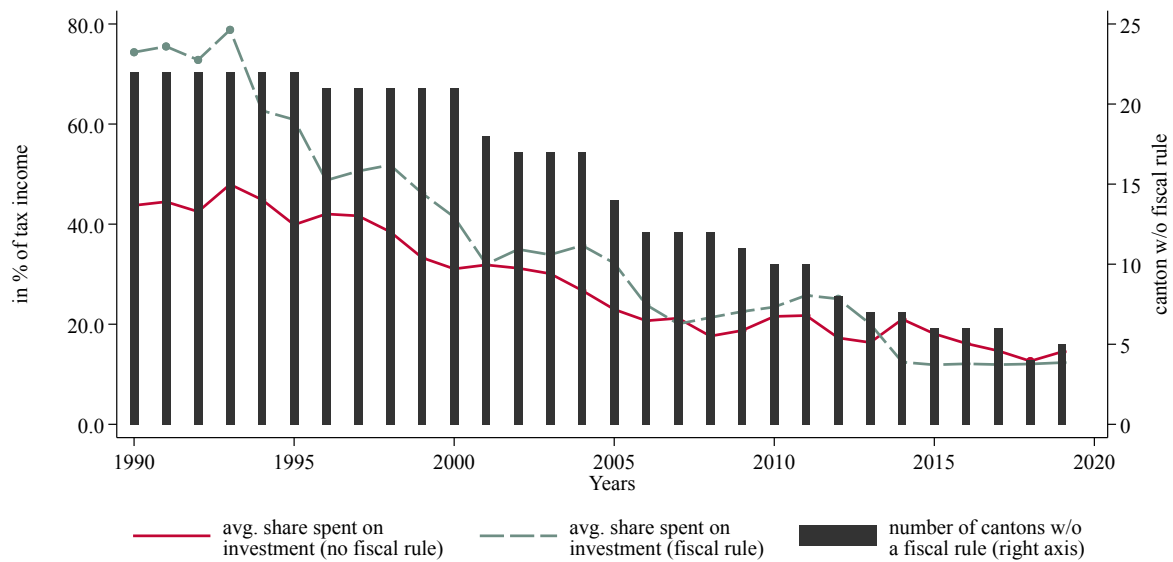
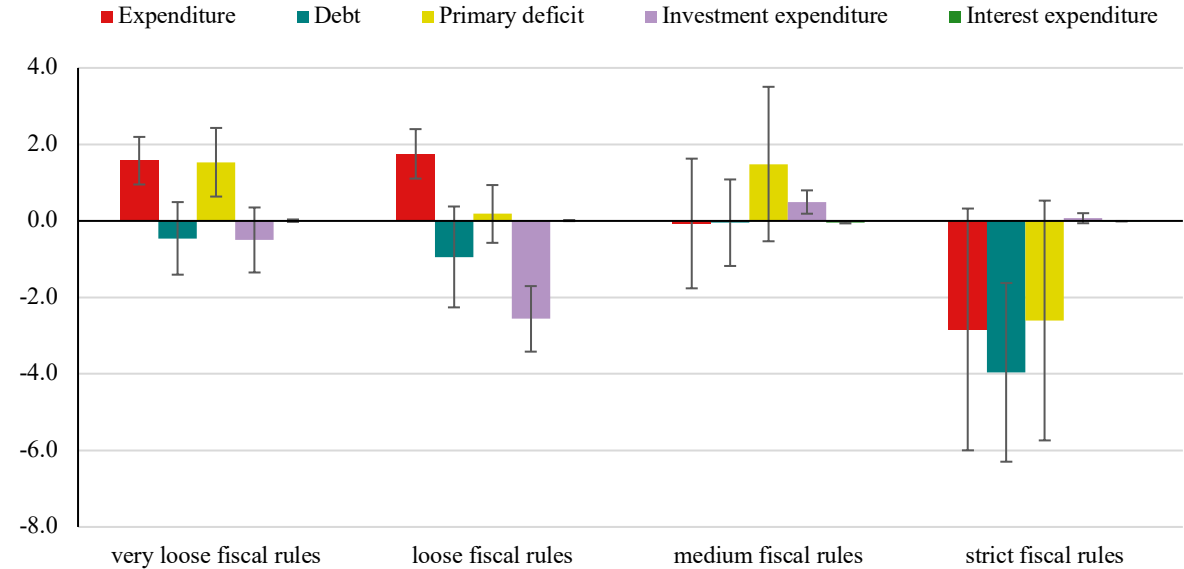
