International Tax and Public Finance
https://doi.org/10.1007/s10797-022-09727-z

The fiscal response to revenue shocks

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Accepted: 15 January 2022

Abstract
We study the impact of fiscal revenue shocks on local fiscal policy. We focus on the very volatile revenues from the immovable property gains tax in the canton of Zurich, Switzerland, and analyze fiscal behavior following large and rare positive and negative transitory revenue shocks. We apply causal machine learning strategies and implement the post-double-selection LASSO method to identify the effect of revenue shocks on public finances. We find that local policymakers predominantly smooth transitory fiscal shocks.

Keywords Local public finance · Fiscal policy · Fiscal shocks

JEL Classification D70 · H11 · H71 · H72

1 Introduction

Identifying the individual drivers of fiscal policy is a daunting task. Observable fiscal outcomes are shaped by many factors such as past policy decisions, the business cycle, financial market conditions, and the institutional, political, and economic environment. All at the same time, these factors might be endogenous themselves to fiscal policy. Even though there is a voluminous academic literature on the drivers of fiscal policy (for recent overviews see, e.g., Alesina & Passalacqua, 2016; Yared, 2019), it remains notoriously difficult to disentangle the impact of such factors from underlying incentives and preferences of decision-makers. The ideal experimental

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Published online: 16 March 2022

setup would consist of exogenously and temporarily shifting the budget constraint of a jurisdiction for one fiscal period and observing the induced fiscal response (if any).

Taking a balanced budget as a starting point, unexpected higher revenues (or lower expenditures) result in a surplus, while unexpected lower revenues (or higher expenditures) result in a deficit, *ceteris paribus*. The budget consists of a predetermined part (e.g., entitlement spending, investment spending, interest payments, depreciations, etc.), which cannot be easily adjusted in the short and medium term, and of a discretionary part (e.g., personnel expenditures, operative expenditures, subsidies, etc.), which is allocated contemporaneously through a complex political bargaining process among the relevant interests within the institutional setup. Thus, any active policy response to a temporary relaxation of the budget constraint in the short run must come from the discretionary part of the budget.

Large fiscal fluctuations—especially unexpected shocks—create opportunities and the potential justifications for decision-makers to use their political leeway to deviate from the *ex ante* budgeted resource allocation in the discretionary part of the budget. We aim to exploit such unexpected and large short-term variations in the tightness of the budget constraint and analyze the fiscal response triggered by it. In order to credibly separate such reactions from larger macro-economic or monetary and fiscal policy dynamics, we focus at the local (instead of the regional or national) level and on revenues from a property transaction tax which is not tightly linked to macro-effects and to the usual tax bases such as income and profit taxes.

We take advantage of arguably (conditionally) exogenous variation in property gains tax receipts in the canton of Zurich (Switzerland) and study the expenditure response of local jurisdictions to transitory fluctuations in their own tax base. The immovable property gains tax (*IPGT*) is a particularly volatile revenue source. The receipts typically vary around a municipality-specific trend, and, from time to time, we observe larger temporary shocks. Fluctuations result in short-term temporary shifts (positive or negative) of the budget constraint. The parameters of the *IPGT* are set at the cantonal level, while the proceeds entirely benefit the respective municipality. Municipal decision-makers are aware of the volatility related to *IPGT* receipts. We define *regular flows* as revenue fluctuations that are within a window of what a municipality could expect *ex ante*. In contrast, *positive shocks* and *negative shocks* are defined as large deviations from this expected trend window (in our definition, deviations larger than ± 3 standard errors away from a trend).

For fluctuations to be credibly exogenous for our purposes, they must emanate from idiosyncratic investment and location decisions by private individuals and must be unrelated to municipal public policy or other economic fluctuations such as the business cycle. To identify causal effects, we limit our analysis to large revenue fluctuations, which are typically unexpected by local policymakers and largely driven by individual location and private investment choices, and we purge variation coming from municipality-specific policy as well as economic factors. To do so, we control for underlying trends in the specific tax base and select from a large number of municipality-specific covariates applying causal machine learning methods. We use the post-double-selection method by Belloni et al. (2014) based on the LASSO estimator (Tibshirani, 1996). Ultimately, identification relies on a conditional independence assumption.

According to traditional, normative public finance theory, the optimal reaction to fiscal fluctuations consists of smoothing them over time. The theory holds that governments should smooth short-term fluctuations and keep tax rates constant to minimize distortions (e.g., Barro, 1979; Lucas & Stokey, 1987). However, there is a large literature in political economics providing evidence that revenue smoothing is often not the chosen policy. More frequently, political processes feature substantial deficit bias leading to unsustainable public finances in many countries (e.g., Alesina & Passalacqua, 2016; Yared, 2019). In a companion paper, we find that a large one-off positive fiscal windfall in the canton of Zurich caused large and persistent fiscal imbalances (Berset & Schelker, 2020).

Our baseline results are, however, predominantly in line with normative public finance theory suggesting revenue smoothing as optimal response to shocks. Only about 20% of positive tax shocks are spent as current expenditures, while no statistically significant effect on current expenditures is observed for negative tax shocks. However, the point estimates of negative shocks are substantially larger than those for positive shocks, but they are not very robust to specification changes.

The rest of the paper is structured as follows. Section 2 reviews the literature and set the relevant theoretical framework. Section 3 formulates testable hypotheses. Section 4 briefly describes the institutional environment of the canton of Zurich. Section 5 discusses the functioning of the property gains tax and our approach to distinguish regular fluctuations from shocks. Section 6 presents the data, the identification strategy and the empirical setup. Section 7 reports results and proposes interpretations. Section 8 concludes.

2 Literature review and mechanisms

2.1 Theoretical mechanisms

The normative theory of tax smoothing initiated by Barro (1979) and further developed by Lucas and Stokey (1987) and Aiyagari et al. (2002) provides a central theoretical prediction of the optimal fiscal response to transitory fluctuations. In order to minimize deadweight losses from taxation, a benevolent social planner would smooth transitory fluctuations in expenditures and revenues through the increase and decrease of debt (or assets). In periods of abnormally positive (negative) fluctuations, the debt-to-income ratio would temporary decrease (increase) but it would remain intertemporally *constant on average*. Permanent structural changes, such as population aging with its implied increases in social security spending, can (optimally) induce adjustments to policy parameters and lead to a new public finance equilibrium.

However, normative theories of optimal fiscal adjustments cannot sufficiently explain the accumulation of public debt in the last few decades. A large politico-economic literature documents and explains systematic tendencies toward deficits ("deficit bias") and the accumulation of public debt (see, e.g., Alesina & Passalacqua, 2016; Yared, 2019). From this perspective, policymakers are self-interested agents, which optimize according to their private incentives for holding office and fail to internalize the intertemporal consequences of sustained fiscal imbalances. They behave like present-biased agents (e.g., Laibson, 1997) with dynamically inconsistent preferences (Yared, 2019).

Various political factors and mechanisms contribute to such unsustainable policy making (see, e.g., Alesina & Passalacqua, 2016 for a recent overview). Politico-economic theories range from *fiscal illusion*, in which voters do not systematically consider the intertemporal budget constraint (e.g., Buchanan & Wagner, 1977); to *political budget cycles*, where voters are imperfectly informed (e.g., Frey, 1978; Frey & Ramser, 1976; Hibbs, 1977; Nordhaus, 1975; Rogoff, 1990; Rogoff & Sibert, 1988); to theories of social conflicts such as the *war of attrition* and *riots*, in which deficit reductions are delayed because the different groups and veto players want to shift the burden of stabilization onto the others (e.g., Alesina & Drazen, 1991; Drazen & Easterly, 2001; Passarelli & Tabellini, 2017); to *public debt seen as a strategic instrument* to constrain future governments in their political decision making (e.g., Alesina & Tabellini, 1990; Lizzeri, 1999; Persson & Svensson, 1989); to *common pool problems* and *legislative bargaining* (e.g., Baron & Ferejohn, 1989; Battaglini & Coate, 2008; Krogstrup & Wyplosz, 2010; Velasco, 2000; Weingast et al., 1981); or to *rent seeking* models, in which policymakers want to extract a maximum of private rents and have to be incentivized by voters to limit rent extraction by keeping them in office (e.g., Acemoglu et al., 2008, 2010, 2011; Yared, 2010).

Another part of the politico-economic literature focuses explicitly on *transitory* fluctuations in incomes and government revenues. Several theoretical and empirical contributions emphasize that income and revenue volatility—due to variation in commodity prices (for a review see, e.g., Deaton, 1999); in the terms of trade (e.g., Brueckner & Carneiro, 2017; Mendoza, 1997; Turnovsky & Chattopadhyay, 2003); in the tax base (e.g., Gavin & Perotti, 1997; Lane, 2003); or in foreign aid (e.g., Arellano et al., 2009)—can have an effect on a wide range of outcomes. These outcomes include the impact of income volatility on economic activity (e.g., Fatás & Mihov, 2003; Fernández-Villaverde et al., 2015); on armed conflicts (e.g., Dube & Vargas, 2013); on corruption, patronage or embezzlement (e.g., Caselli & Michaels, 2013; Svensson, 2000); or on fiscal policies (e.g., Brueckner & Gradstein, 2014; Rodrik, 1998). Regarding the latter effects on fiscal policy, two theoretical channels through which fiscal revenue volatility induces inefficient fiscal responses are worth mentioning explicitly.

First, Talvi and Végh (2005) develop an optimal fiscal policy model in which a political distortion causes pressure to increase public spending when governments run surpluses. As budget surpluses become costly, large and anticipated fiscal revenue fluctuations make procyclical fiscal policies optimal for policymakers. As a result, positive fluctuations induce tax reductions and spending increases, while negative ones have the opposite effect. Second, Robinson et al. (2017) show that public income volatility makes the implementation of inefficient policies less costly in an environment, in which different groups compete for holding office. The authors use a standard politico-economic model, in which policymakers maximize their re-election probabilities by implementing inefficient policies targeted at their own groups. On the one hand, volatility, and thus, uncertainty in public revenues lowers the benefit of holding office and, therefore, the temptation to implement such inefficient policies decrease. As a result, the re-election probability decreases. On the other hand, as policy inefficiencies are concentrated in the future, inefficient policies become less costly for an incumbent, and the implementation of such policies increases.[1]

2.2 Empirical evidence

There is a voluminous related empirical literature analyzing the dynamics of fiscal adjustments to revenues and expenditures fluctuations and shocks. One strand of the literature applies vector-error correction models (VECM) and computes impulse response functions to analyze the dynamics of local fiscal policy adjustment (Martin-Rodriguez & Ogawa, 2017). For instance, Buettner and Wildasin (2006) provide evidence for US municipalities, Buettner (2009) for German municipalities, Solé-Ollé and Sorribas-Navarro (2012) for Spanish municipalities, and Bessho and Ogawa (2015) for Japanese municipalities. Those studies show that municipalities tend to react to fiscal shocks and aim to maintain the intertemporal budget balance through adjustments in their current and investment expenditures, as well as through grant transfers.

