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Application of Granger Causality Tests to Revenue and Expenditure of Swiss cantons

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Summary

This paper applies Granger causality tests to Swiss Cantonal Revenue and Expenditure in levels. It is the first study for Switzerland at the individual regional level and on the basis of vector error correction models distinguishing between long-term and short-term causality. The long-term relation observed either extends from revenue to expenditure, extends from expenditure to revenue, is non-existent or mutual depending on the canton. This confirms the unsuitability of performing the analysis at the aggregate level (all cantons) and shows that policy implications on deficit control and theoretical explanations of public sector growth differ according to the causality observed.

Keywords: [1]
- Local budget and expenditure – H72
- Budget systems and institutional requirements – H61
- Deficit – H62
- Multiple equation model – C32

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[1] The keywords comply with the system of classification of the Journal of Economic Literature – JEL.

1. Introduction

The control of deficits and debt has been a major challenge for governments in Switzerland and in other countries for a number of years. Various measures, in particular measures of an institutional nature, have been proposed or introduced in an attempt to contain budget deficits. While some of these measures focus on expenditure (e.g. linear reductions, curbs on spending etc.), others target revenue (automatic increase of tax pressure in case of excessive deficits etc.).

In an attempt to provide guidance to decision makers on the choice of preventive or corrective measures, many studies have tried to establish whether revenue influences expenditure. More generally, they analyse the existence of a relation between revenue and expenditure as well as the direction of the relation, i.e. whether it goes from revenue to expenditure or vice versa.[2] In addition to the objective of stabilizing public finances, the identification of the direction of causality between revenue and expenditure provides an empirical basis for research aimed at explaining the development of the public sector.[3]

The main aim of this article is to analyse the relationship between revenue and expenditure for Swiss cantons. To do this, we first estimate a bivariate model of revenue and expenditure and then carry out Granger causality tests. This study is the first to do this at the individual cantonal level and on the basis of vector error correction models that can identify long-term influences between revenue and expenditure as well as short-term fluctuations.

Section 2, which follows this introduction, recalls the concept of Granger causality as well as various practical and theoretical elements that support the hypothesis that a relation exists between revenue and expenditure. Section 3 presents and comments on the results of application of the Granger causality tests to the revenue and expenditure of Swiss cantons. Finally, the lessons that can be drawn from the study's findings and its limits are discussed in Section 4.

2. The relation between revenue and expenditure

The concept of Granger causality

If revenue can be better explained on the basis of past revenue and past expenditure than on the basis of past revenue alone, a causal relationship exists from expenditure to revenue according to Granger (1969).

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2 If this relation extends from the revenue to expenditure, a deficit can be more effectively reduced by adjusting expenditure than by adjusting revenue as an increase in revenue would trigger an increase in expenditure and, therefore, not lead to a reduction of deficits in subsequent periods.

3 The theories that explain this development in terms of a growth in the demand for public services and of the behaviour of members of the political-administrative system imply that there is a relation extending from expenditure to revenue, while the theories concerning the development of the public sector are based on fiscal illusion which implies an inverse relationship.

Formally, the different possible Granger causal relations between revenue (T) and expenditure (G) in levels can be expressed using the parameters of equations (1) and (2) which form a vector autoregressive system:[4]

$$T_t = \sum_{i=1}^{\infty} \alpha_i T_{t-i} + \sum_{i=0}^{\infty} \beta_i G_{t-i} + \varepsilon_t \qquad (1)$$

$$G_t = \sum_{i=1}^{\infty} \gamma_i G_{t-i} + \sum_{i=0}^{\infty} \delta_i T_{t-i} + v_t \qquad (2)$$

Thus there is Granger causality from expenditure to revenue if $\beta_i \neq 0$ and $\delta_i = 0 \; \forall \; i$. Similarly, there is causality from revenue to expenditure if $\beta_i = 0$ and $\delta_i \neq 0 \; \forall \; i$. The causality is considered as mutual if $\beta_i \neq 0$ and $\delta_i \neq 0 \; \forall \; i$. Finally, there is no link between revenue and expenditure if $\delta_i = 0$ and $\beta_i = 0 \; \forall \; i$.

Thanks to the recent developments in econometric theory in the area of non-stationary time series, the models used to carry out the joint tests of significance of the coefficients of lagged revenues and expenditures have evolved. We now know that autoregressive models (generally referred to as VAR models, i.e. vector autoregressive models) in levels are specified for stationary series and that autoregressive models of variables rendered stationary are appropriate for integrated series of order greater than 0 and series that are not co-integrated. This development took place in three stages in the empirical literature on public finance: 1) The first stage involved the estimation of autoregressive models for revenue and expenditure in levels; 2) The second stage involved the estimation of autoregressive models in differences or in terms of growth, based on the observation that these series were integrated of the first order; 3) Finally, error correction models were estimated on the basis of the observation that these series were co-integrated. It is also known that error correction models (generally referred to as VEC models, i.e. vector error correction models) are suitable for integrated series of an order greater than 0 and co-integrated (Engle & Granger 1987). Following the example of Miller & Russek (1990), numerous authors have argued that if revenue and expenditure were co-integrated, it would be possible to reach the erroneous conclusion that there is no relationship between revenue and expenditure if we only examine the coefficients of lagged variables in differences, while, in reality, there could be a long-term relation between revenue and expenditure. Formally, this amounts to the interpretation of the "significance" of the coefficients associated with the error correction terms (ψ and ϕ) in the error correction model formed by equations (3) and (4) as proof of the existence of a long-term relation between revenue (T) and expenditure (G):