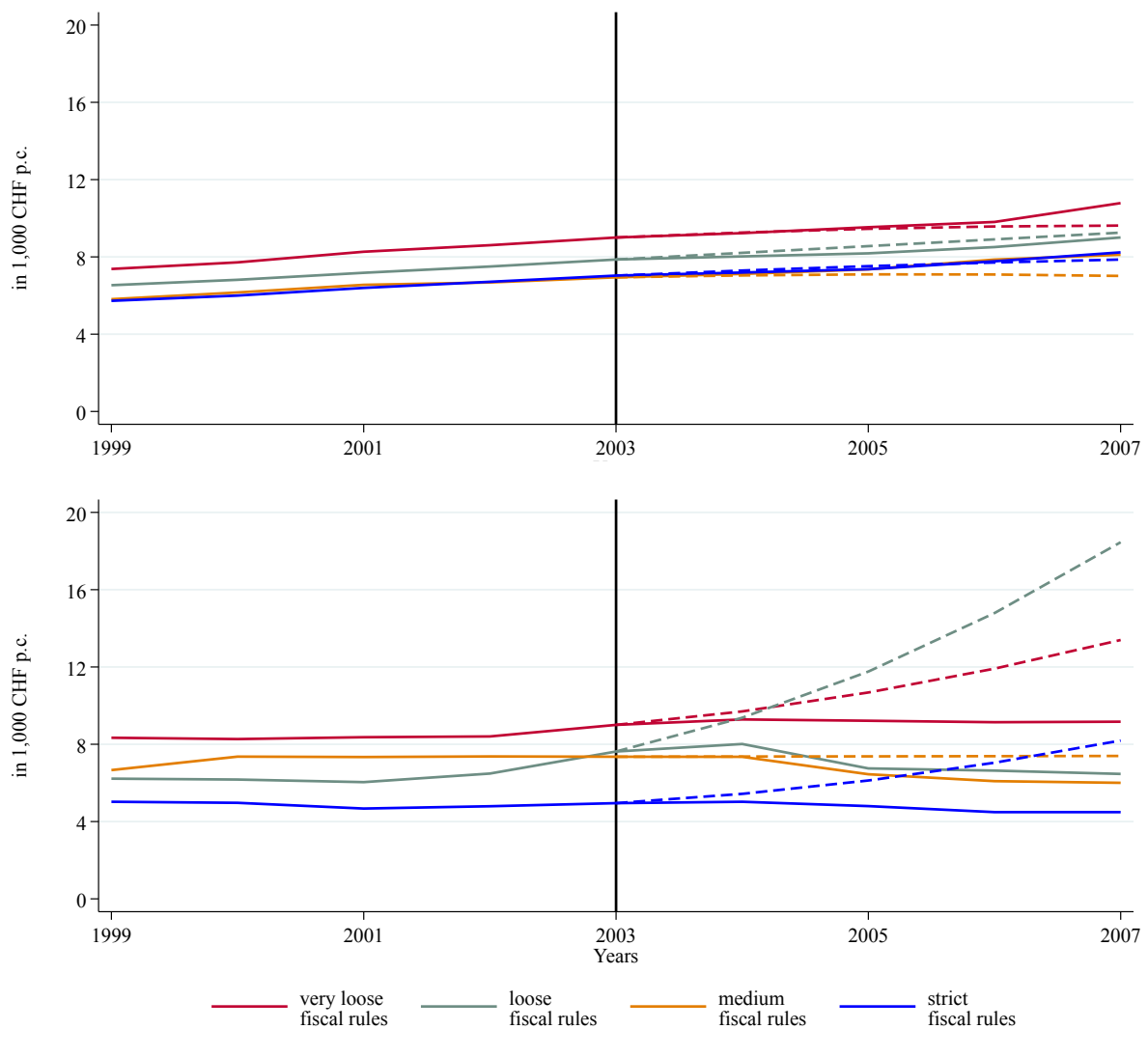