Another strand of the literature is more interested in identifying the causal effects of a change in a specific revenue source, often vertical grants and transfers, on local public finances. For example, Dahlberg et al. (2008) analyze the causal effect of unconditional block grants on local spending and taxation. They rely on an instrumental variable approach, in which a discontinuity in the grant formula serves as an instrument for the observable grant variation. They find that grants increase local spending but leave tax rates unaffected. Subsequent research following similar causal strategies also finds that vertical transfers increase local spending but do not affect taxes (e.g., Baskaran, 2016; Litschig & Morrison, 2013; Lundqvist, 2015). A recent study by Helm and Stuhler (2021) studies the impact of exogenous variation in equalization transfers. The adjustments come primarily from changes in municipal investments and the acquisition of assets, and not so much from changes in current accounts. They show that municipalities take time to adjust to permanent

[1] A third mechanism relates to the "voracity effect" proposed by Tornell and Lane (1998, 1999). They develop a theoretical model that emphasizes the critical role of the fiscal process in determining the response to a positive temporary shock. With powerful groups involved in a fiscal process with weak institutions, a "voracity effect" appears and, in equilibrium, the aggregated appropriation is larger than the shock itself. The voracity effect holds that in an environment with weak institutions and powerful groups, an increase in the raw rate of return in the formal economy (e.g., due to a resource windfall) induces incentives of powerful groups to demand more redistribution which increases the tax rate in the formal sector. The increase in the tax burden in the formal sector shifts investments towards the informal sector. This leads to an overall reduction of the growth rate and the over-dissipation of the rents from an increase in the raw rate of return in the formal sector. Strulik (2012) shows that with an elasticity of intertemporal substitution in consumption below unity the voracity effect disappears. Given that the considered shocks in our application neither result from underlying productivity shocks in the economy nor happen in the context of weak fiscal institution, we do not further explore mechanisms related to the voracity effect.

changes in transfer flows, but that such adjustments go well beyond the increase in transfers due to multiplier effects in other revenues.

Our paper is empirically related to the strand of the literature that aims to estimate causal effects. However, our specific question and the setup differ quite substantially from this literature. We analyze short-term and transitory (non-permanent) fiscal shocks, which originate from a municipality's own tax base and not from transfers and grants from higher-level jurisdictions. We are interested in the underlying individual fiscal behavior of local policy makers as they face a temporary positive or negative revenue shock that does not affect the fiscal or economic outlook of their local jurisdiction. Specifically, we focus on the fiscal reaction of local governments to *transitory* and *short-term* revenue fluctuations from the *IPGT* in the canton of Zurich in Switzerland. We distinguish three types of fluctuations: "regular flows," "positive shocks" and "negative shocks." With this distinction, we investigate whether municipalities react differently to larger fluctuations (shocks) relative to smaller and anticipated "regular" fluctuations, and whether or not positive and negative shocks lead to asymmetric reactions. In contrast to regular flows, the variation in fiscal revenue induced by positive and negative shocks are (1) larger (outside a confidence interval of 3 standard errors around a kernel smoother), (2) unexpected and (3) (conditionally) exogenous from municipal policy decisions.[2]

3 Hypotheses: what are the fiscal reactions to shocks?

Ceteris paribus, shocks induce variation in the municipal current balance in *t*. Shocks temporarily improve or deteriorate the municipal financial position. The potential fiscal reactions of policymakers to a short-term relaxation or tightening of the budget constraint can fall into four archetypical categories. The first two consist of symmetric responses to positive and negative shocks, while the other two entail asymmetric reactions.

3.1 Smoothing hypothesis

Following traditional public finance theory, the optimal strategy consists of smoothing unexpected short-term budgetary shocks over time (e.g., Barro, 1979; Lucas & Stokey, 1987). Positive budget residuals are accumulated and meant to compensate negative ones. Hence, municipalities should neither adjust current expenditures nor current revenues in response to unexpected budgetary shocks. This strategy implies that positive and negative shocks have a symmetric effect. Both types of shocks only affect the current balance in *t*.

[2] For empirical evidence of the asymmetric response to positive and negative shocks, see, for instance, Stine (1994), Heyndels and Van Driessche (2002), or Helm and Stuhler (2021). In contrast, Gamkhar and Oates (1996) find evidence of symmetric local reactions to increases and cuts in federal grants.

3.2 From-hand-to-mouth hypothesis

Alternatively, a jurisdiction could also react sensitively, but symmetrically, to positive and negative shocks, i.e., increase expenditure with a positive shock and decrease it with a negative shock. This, however, requires a strong degree of budgetary flexibility and might induce inefficient fluctuations in the quantity and/or quality of public goods provision. According to Talvi and Végh (2005) and Robinson et al. (2017), such budgetary sensitivity is economically less efficient in comparison to smoothing.

3.3 Politico-economic hypothesis

Positive and negative shocks might trigger asymmetric reactions. While positive shocks trigger fiscal expansion, negative shocks do not trigger fiscal tightening, which leads to systematic deficits and the accumulation of debt (see, e.g., Alesina & Passalacqua, 2016; Yared, 2019). Municipal decision-makers might be tempted to use the spending slack in case of a positive shock to allocate these untied resources to specific interest groups, whereas negative shocks do not trigger cuts in spending and/or increases in taxes. Such an asymmetry would indicate that municipalities spend additional resources when available and run a deficit in case of negative shocks.

3.4 Fiscal conservatism hypothesis

The opposite asymmetry, in which positive shocks are smoothed and negative shocks are mitigated, is also possible. In this case, positive shocks neither affect expenditures nor revenues. They mechanically increase the current balance and capitalize in the stock of assets. Conservative actors with a deficit aversion might try to avoid deficits at all costs and reduce expenditures or increasing taxes in case of a negative shock. Such an asymmetry would indicate that municipalities mitigate negative shocks, and, over time, accumulate the surpluses from positive shocks in their capital accounts.

4 Institutional environment

We focus on variation in the *IPGT* in the canton of Zurich. The tax schedule is defined at the cantonal level, but the tax is levied at and its proceeds are allocated to the municipal level. Municipalities decide upon and provide important public goods autonomously. Moreover, municipalities also decide upon various aspects of their institutional setup.

4.1 Municipal fiscal autonomy

The canton of Zurich has 171 municipalities and qualifies as the most fiscally decentralized canton in Switzerland. The ratio of local expenditure relative to the sum of local and cantonal expenditures is about 50%. The municipalities enjoy great autonomy in the definition of public goods and services and the infrastructure they provide. They are responsible for compulsory education at the primary and secondary school levels (30% of current expenses), social assistance (15%), and local health services (5%). Municipalities also provide other public goods and services regarding culture, security, transportation, and the environment. Finally, infrastructure investments account for a significant share of municipal budgets (on average 15% of total annual expenditures). The provision of some of those services is subject to cantonal, sometimes even national standards. However, the municipalities are far from being simple providers of public services defined by upper-layer governments.

On the revenue side, municipalities are subject to the equivalence principle. They primarily finance expenditures with revenues raised through their own taxation of local sources of income and wealth. On average, about half of the municipal revenues come from the direct taxation of natural persons' incomes and firm profits. The overall income and wealth tax scheme is defined by the canton, while municipalities decide on a tax multiplier. An exception is the *IPGT* which is entirely fixed by the cantonal level. Its proceeds amount to an average of about 3.89% of current revenues. The second source of municipal revenues is user charges and fees (18% of current receipts, on average). Unconditional transfers account for only 10% of municipal current revenues, and transfers with a counterpart for 5% on average. This makes the municipalities relatively independent of inter-governmental transfers compared to other local governments worldwide.

4.2 Local governance

Municipalities are governed by a "local council," which constitutes the executive and is made up of 5–9 members. The local legislative branch is the municipal assembly or, in 13 cases, a local parliament.[3] Local elections are held every 4 years. Most municipalities only elect the local executive, while citizens constitute the legislative body via municipal assemblies several times a year. Parties play a weaker role at the local level, and not all national parties are represented and polarization is not pronounced.

With the introduction of the new cantonal law on municipalities in 2009, municipalities had to install mandatory budget referendums. A mandatory budget referendum has to be held whenever a spending proposition lies beyond a certain threshold. The thresholds for recurring expenditures vary between CHF 40′000 and CHF 1 million. Changes to the local income tax multiplier have to be approved by the legislative organ.

[3] Among the 163 municipalities of our studied sample, 9 municipalities have a local parliament over the entire period and one municipality introduced a parliament in 2014.

4.3 Budget formulation and political leeway

Each fall, municipalities prepare a budget for the next fiscal year, coinciding with the calendar year. The planned budget is, on the one hand, a forecast of the financial flows in the forthcoming fiscal year and, on the other hand, the result of the conjunctions of a series of constraints: One part of the budgeted flows is non-discretionary since it directly results from predetermined expenditure flows, such as entitlements or other spending related to past policy decisions, or cantonal requirements. Another part emanates from local political forces and demands of interest groups.

The revenue side depends more heavily on forecasts. Municipal authorities formulate their expectations on revenue flows based on their experience, the economic cycle, and other information they might have regarding changes of relevant determinants (e.g., anticipated migration of wealthy taxpayers, announced settlement of a firm, etc.). At the budgetary stage, planned expenditures and forecasted revenues should be close to balance.[4] Hence, budgeted fiscal resources are committed to specific purposes. The planned budget corresponds to an equilibrium outcome that results from politico-economic forces constrained to some extent by the forecasted fiscal revenue. In this equilibrium, not all demands from interest groups can be met and a residual demand remains unsatisfied.

It is not uncommon for municipalities to see the realized revenue flows deviating—sometimes substantially—from the budgeted values. Positive budget residuals provide additional untied resources, while negative budget residuals result in a lack of resources to finance the budgeted spending. The resulting budget residuals from revenue fluctuations are in the hands of local decision-makers and not *ex ante* determined.[5] Hence, (positive) fiscal shocks may generate budget residuals and provide decision-makers with the leeway to satisfy at least some of this residual demand.