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[4] Equations 1 and 2 form a simultaneous system if there is a link between revenue and expenditure of the same period, or if the coefficients β_0 and λ_0 are not zero.

$$\Delta T_t = \sum_{i=1}^{q} \alpha_i \Delta T_{t-i} + \sum_{i=1}^{q} \beta_i \Delta G_{t-i} + \psi u_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta G_t = \sum_{i=1}^{q} \gamma_i \Delta G_{t-i} + \sum_{i=1}^{q} \delta_i \Delta T_{t-i} + \phi u_{t-1} + \nu_t \quad (4)$$

with u_{t-1} originating from the stationary relation $u_t = T_t - \lambda G_t$.

Analysis of the budgetary process

Before presenting the budgetary process from the short and long-term perspectives, we would like to stress that the two strands of the principle of universality imply that revenue and expenditure should be included in the budget without any link between them.[5] Despite this, the way in which the budget is constructed and hence implemented implies a link between revenue and expenditure, both from the static and the intertemporal perspective. This link arises from the legal obligation for governments to balance their budgets and/or accounts.[6] As a result, the debit side must be balanced with the credit side. Apart from the legal obligation to balance the budget, the incompressible interest payments (Teulon 1997) imposes a certain rigour on the governments as the latter must adjust their revenue and expenditure so as to ensure that the interest payments they incur does not assume excessive proportions.[7]

Static analysis

Traditionally, the first stage of the budgetary process involves the prediction of the growth of the economy from spring onwards and, therefore, the prediction of the evolution of State revenue. In Switzerland, this tricky task is accomplished by the departments of finance which establishes deficit limits for the various departments on this basis and asks them to submit their budget requests. Given that, as a rule, the consolidation of the various line departments' requests results in a level of expenditure that exceeds the projected revenue, a process of negotiation takes place for the purpose of reducing the budget requests (Potter & Diamond 1999, Delalay 1999). Thus, within the strict framework of the budgetary process, the expected revenue restricts the volume of expenditure.[8]

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5 On the one hand, the principle of not-earmarking the revenue should enable the parliament to freely allocate public money to the tasks it deems necessary while, on the other, the gross budget principle is intended to ensure that the requested sums cannot be presented net of expected revenue.

6 With the exception of AI (for a list of the acronyms denoting the Swiss cantons, see Annex I), all the Swiss cantons have set themselves the legally or constitutionally defined task of ensuring long-term financial security (Novaresi 2001).

7 The constraint resulting from of the importance of interest payments is probably heightened by the risk that a government will end up being forced to borrow to pay it and thus run the risk of entering into a spiral of debt.

8 This constraint is all the more restrictive due to the governments' wish to achieve fiscal equilibrium or come as close to it as possible. In the absence of such a wish, the anticipated revenue would not impose any constraint on expenditure. However, such a relaxation of the rules could not last indefinitely due to the almost universal legal obligation for the governments to balance their budgets and the burden of interest payments.

Examination of the legal provisions governing the passing of the budget (by parliament) confirms that while budget appropriations are not subject to referendum in Switzerland, certain tax propositions are.[9] In fact, apart from the borrowing requirement, only a few propositions relating to the tax burden may be subject to a referendum. These propositions essentially concern the taxe rate.[10] Thus, even if some expenditure is based on a logic that is (fully or partly) intrinsic to it,[11] the influence of budgetary constraint combined with the possibility for citizens to limit the margin of revenue means that revenue is most likely to restrict expenditure. As a result, the estimation of revenue based on predicted economic growth and the tax system in force would appear to predetermine the volume of budgeted spending in the short term.

Dynamic analysis

By examining budget implementation in a broader temporal framework, we can highlight a number of different theories on the nature of the relation between revenue and expenditure. These theories generally involve approaches that explain the underlying evolution of revenue, on the one hand, and/or approaches that describe the tactical use of revenue and/or expenditure, on the other.[12]

The explanation of a relation extending from revenue to expenditure rests on the observation that economic growth gives rise to an increase in taxable income and enables governments to increase the resources at their disposal without increasing the tax burden. Thus, the population would fall prey to fiscal illusion if it were to only consider the tax burden and not the total amount of tax paid. Based on relative reasoning, the population would not therefore demand a reduction in the tax burden which would compensate for the absolute increase in revenue due to the revenue effect (Oates 1975). Once these additional resources have been acquired, the governments would naturally proceed with additional spending (based on the demands of the citizen-taxpayers).[13] The observation of a positive causal link extending from revenue to expenditure could also be explained in terms of the capacity of right-wing regimes to adopt an

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[9] Expenditure is actually subject to democratic control to the extent that Swiss citizens have the right to launch popular initiatives and legislative and fiscal referendums.