Figure A-3: FAT for all dependent variables, cantons grouped by index value, bar graph



Notes: Results for $q_i = 2$, the depicted FATs are calculated as forecasted values minus observed values (in 1.000 CHF per capita), all observations are averaged values over the entire post-treatment period. A negative value indicates that the actual observation was lower than the forecast. The 95% confidence intervals are derived from Newey-West corrected standard errors.

Figure A-4: FAT placebo test for total expenditure and debt, cantons grouped by index value, line graph



Notes: Results for $q_i = 2$, placebo test with pre-treatment period 2000 to 2002, placebo treatment in year 2003 and post-treatment period 2004 to 2007. While total expenditures (upper graph) have in all four groups constant marginal properties, the average marginal effects for debt (lower graph) vary slightly over time in the pre-treatment period. This causes reliable forecasts for expenditure but forecasts with exponential properties for debt. Consequentially the placebo test results for debt in Figure 8 are driven by algebraically correct but probably unrealistic forecasts.

Table A-1: Cantons grouped by fiscal rule stringency (for the year 2010)

Very loose fiscal rules	Loose fiscal rules	Medium fiscal rules	Strict fiscal rules
Uri	Appenzell O.Rh.	Zurich	Nidwalden
Schwyz	Grisons	Berne	Glarus
Zug	Vaud	Lucerne	Fribourg
Basel-City		Obwalden	Solothurn
Schaffhausen		Basel-Country	St. Gallen
Appenzell I.Rh.		Aargau	
Thurgau		Valais	
Tessin		Neuchâtel	
Geneva			
Jura			

Notes: Groups are created by the three definition criteria proposed by Feld and Kirchgässner (2001a, b).
Source: Burret and Feld (2018a).

Table A-2: Descriptive statistics of control variables, 1990 to 2019

	Obs.	Mean	Std.Dev.	Min	Max
Transfers received (in 1,000 CHF per capita)	780	0.36	0.60	0.00	2.50
Tax potential (in 1,000 CHF per capita)	780	2.86	2.13	0.22	14.50
Estimated cantonal GDP (in 1,000 CHF)	780	19,800,000	26,900,000	-69,346	159,000,000
Population	780	291,327	303,065	13,573	1,539,275
Fiscal policy preference (in percentage points)	754	1.13	5.91	-25.46	29.58
Share of population older than 64 years (in %)	780	16.35	2.39	10.90	22.96
Unemployment rate (in %)	779	2.74	1.57	0.05	7.81

Table A-3: Results, dynamic model and interaction term effects for fiscal rules interest rates