5 The immovable property gains tax (*IPGT*) in the canton of Zurich

5.1 Setup

In Switzerland, the value-added of immovable properties is subject to taxation.[6] This tax is levied on transactions and not on the annual estimation of the property value. As a tax on property transactions, the amount of *IPGT* revenue is a function of the number of transactions, the value of transacted properties as well as the tax rates

[4] The municipality law of the canton of Zurich requires that the budgeted current balance must be close to balance. An expenditure surplus can be planned as long as it does not exceed the planned depreciation on the administrative assets plus 3% of the planned tax receipts (Art. 92, Kanton Zürich Regierungsrat 2015).

[5] The annual financial statement is not subject to any balance requirement. Amendments to the accepted planned budget are only required to be mentioned in the annual financial statement.

[6] The definition of « immovable property» is set in the Swiss civil code (Art. 655). Immovable properties include the parcels of land and the buildings thereon, the distinct and permanent rights recorded in the land register, the mines, and the co-ownership shares in immovable property.

applied to those transactions. Cantons are in charge of the design of the tax scheme, and the definition of the tax base, the tax schedule, or the distribution of tax receipt between the canton and the municipalities varies across cantons (see Administration fédérale des contributions, 2015).

In the canton of Zurich, all real estate transactions, i.e., transactions made by private individuals and by firms, are subject to the *IPGT*. Except for a few exceptions, the private gains made from these transactions are not taxed in other ways. The property gain is calculated as the difference between the purchase price and the selling price, both in nominal terms. The tax scheme in the canton of Zurich is progressive, and it depends in complex ways on various parameters. The highest tax bracket is set for gains above CHF 100′000. These are taxed at a 40% rate. To discourage speculation, a surcharge of 50% is added to the tax if the property was held for less than 1 year and 25% if it was held for less than 2 years. A tax deduction is applied for each year the property was held by an owner going from 5 to 20 years (-3% per year).[7] There is a plethora of additional directives potentially affecting the property gains tax in case of legal persons using the property for core purposes of their commercial activity and for professional property dealers. This complexity makes it very difficult to forecast the effective tax rate and timing of the tax revenue flow per transaction (see Online Appendix OA.1).

While the tax scheme is entirely defined by the canton, the fiscal proceeds from this tax benefit exclusively the municipalities where the transactions took place. On average, the fiscal revenue from the *IPGT* represents 3.89% of the current revenue and 4.49% of the current spending (Table 1, Panel A). Note also that the municipal revenue from this tax is not considered for the resource equalization scheme between municipalities and thus remains fully at the disposal of the local jurisdiction. The various conditionalities—e.g., the tax rate is a function of the actual profit of a property transaction relative to its initial value at time of purchase (all in nominal terms), the time a property was held by that same owner, and whether or not the selling party purchases property within a certain time window in the canton—make it very difficult to forecast the tax receipt from a specific property transaction, and, at the aggregate level, the total tax receipt of the *IPGT* at the municipal level.

5.2 Measuring fluctuations and definition of "shocks"

For each municipality, we want to distinguish the expected property gains tax receipt from larger and unexpected fluctuations, which we call "shocks." Ideally, we would take the difference between budgeted and realized values. When a realized tax receipt deviates strongly from its *ex ante* forecast, we would consider it as a shock and investigate how the municipality reacted to it. Our strategy follows this

[7] The tax code provides the option of postponing the tax payment in few specific cases. Typically, when the transaction concerns a family house and the household reinvests the product of the transaction in a new home in the same canton, the gain that is reinvested is not subject to taxation. Therefore, the household might ask the postponing of taxation until the second transaction (maximum 2 years).

Table 1 Descriptive statistics of the immovable property gains tax (1990–2016)

	Obs	Mean (Std.err.)	Min	Max
Panel A: All				
IPGT, in 1000 CHF	4401	1,547.54	−686.33	37,530.87
		(2,371.22)		
IPGT/current spending, in %	4401	5.80	−8.73	114.33
		(5.70)		
IPGT/current revenue, in %	4401	4.93	−9.52	62.57
		(4.20)		
Panel B: Regular IPGT receipts				
IPGT—smoother, in 1000 CHF	2882	-97.96	−5,385.16	3,047.00
		(464.37)		
(*IPGT*—smoother)/current spending, in %	2882	-0.48	−15.08	11.13
		(1.67)		
(*IPGT*—smoother)/current revenue, in %	2882	-0.43	−13.38	8.16
		(1.44)		
Panel C: Positive shocks (*above 3 std. err.*)				
IPGT—smoother, in 1000 CHF	782	1,036.71	15.95	30,401.20
		(1,708.81)		
(*IPGT*—smoother)/current spending, in %	782	5.33	0.47	80.60
		(5.88)		
(*IPGT*—smoother)/current revenue, in %	782	4.23	0.40	38.00
		(3.75)		
Panel D: Negative shocks (*below -3 std. err.*)				
Smoother—*IPGT*, in 1000 CHF	737	612.08	15.53	4,977.35
		(696.98)		
(Smoother—*IPGT*)/current spending, in %	737	3.11	0.36	22.20
		(2.02)		
(Smoother—*IPGT*)/current revenue, in %	737	2.79	0.33	17.34
		(1.82)		

Period 1998–2016; without Zürich, Winterthur, and six municipalities involved in local amalgamations

intuition with the difference that the budgeted values are not observable and need to be estimated.

For each municipality, we approximate the budgeted tax receipts using a kernel-weighted local linear regression based on an Epanechnikov kernel (Fan, 1992; Gutierrez et al., 2003). The method offers several advantages: Local linear regression consists of fitting linear models locally in the neighborhood of specific values of the regressors, with the size of the neighborhood increasing in the bandwidth. It has therefore the simplicity of a standard linear model while being less constraining in terms of linearity assumptions. Here, the bandwidth is specific to each municipality and is calculated according to the rule of thumb (see Silverman, 1986), which provides the optimal bandwidth (entailing the minimum mean integrated squared error)

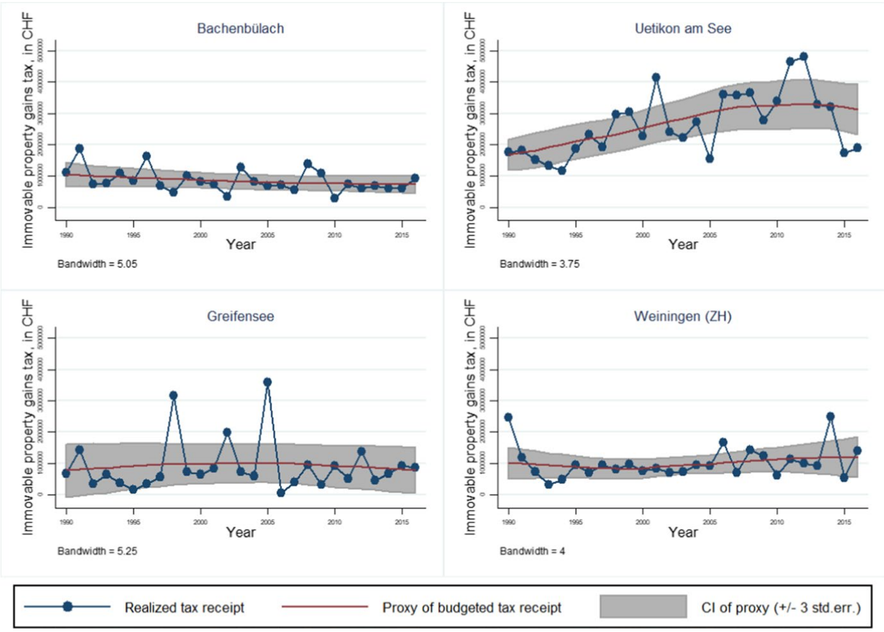


Fig. 1 Distinguishing regular fluctuations from shocks, 4 examples

for kernel smoothing under normally distributed data. This method has the advantage of permitting municipality-specific time trends.

The kernel-weighted local polynomial regression is not only technically useful, but it is economically meaningful for our purposes. It produces a smoother of the realized tax receipt and an associated standard error for each municipality (Fig. 1). For each fiscal period, the smoother can be interpreted as the optimally forecasted *IPGT* receipt per municipality. A municipality that would budget its property gains tax receipt accordingly would, on average, respect intertemporal budget balance.[8]

To make sure that our estimation strategy of the budgeted value of the property gains tax approximates actual budgeting, we contacted a sample of 30 municipalities of the canton (of which 15 replied). From the feedback received, our estimated smoother seems to be an adequate approximation for the municipality-specific forecasts. Municipalities seem to be well aware of the volatility of this revenue source. The realized revenue flows typically fluctuate around a trend (approximated with the kernel smoother) and only deviate moderately from this *ex ante* forecast.

[8] In order to evaluate how precisely the kernel smoother approximates the intertemporal balanced budget path, we compute a measure of relative preciseness for each municipality. We calculate the average of the difference between the realized fiscal receipt and the estimated smoother and express it relative to the average municipal current spending and current revenue. Over the entire sample, the means of these measures equal -0.05% (Min. -0.97%, Max. 0.99%) and -0.04% (Min. -0.86%, Max. 0.89%), respectively. The smoother is extremely close to the intertemporal balanced budget path. The relative deviation from intertemporal balance does not exceed $\pm 1\%$ for any individual municipality.

Fluctuations within such a window around the trend will be referred to as *regular flows*. Technically, we define regular flows as the realized tax receipts remaining within a confidence interval around the smoother. Larger fluctuations, outside the confidence interval, constitute the positive and negative shocks.

To define the confidence intervals around the municipal smoothers (and distinguish fiscal shocks from regular flows), we use the standard error associated with the estimated municipality-specific kernel smoothers. By assumption, we consider as "shocks" all realized fiscal receipts that stand below -3 standard errors (negative shocks) or above + 3 standard errors (positive shocks). This is an arbitrary definition of a shock. It should strike a balance between defining only larger deviations as shocks while at the same time preserving a sufficient number of observations. We conduct robustness checks with alternative specifications using ± 4 and ± 5 standard errors.

Table 1 presents descriptive statistics of the overall *IPGT* receipts (Panel A), as well as grouped by types of revenue flows (panels B to D), over the studied period (1990–2016). The *IPGT* receipts amount to an annual average of CHF 1.55 million, which represent 5.8% of the annual average of total municipal current spending and 4.9% of current revenue.[9] With a threshold at ± 3 standard errors, our sample counts 2882 observations classified as regular flows (65.5%), 782 positive shocks (17.8%) and 737 negative shocks (16.7%). Table OA.2.1 of Online Appendix OA.2 shows that the shocks are also fairly evenly distributed across different municipal sizes. Panels B to D provide summary statistics of the difference between the observed *IPGT* receipt and the estimated smoother for each type of revenue flows, i.e., regular flow, positive shocks, and negative shocks. On average, the observed flows that qualify as "regular" (within ± 3 std. err. around the smoother) are slightly smaller than the smoother (Panel B). Relative to current spending and revenue, this difference corresponds to about 0.48%. Mechanically, the deltas are much larger for shocks. Positive and negative shocks produce deviations from the smoother that equal about CHF 1 million and CHF 0.6 million on average, respectively.