[10] The acronyms for the cantons referred to in the text are explained in Annex I.
Based on the status of the legislation in 2003 (Bureau d'information fiscale 2003, p.10), a referendum is mandatory on the tax rate in the canton of GL, BL, TI and VS. Parliament's decisions may be subject to an optional referendum in seven cantons (OW, ZG, SH, VD, NE, BS and NW). If the tax rate is increased to a level that exceeds a limit set by the law, a referendum is mandatory in the cantons of UR, SO, AI and AG, but optional in the cantons of BE, LU and FR. If the tax rate will exceed the previous year's level, a referendum is mandatory in the canton of GE. In some cantons, the people are not consulted at all, i.e. ZH, SZ, AR, SG, TG, JU, GR.

[11] For example, salaries develop spontaneously partly as a result of the effects of the progressive aging of the population on the pension annuities and health systems.

[12] The "tactical use" of revenue or expenditure occurs when an interest group tends to use revenue to influence expenditure (or vice versa) for the purpose of promoting its interests.

[13] Of course, this explanation does not exclude the possibility of specific interest groups (in particular those mentioned in footnote 15) taking the opportunity of fulfilling their demands by channelling public spending into particular sectors.

"empty coffers" policy (Guex 1998). This policy is based on the theory that any surplus enables the financing of superfluous expenditure (Friedman 1978: 12) and deems it necessary to maintain deficits by cutting taxes.[14] It is important to note, however, that Buchanan & Wagner (1977 and 1978) claim – on the contrary – that a reduction in revenue triggers an increase in expenditure. According to these authors, the population falls prey to a form of fiscal illusion and would perceive the decrease in revenue as a reduction in the price of public services. As a result, it would increase its demands for public services which would in turn have the effect of increasing public expenditure.[15]

Yet another potential sequence of events could point to a relation extending from expenditure to revenue. Various groups (i.e. civil servants,[(a)] the entire political establishment,[(b)] individual political parties,[(c)] etc.) prefer to finance additional public spending primarily through borrowing as a first step.[16] Once the expenditure has been permanently established, the need to tackle the deficits would then trigger an increase in the tax burden. Another explanation could be found in the application of the recommendation of tax smoothing as formulated by Barro (1979) which has a positive impact beyond its normative value (Holsey & Borcherding 1997). Tax smoothing involves initial borrowing in exceptional circumstances followed by the gradual repayment of the ensuing debt with the help of a small increase in taxes as opposed to a significant temporary increase in the tax burden. The aim of this smoothing is to minimize the surplus tax burden as this increases with the rates of taxation.[17]

Various models based on the theory of the median voter (in particular those developed by Musgrave 1966 and Meltzer & Richard 1981) predict that revenue and expenditure vary simultaneously. Thus, in this case, the relation between them would be mutual: the governments would adapt their services to meet the demand expressed by a population which compares the marginal benefit of each service with its marginal cost. The theory of the displacement effect offers another possible explanation in this context. According to this theory, which was formulated by Peacock & Wisemann (1979), taxpayers resist an increase in the tax burden and

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14 This kind of sequence would appear to be similar to the fly paper effect in the theory of fiscal federalism. According to this theory, when governments receive transfers they increase their expenditure instead of repaying all or part of the sums received to its taxpayers in the form of tax cuts (Oates 1979).

15 While the previous sequence involved the increase in revenue followed by an increase in expenditure, this one involves a reduction in revenue followed by a reduction in expenditure.

16 This kind of explanation could only be applied in the case of short-term influences as a reduction in revenue accompanied by an increase in expenditure would trigger increasing deficits. However, this kind of development would not be able to take place in reality due to the aforementioned budgetary constraints (first paragraph of the section concerned with the analysis of the budgetary process) and to the refusal that lenders would not hesitate to issue when they consider the accumulated debt to be excessive.

(a) According to Niskanen (1971), bureaucrats try to maximize their budgets so as to increase the power at their disposal. Thus, they will always exhaust any surpluses that may arise.

(b) According to Olson (1965), all elected representatives try to ensure their re-election. Thus, they will always take advantage of any surpluses to increase spending and thus win new voters.