	(1) Debt	(2) Primary Deficit	(3) Exp.	(4) Investment Exp.	(5) Interest Exp.	(6) Debt	(7) Primary Deficit	(8) Exp.	(9) Investment Exp.	(10) Interest Exp.
SNB interest rate	0.0152 (0.0110)	-0.0830* (0.0451)	-0.180*** (0.0465)	0.00588 (0.0223)	0.00896** (0.00359)	0.0176 (0.0115)	-0.0835* (0.0468)	-0.166*** (0.0487)	0.00780 (0.0235)	0.00936** (0.00367)
low rule stringency	-0.0794*** (0.0285)	-0.0228 (0.119)	0.0554 (0.128)	0.0379 (0.0596)	-0.0137* (0.00767)					
medium rule stringency	-0.0436 (0.0309)	-0.0443 (0.124)	-0.119 (0.131)	0.0426 (0.0634)	0.00337 (0.00831)					
strong rule stringency	-0.0772*** (0.0288)	-0.0191 (0.120)	-0.310*** (0.118)	-0.0194 (0.0579)	-0.00953 (0.00771)					
fiscal rule (median split)						-0.0596** (0.0265)	-0.0307 (0.104)	-0.0753 (0.112)	0.0355 (0.0540)	-0.00375 (0.00701)
<u>Interaction terms: SNB interest rate with:</u>										
## low rule stringency	-0.00956 (0.0150)	-0.0265 (0.0592)	-0.0792 (0.0629)	-0.0488* (0.0296)	-1.71e-05 (0.00409)					
## medium rule stringency	-0.00378 (0.0123)	0.0277 (0.0514)	0.0398 (0.0530)	-0.0112 (0.0254)	-0.00579* (0.00332)					
## strong rule stringency	-0.000736 (0.00853)	0.00556 (0.0336)	0.0239 (0.0365)	-0.0286 (0.0175)	-0.00594*** (0.00228)					
## fiscal rule (median split)						-0.00289 (0.00719)	0.00263 (0.0280)	0.00663 (0.0304)	-0.0260* (0.0145)	-0.00380** (0.00189)
lagged dependent variable	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	754	754	754	754	754	754	754	754	754	754
Number of cantons	26	26	26	26	26	26	26	26	26	26
Joint Significance Chi2-test	15.28	0.86	33.33	6.07	21.78	0.16	0.01	0.05	3.20	4.04
Prob > chi2	0.0182	0.9900	0.0000	0.4150	0.0013	0.6870	0.9250	0.8270	0.0739	0.0444

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Effect of the interaction term interest rate with fiscal rules on fiscal parameters, dynamic model, estimated with a bias-corrected LSDV estimator, fiscal variable per capita, observation period: 1990 to 2019.

Table A-4: Robustness check, substitute central bank interest rate with real interest costs, simultaneous effect estimation for fiscal rules interest rates

	(1) Primary Deficit	(2) Exp.	(3) Investment Exp.	(4) Interest Exp.	(5) Primary Deficit	(6) Exp.	(7) Investment Exp.	(8) Interest Exp.	(9) Primary Deficit	(10) Exp.	(11) Investment Exp.	(12) Interest Exp.
real interest costs	-0.00769* (0.00393)	-0.00809* (0.00413)	1.85e-05 (0.00194)	0.00207*** (0.000226)	-0.00781** (0.00390)	-0.00805** (0.00411)	-3.50e-05 (0.00193)	0.00203*** (0.000223)	-0.00776** (0.00394)	-0.00770* (0.00420)	3.90e-05 (0.00195)	0.00206*** (0.000226)
fiscal rule (continuous)	-0.0179 (0.0410)	-0.0917** (0.0405)	-0.00490 (0.0207)	-0.00144 (0.00247)								
low rule stringency					-0.0552 (0.115)	0.00871 (0.123)	-1.85e-05 (0.0574)	-0.0117* (0.00684)				
medium rule stringency					-0.0362 (0.102)	-0.114 (0.106)	0.0125 (0.0525)	-0.00245 (0.00617)				
strong rule stringency					-0.0566 (0.115)	-0.393*** (0.104)	-0.0525 (0.0554)	-0.00591 (0.00669)				
fiscal rule (median split)									-0.0440 (0.0937)	-0.0912 (0.1000)	0.00272 (0.0485)	-0.00564 (0.00571)
lagged dependent variable	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	754	754	754	754	754	754	754	754	754	754	754	754
Number of cantons	26	26	26	26	26	26	26	26	26	26	26	26
Joint Significance Chi2-test	0.19	5.14	0.06	0.34	0.36	20.61	2.49	4.58				
Prob > chi2	0.6620	0.0234	0.8130	0.5590	0.9490	0.0001	0.4770	0.2050				

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Effect of real interest rate cost variation and fiscal rules on fiscal parameters, dynamic model, estimated with a bias-corrected LSDV estimator, fiscal variable per capita, observation period: 1990 to 2019.