Importantly, our shock measures are (by definition of the data) asymmetric. While positive shocks have theoretically no upper limit, negative shocks cannot go below zero. In the extreme case, no transactions take place and the resulting fiscal revenue from the *IPGT* is zero. Some small municipalities of our sample collect only very low sums from *IPGT*. Their estimated smoother and its lower bound qualifying negative shocks are, thus, close to zero. This might cause an inflated number of negative shocks. In the robustness section, we exclude municipalities in the lowest decile of the average lower bound (-3 std. err. < CHF 17′800) and the municipalities in the lowest decile of the average smoother relative to current spending (< 1.86%). The results excluding such potential outliers are qualitatively similar. Moreover, the robustness section contains estimates applying a more restrictive definition of what

[9] The sample contains 14 negative values mostly concentrated in early 2000. We contacted the cantonal service in charge of municipalities to understand the reason for such negative values. These observations seem to be *ex post* corrections for accounting/attribution errors. There are cases in which the exact amount and timing of an *IPGT* payment had to be corrected to reflect, *ex post*, actual flows.

constitutes a shock. We define the bounds of our shock measure to only include fluctuations outside ± 4 and ± 5 standard errors. Qualitatively the results are similar, but the estimated standard errors of our effects increase due to the smaller number of shocks.

6 Data and empirical strategy

6.1 Data

Our dataset contains 163 of the 171 municipalities. We exclude the large cities of Zurich and Winterthur, as they represent outliers in various dimensions such as their size, population, demographics and their status of beneficiary of particular transfers for agglomerations. We also exclude 6 municipalities involved in the three amalgamations that took place since 2013. We collect extensive municipal accounting data as well as a wide range of economic, demographic, and socio-economic variables. We were able to collect consistent information for the period from 1990 to 2016. All municipalities use the same accounting model, and the same rules apply during the entire period (Direktion der Justiz und des Innern des Kantons Zürich, 1984).

As is standard for public entities in Switzerland, the municipal accounts are organized in three main accounts: the current account, the investment account, and the capital account. Our main focus lies on standard public finance measures from the current account. There are two main reasons for why we focus on the current account: First, by far most of the discretionary spending originates in the current account and it provides the most flexibility in the short run (e.g., Berset & Schelker, 2020). Personnel expenses, operating expenses, and subsidies and transfers to public companies and private individuals are much more flexible in the short run than investment expenditures, which go through a structured and time-consuming planning and decision-making process, frequently including direct decisions in local assemblies. However, not all current expenditures are easily modified in the short run by local policy makers. There are various accounts which contain non-discretionary expenditures, such as depreciations on local administrative assets or rule-based transfers between jurisdictions for mutual services that are negotiated with the canton and/or other municipalities. Secondly, and more importantly from an economic and econometric perspective, the investment account is closely linked to local infrastructure investment and, thus, to local property markets. For example, large local infrastructure investments are likely to have an impact on the number of property transactions and property values, making the receipts from the immovable property gains tax endogenous to such policy decisions. Jointly with the local income and business tax policy, investment policy is one of the key drivers affecting the attractiveness of a local municipality in the competition for a mobile tax base. Hence, such local policy variables must be considered to be potential drivers of property market transactions, and, hence, *IPGT* revenue flows. Third, we abstain from analyzing capital accounts, as they are stock measures and, hence, not suitable in the context of our analysis involving fluctuations in flow measures.

Following our hypotheses, we are primarily interested in the expenditure response to revenue shocks. However, it is also useful to analyze whether or not an *IPGT* revenue shock affects revenues from other tax bases as well as the balance of current revenues and expenditures, reflecting an intuitive measure of smoothing. The analysis of total tax receipts has an additional advantage, as it helps us to evaluate our empirical model: Specific mechanical accounting patterns should be clearly visible and potential endogeneity issues should become apparent from patterns in the estimation. The property gains tax enters the municipal "tax receipt" account, which contains all proceeds from all local tax sources (income and property taxes of natural persons, profit taxes of legal persons, etc.). *Ceteris paribus*, the estimated effect of the property gains tax on this account in t is expected to be close to 1 mechanically. If municipalities neither adjust their tax scheme in response to *IPGT* shocks nor taxes themselves drive the *IPGT* shocks, the estimated coefficients should be close to 0 in all periods preceding or succeeding the shock. On the one hand, this mechanical effect provides a quality check for our estimation approach. On the other hand, we can test whether or not municipalities' overall tax revenues change as a driver of (pre-treatment) or response to (post-treatment) a fiscal shock.

Our measure of current expenditures corresponds to the sum of all economically relevant discretionary spending accounts of the current account (e.g., personnel expenditures, operating expenditures, subsidies, etc.). Accounts that serve pure accounting purposes are excluded from the aggregate (e.g., internal charging). In line with the previous arguments pertaining to the investment accounts, we also exclude depreciation flows related to administrative assets, as such flows are related to past public investments and, thus, local public policy decisions. Analogously, our measure of current balance, officially called "self-financing," is the difference between current expenditures (excluding purely technical accounting positions and depreciations) and current revenues (excluding pure accounting positions).

6.2 Understanding the drivers of the immovable property gains tax

For identification, it is important to understand the potential drivers of revenue fluctuations of the *IPGT*. By design, these are the number of transactions, the value-added in property markets over time and the tax rate applied in the specific transactions. The specificities of the tax scheme are set at the cantonal level and are independent of local policy decisions. However, the number of transactions and the value-added over time are endogenous to, for example, the location of the municipality (e.g., lake shore, closeness to attractive labor markets), local investments in public goods and services, the tax rate, but also the economic cycle, the growth of real estate markets, migration movements, and other structural changes.[10]

The potentially large number of relevant factors in property markets and the difficulty to forecast them, in concert with the complexity of the tax scheme, make

[10] For evidence on capitalization effects relating to local investments, amenities, public goods and services, or local tax and public debt policy in Switzerland, see, for example,Hilbert (1998), Stadelmann and Eichenberger (2014), Basten, von Ehrlich, and Lassmann (2017).

the fiscal revenue itself very difficult to predict. This is a curse and a blessing at the same time: From an econometric point of view, a disadvantage is that specifying an unbiased and sparse model is challenging. However, it also makes it difficult for local policymakers to predict revenue fluctuations, which limits anticipation effects and the potential for reversed causality. According to our explorative survey, municipalities forecast the revenue from the *IPGT* primarily on their experience of the previous years (the number of transactions and the average tax receipt from the last 3–5 years) and a few other known parameters such as the evolution of land prices in the municipality or the municipal reserve of building area (which are observable to the econometrician). This information allows municipalities to forecast a trend window (which we capture with "regular flows"), but they are unlikely to estimate revenues more precisely, as the tax scheme is very complex and, thus, applicable tax rates per transaction and the timing of the revenue flow remain highly uncertain.[11]

To illustrate some of the drivers that might affect property markets and property transactions and, thus, *IPGT* revenues, Online Appendix OA.2 presents summary statistics and a series of correlates from simple OLS regressions. Table OA.2.2 shows that relative to regular non-shock years, we observe about 8 percent more transactions in positive shock-years, and about 10 percent fewer transactions in negative shock years, all while controlling for the population size, the tax base (business cycle), and municipal and year fixed effects.

Even though the total *IPGT* receipt is related to the number of transactions by design, column 1 of the Table OA.2.3 shows that they are not significantly correlated with the actual contemporary tax revenue flow from property transactions. This illustrates the complexity of the tax system and the unpredictable timing and amount of revenue flows. The tax base of this property transaction tax depends on the duration of property ownership as well as the nominal change in property prices over that period. Given the length of time a property remained with the same owner, a different tax rate applies (see Online Appendix OA.1). Moreover, the tax code makes it almost impossible for transactions to be taxed in the year of the actual transaction. As the tax is based on the value added over the time span the property was held by a particular owner (with progressive tax rates for shorter periods), the selling party needs to provide evidence for both the initial transaction price when buying the property as well as the transaction price when selling it. From that value added, further investments in that property over time can be deducted and evidence of such investments has to be provided by the selling party. If the proceeds of the property transaction are or will be reinvested in another property in the canton, the tax liability is deferred or even canceled.

[11] It could be feared that exceptionally large positive fluctuations, due to only a small number of particularly large transactions, might be easy to forecast because such cases might imply long negotiations or prior announcements. However, respondents of our exploratory survey emphasized that even with large and publicly debated transactions, it remains usually unclear what specific tax rate (depending on various parameters) would finally apply and when the proceeds would actually enter the accounts. The number of transactions, as well as the generated value-added, varies often substantially from their forecasts. Deviations might be positive with more transactions of greater value, or negative, with fewer and smaller transactions than expected.

Column 1 of the Table in Online Appendix OA.2 also shows that the income and business tax base (a measure of local economic activity), net investments in local administrative assets, and the size of the local population are significantly correlated with *IPGT* revenues, while the income and business tax multiplier is not. Private construction activities are positively correlated with *IPGT* receipts, while public construction activity is not. Note, however, that the regression equation already includes net administrative investments that are positively correlated with *IPGT* receipts. Column 2 contains results on potential drivers of the number of property transactions. As expected, migratory movements are strongly correlated with transactions numbers. Moreover, some of the private and public construction measures are also correlated with transaction numbers. Column 3 and 4 in turn focus on drivers of such migratory movements and show that the number of marriages (as an example of a personal and private decision), the tax multiplier (as an example of public policy drivers) and some construction measures are correlated with migratory movements. This simple correlational evidence illustrates the necessity to carefully consider potential drivers in our empirical approach.

6.3 Identification strategy

We are interested in the causal effect of positive and negative fiscal revenue shocks from the *IPGT* on local public finances. Identifying causal effects is not trivial, as policymakers might not only anticipate revenue trends (“regular flows”), but potentially also revenue shocks, and because the shocks themselves might have been triggered by some local policy change. In what follows, we address the central identification challenges in turn.