(c) For example, the parties of the Left, which attach a greater role to the State than the other parties, try to avail of every opportunity to increase public spending (Friedman 1978).

the demand for new services remains latent. In exceptional situations (e.g. wars, economic crises etc.) taxpayers will accept a simultaneous increase in services and taxes.[18]

According to Darrat (1998), different authors, including Widavsky (1988), predict that the level of revenue and of expenditure can be defined independently (thus, in this case there would be no relation between revenue and expenditure): expenditure would be defined on the basis of the requirements expressed by the population and revenue would depend on the maximum tax burden tolerated by the population. As a result, the achievement of fiscal equlibrium would be merely a matter of luck.[19]

Finally, it is also important to mention some other approaches that do not have any clear implications in terms of the relation between revenue and expenditure, but also allow us to explain the development of the State.[20] Wagner's theories (1893) deserve a particular mention because they are compatible with all of the relations presented (except the zero relation), depending on whether the influence that the first approach predicts on revenue manifests itself before, during or after that on expenditure. These theories are: 1) The industrialization process made it possible for populations to acquire wealth. This acquisition of wealth translated into stronger growth in the demand for public services. 2) The industrialization process is reflected in a complexification of societies which made greater intervention on the part of the State necessary. 3) In order to continue (or manifest itself), this process necessitated the creation of infrastructure that is too expensive to be provided by the private sector.

Empirical contributions

Although there are numerous empirical contributions on the application of Granger causality tests to public revenue and expenditure at the international level (in particular in the USA), a real lack exists in terms of its application to the governments at the regional/cantonal level in Switzerland.[21] In fact, there are only three studies on this topic, all of which undertake the estimation of autoregressive models intended to explain the differences between the logarithms

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17 For an illustration of this point, cf. Weber (1997).

18 A variant of this theory predicts that expenditure will increase in response to the crisis and that revenue will follow this increase. The main difference between this theory and the tax-smoothing approach is that it predicts that after the crisis, expenditure will stabilize above its initial underlying level.

19 Moreover, according to Baghestani & McNown (1994), Buchanan & Wagner (1977) confirm that there is no reason why revenue or expenditure adjust to each other unless a legal provision exists that aims to re-establish a balance between them.

20 The results obtained in our study do not enable us to comment on the veracity of Baumol's (1967) theory as it has no implications in terms of the relation between revenue and expenditure. For the purpose of developing his theory, Baumol places himself in a world consisting of two production factors, i.e. capital and labour. He then suggests that public sector activities are more demanding in terms of labour than private sector activities. Thus, activities that are demanding in terms of capital would benefit from greater gains in productivity than other (i.e. public) activities. As a result, over time, the proportion of public expenditure in the economy would tend to increase.

21 For a review of the literature on these empirical contributions, cf. Darrat (1998) and/or Ross & Payne (1998).

of revenue and expenditure at the aggregate level; all the series in question were found to be stationary.

In his study, Ram (1988) analyses eleven developed countries, including the Swiss Confederation, for the period 1968-1986 and does not identify any causal link (in the sense of Granger) between revenue and expenditure. The same applies for Joulfaian & Mookerjee (1990) who analyse revenue and expenditure for all of the Swiss cantons and municipalities for the period 1960-1986. In addition to significance tests, Manzini & Zarin-Nejadan (1995) also apply the procedure for the Granger causality test suggested by Hsiao (1979) to the revenue and expenditure of the Swiss Confederation, the Swiss governments put together, the cantons put together and the municipalities put together, for the period 1950-1992.[22] These authors detect a weak relation extending from revenue to expenditure at the aggregate level. Unlike Ram (1988), they confirm the existence of a strong relation extending from revenue to expenditure for the Swiss Confederation (with a slight feedback) and detect a weak causal link extending from revenue to expenditure at both the cantonal and the municipal levels.[23] The general conclusion drawn from these observations is that revenue gives rise to expenditure in Switzerland.

It is entirely understandable that Manzini & Zarin-Nejadan only observe a strong relation in the case of the Confederation. In fact, the decisions on revenue and expenditure are taken at the level of individual governments and not at the aggregate level (i.e. the entire country, all cantons or all municipalities). Based on this and given the level of autonomy enjoyed by the governments in question, i.e. the Swiss cantons, it can only be expected that the relation between revenue and expenditure will differ from one canton to the next. For this reason, it makes sense to analyse each canton individually rather putting the cantons together as a group.

3. Empirical application

Variables and data studied

The studies dealing with the Swiss governments focus on the analysis of the differences between nominal logarithmized series. As far as our study is concerned, the basic explained variables are expressed in levels and in real per capita terms. Moreover, like Joulfaian & Mookerjee (1990) and Manzini & Zarin-Nejadan (1995), we examine the revenue and expenditure net of transfers paid by the Confederation.

The choice of explained variables is justified by the decision-making structure studied. In our view, the governments are concerned with both the relative and absolute variations of revenue and expenditure, whether in nominal or real terms. Nevertheless, given that the norm of fiscal

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[22] This procedure is not suitable for systems of equations.
[23] The relation is inverse for the municipalities if a lag of 1 is used.

equilibrium relates to the level of revenue and expenditure, the analysis of these quantities in levels is preferable to their analysis in terms of growth.[24] Because the governments take the expected level of inflation into account in their decision-making and because the amount of actual revenue and expenditure depends on inflation, we analyse the series in real rather than nominal terms. Moreover, given that the transfers paid by the Confederation are under its control, we subtracted them from the cantonal revenue and expenditure.[25]