Table A-5: Robustness check, dynamic model and simultaneous effect estimation for fiscal rules interest rates

	(1) Debt	(2) Primary Deficit	(3) Exp.	(4) Investment Exp.	(5) Interest Exp.	(6) Debt	(7) Primary Deficit	(8) Exp.	(9) Investment Exp.	(10) Interest Exp.	(11) Debt	(12) Primary Deficit	(13) Exp.	(14) Investment Exp.	(15) Interest Exp.
SNB interest rate	-0.0272*** (0.00585)	0.00400*** (0.000928)	-0.0314*** (0.00555)	-0.0131*** (0.00339)	-0.000371 (0.000242)	-0.0297*** (0.00551)	0.00410*** (0.000878)	-0.0327*** (0.00529)	-0.0139*** (0.00322)	-0.000458** (0.000229)	-0.0276*** (0.00573)	0.00383*** (0.000909)	-0.0314*** (0.00545)	-0.0131*** (0.00332)	-0.000402* (0.000236)
fiscal rule (continuous)	-0.0175** (0.00787)	0.00126 (0.00127)	-6.26e-06 (0.00746)	0.00178 (0.00455)	-0.000538* (0.000326)										
low rule stringency						-0.0707*** (0.0242)	-0.00189 (0.00378)	-0.0168 (0.0232)	-0.0114 (0.0141)	0.00297*** (0.00101)					
medium rule stringency						-0.0204 (0.0184)	-0.000271 (0.00292)	0.0128 (0.0176)	0.0114 (0.0107)	-0.000814 (0.000765)					
strong rule stringency						-0.0797*** (0.0213)	0.00916** (0.00358)	-0.0241 (0.0205)	-0.00926 (0.0124)	-0.00209** (0.000889)					
fiscal rule (median split)											-0.0418** (0.0184)	0.000124 (0.00290)	-1.54e-05 (0.0174)	0.00225 (0.0106)	-0.00161** (0.000760)
lagged dependent variable	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	754	754	754	754	754	754	754	754	754	728	754	754	754	754	754
Number of cantons	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Joint Significance Chi2-test	4.93	0.99	0.00	0.15	2.72	27.93	17.27	9.56	9.96	13.77					
Prob > chi2	0.0263	0.3210	0.9990	0.6950	0.0991	0.0000	0.0006	0.0227	0.0189	0.0032					

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Effect of interest rate variation and fiscal rules on fiscal parameters, dynamic model, estimated with a bias-corrected LSDV estimator, fiscal variable as share of GDP, observation period: 1990 to 2019.

Table A-6: Robustness check, substitute investment expenditure with administrative property and capital assets variation, simultaneous effect estimation for fiscal rules interest rates

	(1) Admin. property	(2) Capital assets	(3) Admin. property	(4) Capital assets	(5) Admin. property	(6) Capital assets
SNB interest rate	-0.0249 (0.0709)	-0.000784 (0.0313)	-0.0784 (0.0764)	-0.0115 (0.0338)	-0.0691 (0.0874)	-0.00606 (0.0385)
fiscal rule (continuous)	-0.0488 (0.0904)	-0.0314 (0.0405)				
low rule stringency			-0.242 (0.158)	-0.0937 (0.0699)		
medium rule stringency			-0.0867 (0.271)	-0.0352 (0.120)		
strong rule stringency			-0.182 (0.174)	-0.145* (0.0784)		
fiscal rule (median split)					-0.146 (0.195)	-0.0651 (0.0868)
lagged dependent variable	no	no	no	no	no	no
controls	yes	yes	yes	yes	yes	yes
Observations	728	728	728	728	728	728
Number of cantons	26	26	26	26	26	26
Joint Significance Chi2-test	0.29	0.60	4.23	7.26		
Prob > chi2	0.5890	0.4380	0.2380	0.0641		

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Effect of interest rate variation and fiscal rules on different public investment parameters, dynamic model, estimated with a bias-corrected LSDV estimator, fiscal variable per capita, observation period: 1990 to 2019.

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