6.3.1 Timing

To capture potential anticipation effects, we introduce the shock measures for two pre-treatment periods. This helps us to detect anticipation effects, which would cast doubt on the (conditional) exogeneity of such shocks and it provides evidence on the validity of the parallel trend assumption. Similarly, a fiscal revenue shock might trigger delayed and/or persistent adjustments over the following budgetary periods. To capture such delayed responses, we include 5 post-treatment periods in our baseline regression (from $t-2$ to $t+5$) and up to 10 post-treatment periods in the robustness section (from $t-2$ to $t+10$). We are careful to include a sufficient number of post-treatment periods to make sure that any potential effects of a shock have time to fade out. If that were not the case, effectively treated periods (due to a potentially lasting fiscal change given some shock) would end up among the control periods and, hence, bias the estimates. In simple event study setups with a permanent change in the treatment status, this problem is solved by endpoint binning (e.g., Schmidheiny & Siegloch, 2020). This, however, is not possible in our setup with non-persistent, but potentially repeated shocks, which requires a sufficient number of lags for shocks to fade out.

6.3.2 Endogeneity to local public policy decisions

Even though the parameters of the *IPGT* are defined at the cantonal level, and local property transactions and their specific timing are the result of private decisions, the potential endogeneity of the *IPGT* fluctuations to local public policy decisions (affecting such personal decisions) is a direct threat to valid inference. If changes to local public policy were predictable, rarely came as shocks and tended to be persistent at least for some time, they would smoothly capitalize in local property markets and should largely be picked-up by our smoother reflecting local property market trends. In such a scenario, most of the remaining variance in *IPGT* receipts due to (smooth) policy changes would then likely be captured by "regular flows." Yet, we cannot exclude that some policy initiatives might cause larger deviations resulting in what we measure as shocks. Ideally, we would purge all variation related to local policies. Two important policy instruments in the local competition for a mobile tax base are the tax burden and local infrastructure that affect local property markets (e.g., Basten et al., 2017; Hilbert, 1998; Stadelmann & Eichenberger, 2014). In Online Appendix OA.3, we provide suggestive evidence showing that both of these policy instruments, the tax multiplier for income and profits as well as net administrative investments, are correlated with *IPGT* receipts. We observe pre-treatment trends as well as post-treatment dynamics in the coefficients. This strongly points toward the endogeneity of *IPGT* receipts to local tax and investment policy and corroborates our approach to control for such effects in our empirical framework.[12] We are able to observe and control for measures relating to infrastructure investments, the provision of public goods and services, the exploitation of the local tax base (income and business tax multiplier) and inter-jurisdictional transfers. Moreover, we dispose of a large number of covariates that reflect local institutions that mediate local policy decisions, such as whether a municipality holds town meetings or has a parliament, whether or not there is a mandatory fiscal referendum, or the electoral cycle, and other economic, socio-demographic and other outcomes.

[12] It has been suggested that another worry might be reverse causality, in that *IPGT* shocks affect local investment and tax policy—instead of our proposed mechanism going in the other causal direction. Such an argument would necessitate the anticipation of *IPGT* shocks well before they actually occur. For instance, public investment must go through a structured and often time-consuming policy process. Reverse causality would require that future *IPGT* shocks are accurately anticipated a few years in advance. Such a causally reversed mechanism is not credible and stands in stark contrast to (i) the information provided by municipalities in our short survey, (ii) the pronounced complexities of the tax code making it very difficult to predict the actual tax liability and the payment timing per transaction, (iii) the empirical observation that there are no anticipation effects in fiscal aggregates, such as current expenditures, which can be adjusted rather flexibly even in the short run (as opposed to, for example, administrative investments), and (iv) the empirical observed pre-treatment patterns in Figures OA.3.1 and OA.3.2 of the Online Appendix, going in the opposite direction of what such an intuition would suggest. If anything, one would expect an *increase* in administrative investments prior to the shock, or that jurisdictions would try to *increase* tax revenue prior to negative shocks if anticipation were possible.

6.3.3 Endogeneity to the business cycle

As we are interested in the fiscal response of local policymakers, independent of the economic environment, a second source of potentially confounding variation is the local macro-economic cycle. We are able to control for business cycle dynamics captured by the tax capacity (essentially the normalized tax base) of natural and legal persons incomes and profits and the unemployment rate. We can also control for trends in local property markets. A relatively direct measure of such trends is the trend receipts of the *IPGT*, which we approximate with our kernel smoother. Municipal and time fixed effects and municipality-specific linear and quadratic time trends control for invariable (e.g., lake shore) and slow-moving location effects as well as year specific effects (e.g., financial markets), all of which can affect property markets and migration decisions.[13] Note that national fiscal policy decisions as well as monetary policy affect municipalities similarly and are thus accounted for by time effects.

6.3.4 Covariate selection and the risk of overfitting

Given the large number of potential covariates as well as the demanding lag structure, the risk of overfitting is high. Therefore, we opt for the post-double-selection method by Belloni et al. (2014), which consists of a data-driven process of covariate selection based on LASSO estimation (Tibshirani, 1996). The LASSO is a machine learning method, which is capable of selecting influential control variables among a large number of covariates, while shrinking the importance of (mostly) irrelevant covariates. The method perfectly fits our setup with limited degrees of freedom and a risk of overfitting (which may lead to a high variance).[14] Ultimately, identification is based on a conditional independence assumption (e.g., Wooldridge, 2002); specifically the assumption that revenue shocks can be treated as exogenous conditional on a linear combination of a set of potential control variables chosen by post-double-selection LASSO.

Following the post-double-selection methodology by Belloni et al. (2014), we first select the set of covariates that best predict the respective outcome variables. Secondly, we select the variables which best predict our causal variables pertaining to the *IPGT* variation (regular flows, positive shocks, negative shocks, shock years and smoother). Third, we estimate the full model using the union of the selected covariates from the previous steps in an OLS regression. A potential downside of this approach is that for every outcome variable a different model specification is

[13] Note, however, that it would be problematic to control for local property prices, as they are directly affected by idiosyncratic private decisions. Controlling for this variation would purge relevant variation in the *IPGT* and, hence, bias the results.

[14] We also implemented estimators based on causal random forests. Given the limited sample size, the method provided only very noisy estimates and proved to be inadequate in our case.

estimated. This makes it impossible to perfectly reconstruct accounting mechanics in coefficient patterns across accounts and subaccounts (see Berset & Schelker, 2020).

6.3.5 Bad controls

We need to pay particular attention to the set of covariates from which the algorithm may select. Our goal is to estimate the impact of large variations (shocks) in *IPGT* receipts on particular public finance outcomes. These shocks should be (conditionally) orthogonal to municipal policy decisions and must emanate from independent private decisions that generate unexpectedly high or low tax receipts. Controlling directly for parameters reflecting private decisions would absorb part of the relevant variation and would qualify as bad controls (Angrist & Pischke, 2009). Therefore, we do not include covariates such as the number of real estate transactions, real estate prices, or migration movements in the pool of potential covariates.

The set of covariates includes, for instance, information on the available building and construction area, investments local administrative assets such as transportation and other public infrastructure, the tax multiplier, and a wide range of economic, political, demographic, and socio-economic municipal characteristics. We also dispose of the necessary information to separate the effect of the shocks from the potential impact of transfers such as equalizations transfers, cantonal grants, and the like. All variables enter the pool of potential covariates with the same temporal structure as our main explanatory variables, and they range from t–2 to $t+5$. Finally, we include municipal linear and quadratic time trends. We chose to never penalize the municipal and year fixed effects. All estimations include robust standard errors clustered at the municipal level.

In addition, Online Appendix OA.4 provides complementary results from simple OLS regressions as well as different variants of the LASSO specifications including changes to the covariate pool (e.g., without time trends) and changes to the definition of what constitutes the causal variables in the post-double-selection LASSO specifications (e.g., excluding the *IPGT* smoother; including the smoother to the set of unpenalized regressors and excluding covariate selection on the smoother, etc.).

6.4 Empirical specification

We estimate (variants of) the following distributed lag model and use the (conditionally exogenous) *IPGT* shocks to obtain the effect on tax receipts, current expenditures and current balance ("self-financing"). In order to evaluate potential pre-treatment trends, we include two pre-treatment periods. Our analyses show that potential effects fade out over five post-treatment periods. Therefore, we present specifications with five lags and two leads. As discussed at length in the previous sections, identification ultimately relies on the conditional independence assumption.

$$\begin{aligned}
Y^j_{it} = \alpha &+ \sum_{\tau=-5}^{\tau=2} \beta_\tau IPGT_{i,t+\tau} + \sum_{\tau=-5}^{\tau=2} \gamma_\tau ShockYear^{Pos}_{i,t+\tau} + \sum_{\tau=-5}^{\tau=2} \delta_\tau ShockYear^{Neg}_{i,t+\tau} \\
&+ \sum_{\tau=-5}^{\tau=2} \sigma_\tau IPGT_{i,t+\tau} \times ShockYear^{Pos}_{i,t+\tau} + \sum_{\tau=-5}^{\tau=2} \rho_\tau IPGT_{i,t+\tau} \times ShockYear^{Neg}_{i,t+\tau} \\
&+ \sum_{\tau=-5}^{\tau=2} \varphi_\tau Smoother_{i,t+\tau} + \boldsymbol{X}_{i,t+\tau}\boldsymbol{\theta} + \vartheta_i + \mu_t + \epsilon_{it},
\end{aligned} \tag{1}$$

with the indices i and t referring, respectively, to municipalities and years and τ reflecting the lag and lead structure for the variables of interest. With the lead and lag structure, we estimate potential anticipation and persistence effects. The index j refers to the outcome variables *tax receipts, current expenditures,* and *self-financing* (Y^j_{it}). Besides the *IPGT*, the respective shock-year dummies ($ShockYear^{Pos}_{i,t}$ and $ShockYear^{Neg}_{i,t}$) and their interactions (our variation of interest), the specification includes the $Smoother_{i,t}$ and a matrix of LASSO-selected covariates ($\boldsymbol{X}_{it+\tau}$) including municipality-specific linear and quadratic time trends, and municipal (ϑ_i) and time (μ_t) fixed effects.

The two shock-year dummies, $ShockYear^{Pos}_{i,t}$ and $ShockYear^{Neg}_{i,t}$, capture variation that is specific to all years in which a shock with respect to *IPGT* flows is observed. A shock is defined as a ± 3 standard errors deviation from the *IPGT* kernel-weighted local polynomial smoother. From this setup we are able to infer the effect of regular *IPGT* variation within a trend window (within ± 3 standard errors of the smoother) as well as the effects of positive and negative shocks.

Our main parameters of interest are σ_τ and ρ_τ of the interaction terms: The parameter σ_τ of the interaction $IPGT_{i,t} \times ShockYear^{Pos}_{i,t}$ estimates the marginal effect (in CHF) of a positive *IPGT* shock relative to a regular revenue flow on public finance outcomes Y^j_{it} in a specific year. The parameter ρ_τ of the second interaction $IPGT_{i,t} \times ShockYear^{Neg}_{i,t}$ estimates the marginal effect (in CHF) of a negative *IPGT* shock relative to a regular flow in a specific year. Hence, our estimates are based on the intensive margin of the *IPGT* variation and the effects have a direct monetary interpretation.[15] Economically speaking, we are interested in the effect of the intensity of a shift in the budget constraint (in CHF) in shock years. We evaluate the effects against the null hypothesis of not being different from zero. In the case of shocks, we also estimate whether or not the *IPGT* shocks are statistically different from one another to evaluate the symmetry of the fiscal reaction (see our hypotheses).