The dataset on which the construction of our variables is based are published by the Federal Finance Administration (FFA) and the Federal Statistical Office (FSO). To be more precise, we used the FFA's series of cantonal revenue and expenditure for the period 1973 to 2002 as well as the series relating to the transfers paid to the cantons by the Confederation for the period 1977 to 2002. The FSO data relates to the population.[26] In fact, before subtracting the transfers from revenue and expenditure and deflating them by the consumer price index published by the FSO (2002 = 1), we adjusted these series on the basis of particular events that had a significant impact on revenue and/or expenditure.[27]

In the presentation of results, we focus on those arising from the use of real series minus transfers and adjusted for the impact of the aforementioned events for the period 1977 to 2002 (series 1). However, the tables also contain the results obtained for the period 1977 to 2002 from the same series minus transfers but *not* adjusted for the impact of particular events (series 2),

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[24] If one considers that it is more important to analyse the rate of growth of revenue and expenditure, one might as well analyse these growth rates rather than the serial differences in logarithmic form as many authors do under the pretext that such differences provide a good approximation of growth rates.

[25] Furthermore, this argument explains why all of the transfers received by the cantons should not be subtracted. These transfers also include both non-associated revenue (i.e. revenue whose allocation is controlled by the cantons) and the cantons' share of the direct federal taxes.
The subtraction of these transfers eliminates the breaks in these series arising from investments associated with national roads: the latter have a serious impact on the evolution of the series for cantonal revenue and expenditure (in particular those of the small cantons).

[26] We use the series relating to the permanent resident population of the cantons at year end.

[27] Our adjustments actually make it possible to take the direct impact of the events in question into account. By direct impact we mean that only the effects of these events have been adjusted as it is not possible to simulate how the cantons would have behaved (before, during and after) if these events had not taken place and that it is very difficult to simulate the financial influences of these adjustments.
Thus, the revenue were adjusted to eliminate the direct influence of the privatization of the cantonal bank of AR in 1996 (CHF 180 million, which represents over 57% of the canton's revenue; in each case the percentages are expressed as a function of the adjusted levels), the conversion of the cantonal bank of SG into a public limited company in 2000 (CHF 500 million, 16%) and privatization of the same bank in 2001 (CHF 160 million, 5%) and again two exceptional bequests in TI in 1988 (6%) and in 1994 (almost 5%).
Similarly, the expenditure was adjusted to neutralize the direct effects of the capitalization of the Genevan cantonal bank in 1993 (CHF 147 million, over 2.5%), the transformation of the cantonal bank of St Gallen into a public limited company in 2000 (CHF 255 million expenditure, over 8.5%), the bankruptcy of the cantonal bank of SO in 1996 (CHF 34 million, 2.7%), in 1997 (CHF 34 million, over 2.5%) and in 1998 (CHF 125 million, 9%), the recapitalization of the cantonal bank of JU in 1997 (CHF 42 million, 7.5%) and the termination in 1994 of the special construction programme in the canton of JU dating from 1985 whose smoothing was planned over 25 years (CHF 41 million, almost 9%). Furthermore, the expenditure series were adjusted on the basis of complementary services provided to the pensions and invalidity insurance schemes (Assurances vieillesse et survivants (AVS) and Assurance invalidité (AI)) by BE in 1986 (CHF 242 million, over 6%), the unexplained CHF 36 million break (6%; deviation from the linear interpolation between 1984 and 1986) in the series for Jura's expenditure clearly evident in 1985 following the subtraction of transfers, the costs that arose in Valais due to the storms of 2001 (over CHF 175 million, or almost 8.5%) as well as the re-establishment of hydro-electric power stations at a cost of CHF 100 million (almost 5%).

series for the period 1973 to 2002 that *include* transfers and are adjusted for the impact of particular events (series 3) and, finally, series for the period 1973 to 2000 that *include* transfers but are *not* adjusted for particular events (series 4).[28]

Unit Root and Co-integration Tests

The unit root tests carried out indicate that all of the series are first-order integrated. This corresponds to the general observations on revenue and expenditure in the empirical studies.[29] Without going into the results provided in Annex II in detail, it can be said that the revenue and expenditure for the majority of cantons do not emerge as being co-integrated on the basis of Johansen's (1988) method.[30] In addition to the fact that these series generally emerge as co-integrated for the other governments, in our view revenue and expenditure can only constitute co-integrated series due to the constraint imposed by the norm of fiscal equilibrium. In fact, the existence of this norm prevents revenue from departing from expenditure in any significant or permanent way. This is why we also observe (graphically) that revenue and expenditure tend to follow each other along sufficiently extended temporal horizons even in cases in which cointegration is statistically rejected. Finally, the enormous sensitivity of tests to the length of the period examined (with integration in certain intervals and no integration in others) prompts us to admit co-integration and use error correction modelling.

Results

We adopt the following convention in both the text and the tables of results: The symbol "----" indicates that no relation has been observed between revenue and expenditure. An arrow pointing to the right (→) signifies the existence of a relation extending from revenue to expenditure and the opposite is indicated by an arrow pointing to the left (←). The bi-directional arrow (↔) indicates the existence of a mutual relation between revenue and expenditure for the canton in question.

Table 1 contains the results of estimation of our error correction models for the four series considered. We would like to stress from the outset that the conclusions with respect to the relation between revenue and expenditure sometimes vary on the basis of the lag length. Given that no model with more than one lag includes lagged variables (revenue or expenditure) whose

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[28] The canton of Jura was created in 1979 as a result of the division of the canton of Bern. Surprisingly, the series for Bern do not show a marked break for this year. Thus, the analysis of the data on the canton of Bern is carried out for the same period as the other cantons and that on the data for Jura is carried out for the period 1979-2002.

[29] Knowing that the unit root tests do not all give the same results and do not always give the right results (Maddala 2001), we carried out different tests as well as graphical checks. The only stationary series identified were those for Jura that included transfers. In fact, according to the Phillips-Perron (1988) test for lags ranging from 1 to 3, all of the series are integrated to the first order. The same applies to the Dickey-Fuller (1979) test. As opposed to this, in the case of the Dickey-Fuller test augmented for lags of 1 or 2, various series sometimes emerge as being integrated to the second order.

[30] The same applies to the tests carried out using the method developed by Engle & Granger (1987).
All of the results used in this study were generated using commands available for STATA 8.2, with the specific exception of the results of the Engle & Granger tests which were generated using TSP 4.5.

coefficients are significantly different from 0, we only retained models with either one lag (i.e. with a short term effect and a long term effect) or no lag (i.e. with a long-term effect only). On each occasion, we selected the model minimizing the Akaike information criterion.[31]

In terms of series 1, the model without a lag is chosen for 16 cantons, which amounts to a zero short-term relation between revenue and expenditure for these cantons. Thus, the table indicates the existence of a short-term relation in only nine cases. With the exception of BS where it is the opposite, in all cases, the relation extends from revenue to expenditure.[32] Regarding the long-term effect, there is no relation between revenue and expenditure for the cantons of BE, OW, BS, BL, SH, SG and TG.[33] As opposed to this, the relation extends from revenue to expenditure for ZH, UR, SZ, NW, FR, SO, AI, GR, AG, VD, VS, NE and GE and from expenditure to revenue for the cantons of LU, GL, ZG and JU. The relation is mutual for the cantons of AR and TI. In the case of the total series (i.e. without subtraction of the transfers), the cantons of UR, SZ, NW and SO move from the group of cantons for which a relation extending from revenue to expenditure is observed to that for which there is no relation. The cantons of BE and TG follow the opposite course ($\rightarrow$ instead of ----). The results for the cantons of ZG ($\leftarrow$ or $\leftrightarrow$ rather than $\rightarrow$) and JU ($\rightarrow$ instead of $\leftarrow$) also change here. Moreover, failure to adjust the series for the impact of particular events only changes the observations made for AR ($\leftarrow$ instead of $\leftrightarrow$) and SG ($\leftarrow$ instead of ----). As opposed to this, the failure to do it for the series including the transfers has an impact for the cantons of BE and SG (---- instead of $\leftarrow$), UR ($\leftarrow$ instead of ----), SO ($\rightarrow$ instead of ----) and AR ($\leftrightarrow$ instead of $\leftarrow$). Even if it comes down to one canton, it is remarkable to observe that the results coincide for a majority of cantons (14 as opposed to 12 cantons) when one considers all of the series. Thus, the relation extends from revenue to expenditure for ZH, FR, AI, GE, AG, VD, NE and GE, while it extends from expenditure to revenue for LU and GL and is zero for OW, BS, BL and SH. Furthermore, it is possible to note a quasi convergence of the results for BE, SO and VS ($\rightarrow$ with the exception of series 3 ----) as well as for TI ($\rightarrow$ with the exception of series 1 $\leftrightarrow$). In summary, when we consider all of the results or merely the convergent ones, it is impossible not to note a tendency for revenue to influence expenditure.[34]

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[31] This criterion is defined as follows: -2(ML/T)+2p/T, with "ML" being the maximum of likelihood, "T" the number of observations and "p" the number of parameters estimated.

[32] The acronyms used to denote the cantons are listed in Annex I.

[33] In fact, the long-term relation observed for the models with only one lag changes in exceptional cases as compared with that observed for a zero lag. Thus, for series 1, this relation would be zero for BL and JU and inverse for AI. For series 2, it would be zero for JU. For series 3, it would be inverse for AI and zero for JU. For series 4, it would be zero for SO.