We always include the $Smoother_{i,t}$, which reflects the municipality-specific trend in *IPGT* receipts according to the kernel-weighted local polynomial regression. It allows us to control for the expected trend revenue flow respecting the intertemporal budget constraint. It is an (*ex post*) optimal intertemporal prediction of the revenue

[15] For example, a correlation of 0.75 corresponds to a CHF 0.75 reaction to a CHF 1 of fiscal variation.

flow and incorporates trends in real estate markets, the business cycle, and other covariates that affect *IPGT* receipts.

7 Results and interpretations

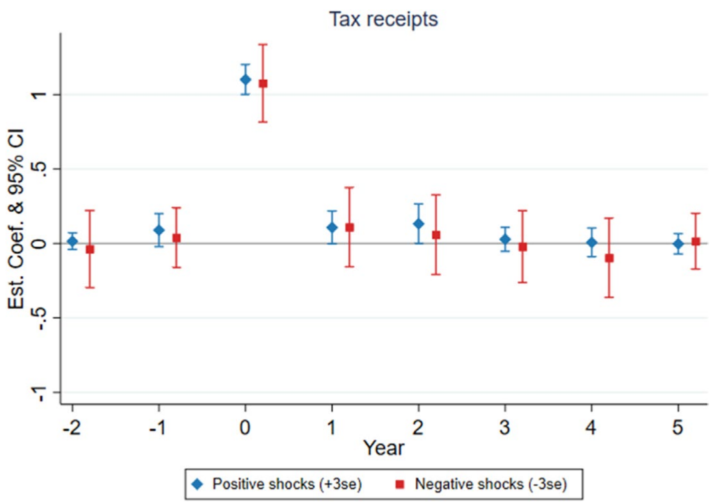
Our theoretical arguments focus primarily on unexpected shocks. Such shocks shift the budget constraint in the short run and provide political slack in the reaction to the unexpected tax revenue variation. We argue that such shocks are difficult to predict, and are hence more credibly conditionally exogenous than "regular flows." In what follows, we provide regression results on the impact of positive and negative shocks on total tax receipts, current expenditures, and self-financing.

We report the results in graphs, where we plot the estimated coefficients and the respective confidence intervals when testing against zero. Each plot relates to one outcome and shows the estimated *total impact* of positive shocks and negative shocks.[16] The total impact of a shock is the sum of the baseline effect (regular flow) plus the respective interaction effect, i.e., the Total impact of positive shock$_\tau$= $\beta_\tau + \sigma_\tau$ from Eq. 1. The 95% confidence intervals around the point estimates test against the null hypothesis of a coefficient not being significantly different from zero.

Below the graphs, we document the p-values of further test statistics. First, we present significance tests of the shock coefficients (e.g., positive shock) against regular flows as well as against the other shock coefficient (e.g., negative shock). Secondly, we also present p-values of joint significance F-tests including four post-treatment periods (lag 1 to lag 4). Again, we present such tests for both shocks against regular flows as well as between the two shocks. These tests allow as to distinguish between our four hypotheses: "smoothing," "from-hand-to-mouth," "politico-economic," and "fiscal conservatism."

For illustrative purposes, we present further specifications in Online Appendix OA.4: First, we document regression results on the total *IPGT* variation, hence, without a distinction between regular flows and shocks (Figures OA.4.1–OA.4.3). The results of these benchmark specifications are very consistent and complement the picture of our main analysis. Second, we always present results from simple OLS specifications, including only a few economically relevant covariates, alongside a series of alternative LASSO specifications. In the simple OLS, we estimate Eq. 1 and chose the $\boldsymbol{X}_{it+\tau}$ following some loose economic intuition. We control for the business cycle by including the tax capacity (essentially a measure of local income), the population size, two measures reflecting changes to local policy (the tax multiplier and local public investments), and municipal and time fixed effects. The alternative LASSO specifications differ in that we (1) exclude municipality-specific trends from the pool of covariates, (2) exclude the smoother from our model but continue to include municipality-specific trends and quadratic trends in the pool

[16] For the sake of completeness, Online Appendix OA.4 also contains the results for regular flows.



Timing	t - 2	t - 1	t	t + 1	t + 2	t + 3	t + 4	t + 5
Significance tests: p-values								
positive vs. regular	0.05	0.73	0.07	0.33	0.75	0.33	0.12	0.26
negative vs. regular	0.76	0.43	0.74	0.43	0.46	1.00	0.67	0.74
positive vs. negative	0.69	0.45	0.83	0.99	0.45	0.64	0.31	0.82
F-tests of joint significance (L1-L4): p-values								
positive vs. regular				0.37				
negative vs. regular				0.38				
positive vs. negative				0.62				

Fig. 2 Effect of *IPGT* shocks on municipal tax receipts. *Notes*: This figure reports the coefficients of the impact of positive as well as negative shocks of the immovable property gains tax (*IPGT*) on total tax receipts from the estimation of a distributed lag model according to a variant of Eq. 1. This specification defines shocks as variation situating outside ± 3 standard errors around a kernel smoother. The 95% confidence intervals around the point estimates test against the null hypothesis of coefficients not being significantly different from zero (perfect smoothing). Standard errors are clustered at the municipal level. The reported significance tests below the graph report p-values of t-tests and joint significance F-tests for lags 1 to 4 when testing either shock against regular flows or against the opposite shock

of covariates, or (3) exclude the smoother and the shock-year-dummies from the set of causal variables, for which LASSO selects covariates.

7.1 Tax receipts: mechanical effect

We start with regression results on total tax receipts (Fig. 2). The revenues from the *IPGT* are contained in this aggregate account including the receipts of all other tax bases such as the income tax from natural and legal persons. This regression informs us directly on two important issues: First, econometrically, it serves as a specification test. Mechanically, the entry of the *IPGT* should show up as a one-to-one relationship, i.e., the coefficient should be one in treatment period *t* and zero in pre- and post-treatment periods. This exercise provides evidence of whether or not other tax bases (such as income and profit taxes) are correlated with the *IPGT*. If there is a correlation different from zero in non-treatment years and/or a correlation different from one in treatment years, the results might point to endogeneity issues. Secondly, if it were the case that the one-to-one relationship did not hold, this regression would quantify the size of the reaction in other tax bases.

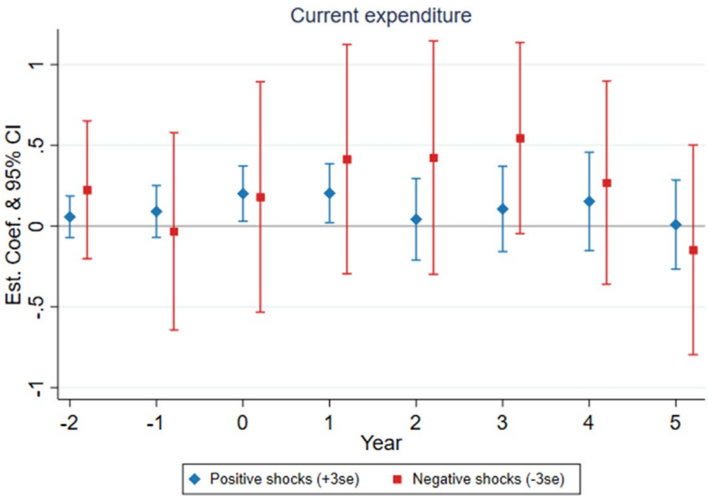
The coefficients in the treatment period *t* are very close to one and significantly different from zero (Fig. 2). However, when tested against one (instead of zero), the positive shock coefficient is statistically different from one at the 5% level in the treatment period *t*; negative shocks and regular flows are not statistically different from one. CHF 1 of shock results in roughly CHF 1.1 in municipal total tax receipts in case of a positive shock, and about CHF 1.07 in case of a negative shock, though this difference is not statistically significant.[17] The pre-treatment coefficients are very close to and statistically not different from zero. Post-treatment effects are also typically not significantly different from zero. Exceptions are the coefficients estimated for positive shocks which amount to 0.1 in $t+1$ and 0.13 in $t+2$, both of which are significant at the 10% level. Note that the negative shock coefficient in $t+1$ is similar in size, but far from any conventional level of statistical significance. However, these deviations from zero are not robust to changes in LASSO specifications, and are typically not statistically different from zero (see Online Appendix OA.4). Overall, the result of a one-to-one relationship of *IPGT* receipts and total tax receipts holds beyond the presented specification in Fig. 2.

In order to test for asymmetries in the effects of shocks, the lower part of Fig. 2 reports the p-values of a series of significance tests. To distinguish among the various hypotheses, we test our shock measures against regular *IPGT* flows and against the respective opposite shock. In the first three rows, we report t-tests, in which we test individual coefficients against each other. In the subsequent three rows we document F-tests of joint significance taking together the effect of four post-treatment periods (lag 1 to lag 4).[18] Individually, only very few differences are significant: Positive shocks are significantly different from regular flows in $t-2$ and in *t*, but the differences in coefficients are negligible. None of the joint significance test reach standard levels of statistical significance.

Overall, the expected mechanical effect of the one-to-one relationship is present across different specifications. The differences to the one-to-one benchmark in *t* up to $t+2$ in Fig. 2 are small, about 0.1, and are not corroborated by alternative specifications in Online Appendix OA.5.

[17] To prevent misunderstandings: "negative shocks" are positive revenue flows in our specification (just much lower than expected), and thus, we observe positive correlations.

[18] As shocks fade out by lag 5, we only test for joint significance up to lag 4.