[34] If one considers the results for all cantons put together, it is possible to observe a relation extending from revenue to expenditure in the long term in every case (the influence observed for series 4 is mutual).
It is interesting to note that this tendency becomes even more marked if one considers that in four cases (out of 74) the validity of the observation according to which expenditure influences revenue is doubtful. This doubt arises because in these cases the sign of the estimated coefficient differs from that which would have been

Table 1
Error correction models: the relation mainly extends from revenue to expenditure

	Real series minus transfers and adjusted, from 1977 to 2002, series (1)		Real series minus transfers and not adjusted, from 1977 to 2002, series (2)		Real series including transfers and adjusted, from 1973 to 2002, series (3)		Real series including transfers and not adjusted, from 1973 t0 2002, series (4)	
	Short term	Long term	Short term	Long term	Short term	Long term	Short term	Long term
Zurich	X	→**	Same		X	→**	Same	
Bern	X	----	X	----	X	←*	X	----
Lucerne	X	←*	Same		←**	←**	Same	
Uri	→**	→**	X	→**	X	----	←*	←**, ↔*
Schwyz	→**	→**	Same		X	----	Same	
Obwalden	X	----	Same		X	----	Same	
Nidwalden	----	→**, ↔*	Same		X	----	Same	
Glarus	X	←**	Same		X	←**	Same	
Zug	X	←**	Same		X	→**, ↔*	Same	
Freiburg	X	→**	Same		X	→**	Same	
Solothurn	→**	→**	→**	→**	X	----	←*	→**
Basel-Stadt	←*	----	Same		⇐*	----	Same	
Basel-Landschaft	→*	----	Same		X	---	Same	
Schaffhausen	X	----	Same		X	----	Same	
Appenzell A.Rh.	X	↔**	←**	←**	X	↔**	X	←**
Appenzell I.Rh.	→**, ↔*	→**	Same		→**, ←*	→**	Same	
St Gallen	X	----	----	←**	X	---	X	←**
Graubünden	X	→**	Same		X	→*	Same	
Aargau	X	→**	Same		X	→**	Same	
Thurgau	X	----	Same		X	←**	Same	
Ticino	→**	↔**	----	→**	X	→**	----	→**
Vaud	X	→**	Same		X	→**	Same	
Valais	X	→*	----	→**	X	----	----	→**
Neuchâtel	→*	→**	Same		----	→**	Same	
Geneva	X	→**	----	→**	----	→**	----	→**
Jura (a)	→**	←*	----	←*	←*	→**	----	→**
All cantons	→*	→**	X	→**	←*	→**	X	↔**

X indicates that the model does not contain a short-term relation.
---- indicates that there is no relation between revenue and expenditure.
→ indicates that there is a relation extending from revenue to expenditure.
← indicates that there is a relation extending from expenditure to revenue.
↔ indicates that there is a mutual relation between revenue and expenditure.
* indicates that the coefficient is not zero at the 95% significance level.
** indicates that the coefficient is not zero at the 99% significance level.
Same indicates that there is no adjustment for the canton in question. Thus, the result is identical to that obtained for the 'adjusted' series.
(a) Analysis for the period 1979-2002 (cf. note 287).

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expected. If these relations were to be considered as invalid, the series 1 results for NW would be →** rather than →** and ↔*; →** instead of ↔** for TI; and ---- instead of ←* for Jura. In the case of series 4, the result for all of the cantons would be →** instead of ↔**.

For the purpose of comparison, we also carried out an analysis of the growth rates of real revenue and expenditure. Given that these series are stationary for all of the cantons, we estimated autoregressive models. Inasmuch as studying the differences between revenue and expenditure does not mean entirely the same thing as studying variables in levels, we preferred to model the growth rates so as to be able to compare the results with those from the existing studies dealing with the Swiss cantons. As was the case with method used for the error correction models, we limited our tests to models with and without a lag. If Akaike's criterion were followed, models with one lag for revenue and expenditure would always be adopted in the equations for revenue and expenditure. However, a closer scrutiny of these models reveals that for the four or five variants for which the Akaike criterion is the smallest, the values are very close to each other.[35] It should also be noted that the coefficients of lagged values of the explained variable are often not significant. Hence we opted to estimate all the models and bring out in Table 2 the relation that emerges from the results obtained. This process is substantiated in Annex III which comments on three typical examples: one example for which the relation is unequivocal, one for which it is not unequivocal but still clear and one for which it is uncertain.

[35] If the selection of lags for a variable is restricted to 0 and 1, 16 variants may be constructed on the basis of equations (1) and (2). Among these variants, 12 allow the application of a Granger causality test. These systems are explained in Annex II.