Timing	t - 2	t - 1	t	t + 1	t + 2	t + 3	t + 4	t + 5
Significance tests: p-values								
positive vs. regular	0.44	0.54	0.52	0.68	0.83	0.85	0.97	0.85
negative vs. regular	0.47	0.82	0.77	0.26	0.10	0.02	0.60	0.51
positive vs. negative	0.36	0.67	0.95	0.50	0.20	0.08	0.64	0.53
F-tests of joint significance (L1-L4): p-values								
positive vs. regular					0.91			
negative vs. regular					0.16			
positive vs. negative					0.45			

Fig. 3 Effect of *IPGT* shocks on municipal current expenditure. *Notes*: This figure reports the coefficients of the impact of positive as well as negative shocks of the immovable property gains tax (*IPGT*) on current expenditures from the estimation of a distributed lag model according to a variant of Eq. 1. This specification defines shocks as variation situating outside ± 3 standard errors around a kernel smoother. The 95% confidence intervals around the point estimates test against the null hypothesis of coefficients not being significantly different from zero (perfect smoothing). Standard errors are clustered at the municipal level. The reported significance tests below the graph report p-values of t-tests and joint significance F-tests for lags 1 to 4 when testing either shock against regular flows or against the opposite shock

7.2 Current expenditures

Positive shocks: Both pre-treatment effects in Fig. 3 are very close to and statistically not different from zero (Fig. 3). We find statistically significant effects of positive shocks on current expenditures in the treatment period t and the first post-treatment period $t+1$ when tested against zero (smoothing). Both effects indicate an increase in current expenditures of about CHF 0.20 per CHF 1 of positive shock and both are statistically different from zero. None of these effects are statistically different from regular flows and only in $t+3$ positive shocks are statistically different from negative shocks at the 10% level.

Overall, we find small positive effects of positive shocks in t and $t+1$. While results from other LASSO specifications are fairly similar, the simple OLS results cannot reject perfect smoothing (Online Appendix OA.4).

Negative shocks: None of the negative shock coefficients are significantly different from zero at the 5% level, and only in $t+3$ the coefficient crosses the 10% significance cutoff. Overall, the coefficient sizes are quite substantial, but so are the standard errors resulting in very large confidence intervals. None of the joint significance tests indicates statistically significant differences. Alternative LASSO specifications also show insignificant results with rather large confidence intervals, but again, substantial point estimates.

Overall, the estimates suggest small positive and statistically significant effects of positive shocks on current expenditures in t and $t+1$. The predominant part of these shocks is smoothed; however, perfect smoothing is rejected. Smoothing cannot be rejected for negative shocks. We reject the hypothesis that the reaction to the shocks is asymmetric.

7.3 Current expenditures: main subaccounts

With the available data, we can look at which of the relevant current expenditure categories could be directly influenced by local policy makers in case of shocks. We focus on the economically relevant expenditure categories in subaccounts, over which local governments have (at least some) discretion in the short run. We analyze subaccounts regarding personnel expenses, operating expenses, interest paid, and subsidies. We do not focus on subaccounts that serve pure accounting purposes, are non-discretionary such as transfer accounts that are negotiated between jurisdictions, and depreciations.[19]

Figure 4 shows that we do not find striking or consistently significant patterns in these subaccounts. Some of the patterns observed in "Negative shocks" on current expenditures could be related to operating expenses. But, again, standard errors are large and smoothing cannot be credibly rejected.

7.4 Self-financing

Let us turn to our measure of the current balance, self-financing. It excludes purely technical transfer accounts as well as depreciations and is the officially published and preferred indicator of the current balance according to the cantonal authorities.

[19] See our discussion in Sects. 6.1 on data and 6.3 on identification: financial flows from depreciations are a lagged consequence of administrative investments. Those investments are the results of local public policy and are directly linked to property markets. Consequently, administrative investments are part of the pool of potential covariates. Including depreciations would import this potential endogeneity in our measure.

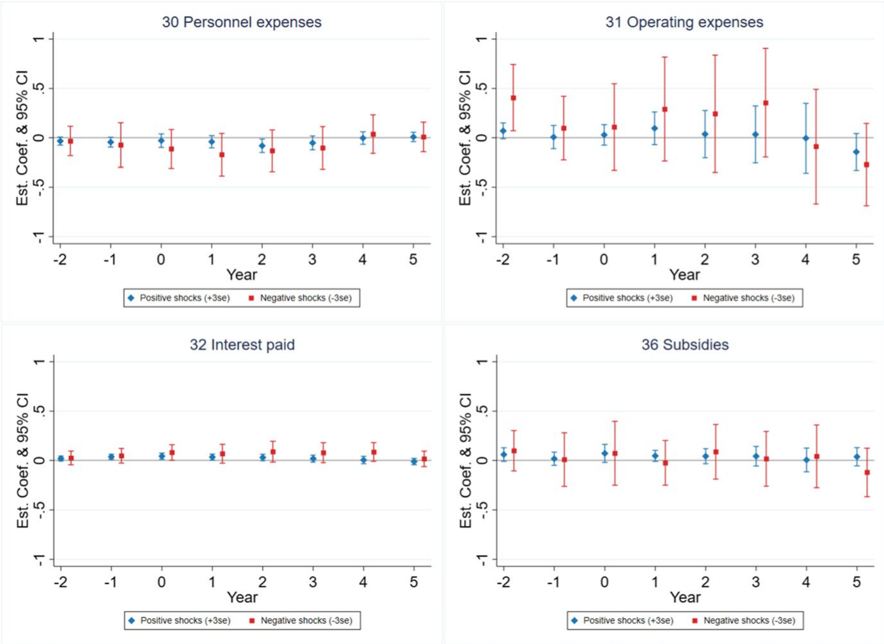


Fig. 4 Main subaccounts of current account: personnel expenses, operating expenses, interest paid, subsidies. Notes: These figures report the coefficients of positive as well as negative shocks of the immovable property gains tax (*IPGT*) on the main discretionary subaccounts from the current account. Results are based on the estimation of a distributed lag model according to a variant of Eq. 1. All specifications define the shocks as variation situating outside ± 3 standard errors from a kernel smoother. The 95% confidence intervals around the point estimates test against the null hypothesis of coefficients not being significantly different from zero. Standard errors are clustered at the municipal level

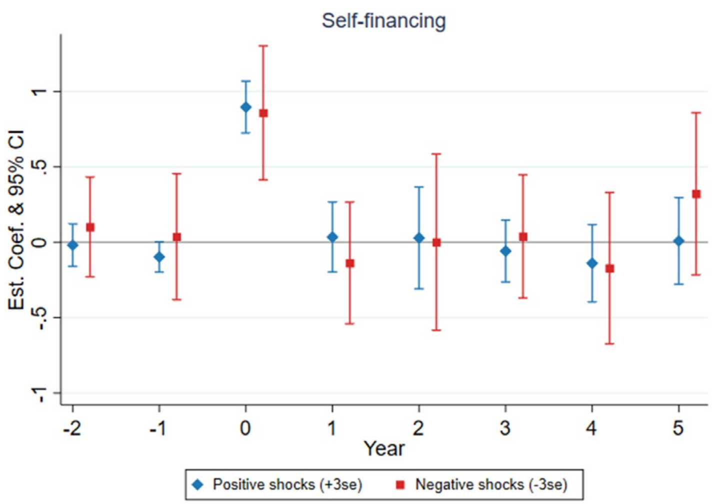
Figure 5 shows that there are essentially no significant pre- and post-treatment effects, neither in positive nor in negative shocks. The results show clear patterns in accordance with the smoothing hypothesis. Alternative specifications, as reported in Online Appendix OA.4, do not challenge these results.

7.5 Robustness checks

In what follows, we investigate the robustness of our baseline results by a) excluding outlier municipalities in terms of *IPGT* receipts and b) redefining shocks as variation situating outside of ± 4 and ± 5 standard errors from the kernel smoother.

7.5.1 Excluding outlier municipalities with systematically low property gains tax receipts

It is important to remember that our shock measures are conceptually asymmetric: While positive shocks have no upper limit, negative shocks have a lower bound at zero (no transactions take place). In this robustness exercise, we exclude 23



Timing	t - 2	t - 1	t	t + 1	t + 2	t + 3	t + 4	t + 5
Significance tests: p-values								
positive vs. regular	0.12	0.53	0.27	0.75	0.02	0.65	0.63	0.00
negative vs. regular	0.45	0.34	0.78	0.63	0.18	0.53	0.95	0.78
positive vs. negative	0.43	0.53	0.84	0.31	0.87	0.53	0.87	0.09
F-tests of joint significance (L1-L4): p-values								
positive vs. regular				0.04				
negative vs. regular				0.31				
positive vs. negative				0.81				

Fig. 5 Effect of *IPGT* shocks on municipal self-financing. *Notes*: This figure reports the coefficients of the impact of positive as well as negative shocks of the immovable property gains tax (*IPGT*) on the current balance net of pure accounting transactions (self-financing) from the estimation of a distributed lag model according to a variant of Eq. 1. This specification defines shocks as variation situating outside ± 3 standard errors around a kernel smoother. The 95% confidence intervals around the point estimates test against the null hypothesis of coefficients not being significantly different from zero (perfect smoothing). Standard errors are clustered at the municipal level. The reported significance tests below the graph report p-values of t-tests and joint significance F-tests for lags 1 to 4 when testing either shock against regular flows or against the opposite shock

municipalities which collect systematically only very minor receipts from the *IPGT* and are situated in the lowest decile.

Tax receipts The mechanical impact on total tax receipts in Fig. 6 is virtually identical to the baseline results in Fig. 2.

Current expenditures The results on current expenditures reported in Fig. 6 are qualitatively very similar to the baseline in Fig. 3. For positive shocks, there are two marginally significant effects in t and $t+1$ of similar magnitude as in the baseline. Negative shocks have somewhat smaller coefficient sizes and feature even larger standard errors.

Self-financing The results in Fig. 6 are robust and virtually identical to those including these outlier municipalities in the baseline in Fig. 5.

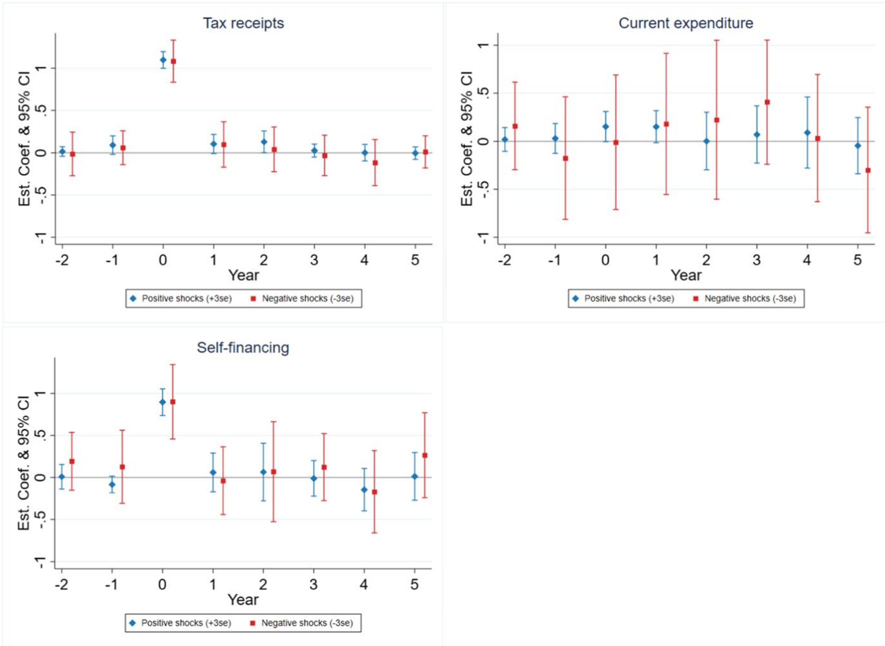


Fig. 6 Excluding negative outlier municipalities. *Notes*: These figures report the coefficients of the impact of positive as well as negative shocks of the immovable property gains tax (*IPGT*) on total tax receipts, current expenditures as well as self-financing from the estimation of a distributed lag model according to a variant of Eq. 1. These specifications define shocks as variation situating outside ± 3 standard errors around a kernel smoother. The 95% confidence intervals around the point estimates test against the null hypothesis of coefficients not being significantly different from zero (perfect smoothing). Standard errors are clustered at the municipal level. These results exclude 23 outlier municipalities with only very minor tax receipts for the *IPGT* (lowest decile)

7.5.2 Alternative shock thresholds

The threshold defining a fiscal shock (± 3 standard errors beyond the smoother) was chosen rather arbitrarily. As robustness checks we conduct the same estimations with shocks defined as deviations of ± 4 and ± 5 standard errors beyond the smoother. These definitions are even more restrictive, and fluctuations must be even more extreme to qualify as a shock, which leaves us with many fewer observations.

Figure 7 presents the results using two different definitions of what consists of a shock: ± 4 standard errors and ± 5 standard errors beyond the kernel smoother (including again negative outlier municipalities). Overall, the picture remains qualitatively similar to the baseline, as we cannot credibly reject smoothing. As can be seen from the estimations on tax receipts (panels A and B), these specifications can replicate the underlying mechanical relationship reasonably well. With respect to current expenditures, the results are less robust and we observe results close to zero

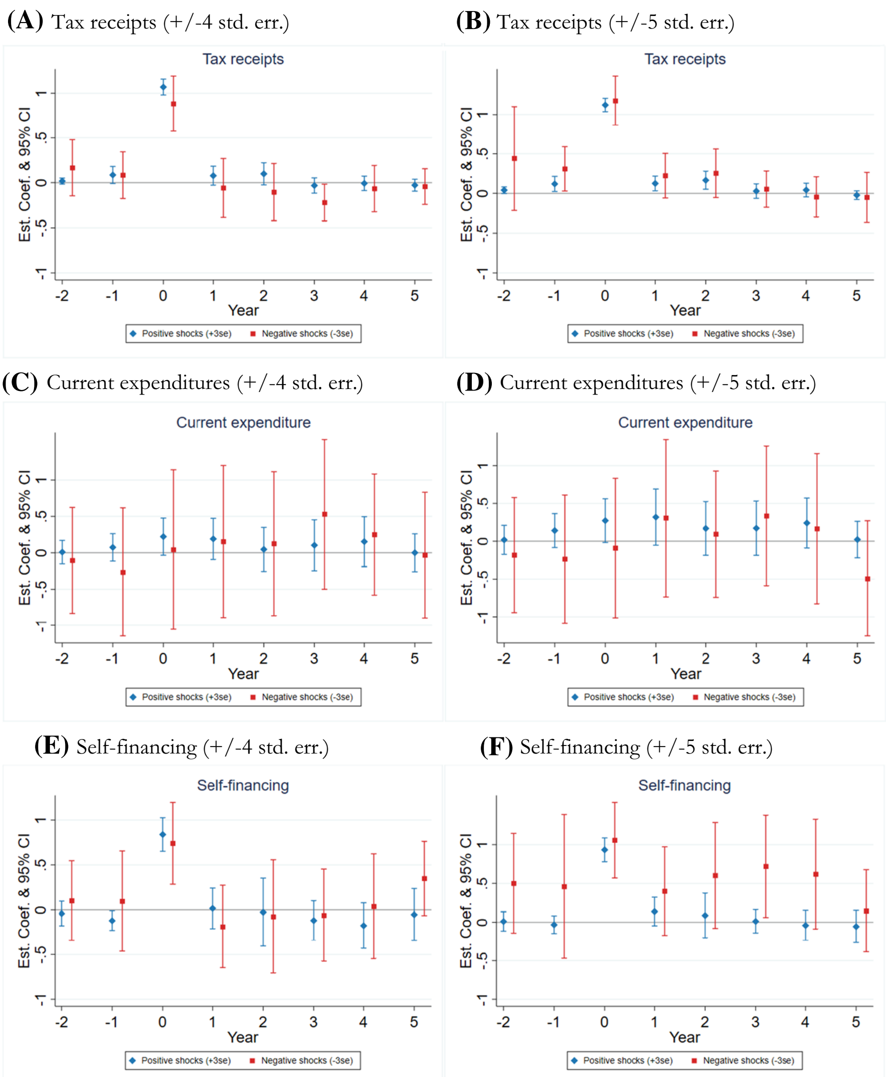


Fig. 7 Impact of *IPGT* shocks under alternative shock definitions. *Notes*: These figures report the coefficients of the impact of regular flows, positive as well as negative shocks of the immovable property gains tax (*IPGT*) on total tax receipts, current expenditures as well as self-financing from the estimation of a distributed lag model according to a variant of Eq. 1. These specifications define shocks as variation situating outside ±4 or 5 standard errors around a kernel smoother. The 95% confidence intervals around the point estimates test against the null hypothesis of coefficients not being significantly different from zero (perfect smoothing). Standard errors are clustered at the municipal level

for negative shocks, although the confidence intervals remain very large and point estimates are not statistically significant (panels C and D). Positive shocks are once more not significantly correlated with current expenditures. The results pertaining to self-financing are less robust when focusing on the definition of ±5 standard errors around the smoother, where negative shocks show larger coefficients but remain typically insignificant (panels E and F). Overall, we cannot credibly reject the null hypothesis of smoothing of *IPGT* shocks.

7.6 Interpretation

What is the global picture of evidence with respect to our formulated hypotheses? Overall, we find predominant evidence in line with the smoothing hypothesis of shocks. The few significant deviations from the smoothing hypothesis occur with positive shocks in t and $t+1$, but they remain small and are not robust to alternative shock definitions. In case of the impact of negative shocks on current expenditures, standard errors are very large and, hence, confidence intervals typically include zero. The point estimates are not robust to changes in shock definitions. When focusing on self-financing, we find again consistent evidence for the smoothing hypothesis for the standard shock definitions relying on ± 3 standard errors, while alternative shock definitions affect point estimates, but once more, results cannot credibly reject the smoothing hypothesis.

Taken all together, we conclude that the fiscal reaction to unexpected immovable property gains tax receipt (*IPGT*) shocks in the municipalities of the canton of Zurich is predominantly characterized by *fiscal smoothing*.

8 Conclusion

Understanding and identifying fiscal behavior of public decision-makers is a daunting task. It requires disentangling underlying political and private incentives from a multitude of endogenous economic and policy factors. In this paper, we take advantage of variation in the immovable property gains tax (*IPGT*), a very volatile source of fiscal revenue in the municipalities of the canton of Zurich. These revenue streams typically vary within a predicted window around a municipality-specific trend, but, from time to time, create budget shocks. These shocks result in short-term shifts (positive or negative) of the municipal budget constraint and provide policymakers the opportunity and justification to use their ad hoc political slack to deviate from the budgeted resource allocation in the discretionary part of the budget. Hence, we aim to estimate the effect of fiscal revenue shocks on the spending behavior of local policymakers.

In order to attempt to identify causal effects, we employ causal machine learning techniques. Our post-double LASSO variable selection estimates show that, on average, policymakers in the municipalities of the canton of Zurich tend to *smooth* fiscal shocks. If any, only minor parts of positive tax shocks are allocated to increases in current expenditures in t and $t+1$. The impact of negative shocks is noisier. The confidence intervals are large and typically include zero, while point estimates are not very robust to changes in the shock definition. Overall, the evidence points toward predominant smoothing behavior.

Our results are, thus, inconsistent with a politico-economic hypothesis. This result is in some contrast to the international literature finding widespread evidence for more or less pronounced deficit biases (see, e.g., Alesina & Passalacqua, 2016; Yared, 2019), and it is in stark contrast to a companion paper (Berset & Schelker, 2020) studying a very salient and highly mediatized fiscal shock in the same municipalities during an overlapping time period. Due to the IPO of Glencore on the London Stock Exchange in 2011, municipalities received, on average, a positive fiscal windfall of about CHF 1 million through the cantonal fiscal equalization scheme in 2013. Our causal estimates show that the windfall resulted in large increases in current expenditures (mostly due to expenses for public employees, and subsidies to private individuals) and persistent tax cuts, and caused an increase in municipal debt of about 7.5 times the initial windfall over a period of 5 years before our data end.

One way to reconcile the obvious differences in fiscal behavior could be that different forces are at play: On the one hand, transitory revenue shocks from the immovable property gains tax appear on a regular basis, have to be expected, can be positive as well as negative, originate from and affect a municipality's own tax base, and do not cause much media attention. On the other hand, the Glencore shock was truly exceptional, entirely positive and clearly non-recurring. Moreover, it originated from the tax base of another municipality and affected municipalities through the fiscal equalization scheme, while creating an enormous amount of media attention. The different characteristics of the shocks (Glencore: one-off positive *versus IPGT*: positive and negative and potentially recurring) and the difference in the salience of the shock might have caused very different reactions and pressures from relevant interest groups. The origin and specificities of fiscal shocks seem to matter greatly.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10797-022-09727-z.

Acknowledgements We thank the Statistisches Amt and the Gemeindeamt of the canton of Zurich for answering our numerous questions efficiently as well as for their invaluable help in our data collection. Special thanks go to Nadine Riedel, the editor, for her valuable guidance throughout the reviewing process. We thank two anonymous reviewers for their comments. Critical feedback and discussions that strongly improved the manuscript were provided by Reiner Eichenberger, Sonia Paty, and Christoph Schaltegger as well as participants of the Research Seminar of the University of Basel, the Annual Congress of the European Economic Association (EEA), the International Institute of Public Finance (IIPF), the Swiss Workshop on Local Public Finance and Regional Economics, the workshop of the Swiss Network on Public Economics (SNoPE) at ETH Zurich, the Political Economy and Development Workshop of the University of Zurich, the Ski & Research Workshop of the University of Fribourg, and the Assistentenkonferenz in Innsbruck.

Funding Open access funding provided by University of Fribourg.

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