Table 2:
Autoregressive models for the growth rates of revenue and expenditure

	Real series minus transfers and adjusted, series 1	Real series minus transfers and not adjusted, series 2	Real series including transfers and adjusted, series 3	Real series including transfers and not adjusted, series 4
Zurich	←	Same	----/ ?	Same
Bern	---- u	----	----	----/ ?
Lucerne	----	Same	----/←	Same
Uri	→ u	----	----/ ?	----/ ?
Schwyz	---- u	Same	---- u	Same
Obwalden	---- u	Same	---- u	Same
Nidwalden	----	Same	←	Same
Glarus	---- u	Same	----	Same
Zug	---- u	Same	----u	Same
Freiburg	---- u	Same	----/←	Same
Solothurn	----	----/→	---- u	----/←
Basel-Stadt	----	Same	----/ ?	Same
Basel-Landschaft	---- u	Same	----/←	Same
Schaffhausen	---- u	Same	---- u	Same
Appenzell A.Rh.	----	---- u	----	---- u
Appenzell I.Rh.	----/?	Same	----	Same
St Gallen	----	----/→	----/ ?	----/→
Graubünden	---- u	Same	---- u	Same
Aargau	↔	Same	→ u	Same
Thurgau	---- u	Same	---- u	Same
Ticino	----/?	---- u	----	---- u
Vaud	----/?	Same	----/ ?	Same
Valais	→ u	----/←	---- u	---- u
Neuchâtel	---- u	Same	----/ ?	Same
Geneva	→ u	→ u	→	→ u
Jura (a)	----	---- u	----/ ?	----/ ?
All cantons	----/←	←/----	----/←	----/←

----	indicates that there is no relation between revenue and expenditure.
→	indicates that there is a relation extending from revenue to expenditure.
←	indicates that there is a relation extending from expenditure to revenue.
↔	indicates that there is a mutual relation between revenue and expenditure.
Same	indicates that there is no adjustment for the canton in question. Thus, the result is identical to that obtained for the 'adjusted' series.
/	indicates the alternative to the result judged as most probable.
u	indicates that all of the tests carried out result in an unequivocal relation between revenue and expenditure.
(a)	indicates that the analysis applies to the period 1979-2002 (cf. footnote 28).
?	indicates that it is difficult to comment on the existence or direction of the relation.

In the vast majority of cases, the tests carried out point to the absence of a relation between the growth rates of revenue and expenditure. At most, one can say, by examining the first column, that there is a relationship extending from revenue to expenditure for the cantons of UR, VS and GE. In addition to this, a mutual relation is observed for AG and a relation extending from expenditure to revenue is observed for ZH. The results for the other series differ very little from those obtained for series 1. In the case of the real adjusted series, there is no relation for ZH and

VS (as opposed to → in series 1), the relation extends from revenue to expenditure for AG (as opposed to ↔ in series 1) and from expenditure to revenue for NW (as opposed to ---- in series 1).

When the aggregate values for all the cantons are considered as a whole, our results tend to demonstrate that there is no relation between revenue and expenditure. This observation coincides with the general observation made above. It should be stressed, that on the basis of the variants examined an alternative to the zero relation could emerge and that, contrary to our expectations, this relation would extend from expenditure to revenue. In our view, this last point expresses the importance of carrying out the analysis at an individual level (here cantonal) as opposed to the aggregate level (here all cantons together). If a relation extending from expenditure to revenue coincides with the outcomes observed for ZH and AG (a mutual relation which includes the relation mentioned), it contradicts entirely the outcomes observed for UR, VS, GE (→) and partially for AG (↔ which includes →). This finding can probably be explained by the relative importance of Zurich's financial standing.

The conclusions drawn from the autoregressive models for UR, AG, GE and VS coincide with those drawn from the error correction models which demonstrate a relation extending from revenue to expenditure (this is also the case for AG as a ↔ relation also includes a → relation). Similarly, the results agree regarding the absence of a relation for OW, BS, BL and SH (irrespective of the series considered) and for BE, SG and TG when series 1 is considered. As opposed to this, the results observed for the other cantons do not tally. That is, a causal relation is confirmed with the error correction models while no relation is confirmed with the autoregressive models.[36] This may be explained by the fact that the error correction models include long-term relations while the autoregressive models only estimate short-term relations.

Finally, it should be noted that the above conclusions, which are based on the estimations of autoregressive models of growth rates (i.e. no relation between the growth rates of revenue and expenditure), agree with the conclusions reached by Ram (1988) and by Joulfaian & Mookerjee (1990). However, they contradict the findings of Manzini & Zarin-Nejadan (1995) for whom there is a relation extending from the growth rates of revenue to those of expenditure. It should be noted, however, that their estimations are based on aggregate series.

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[36] The opposite applies for NW (series 3). For the canton of ZH (series 1) and all of the cantons (series 2), → is observed with the error correction model while ← emerges with the autoregressive model.

4. Conclusion

While the few existing studies dealing with the relationship between revenue and expenditure for Swiss cantons apply the Granger causality test to the growth rates of revenue and expenditure for all cantons put together (aggregate level),[37] we present theoretical elements in support of the hypothesis that it is more relevant to place the analysis 1) at the level of individual cantons (individual level) and 2) for expenditure and revenue *in levels* rather than growth rates. In fact, we observe that, depending on the canton, the long-term relation can be zero, can extend from revenue to expenditure, can extend from expenditure to revenue or can be mutual. This confirms that the best level for analysis is that of the individual governments and not the aggregate level as the latter does not have the necessary refinement to allow for such a diversity in behaviour.

In our view it makes more sense to analyse revenue and expenditure in levels as in the vast majority of cases (63 out of 74) we observe that there is no relation between the growth rates of revenue and expenditure. However, this observation that there is no relation between revenue and expenditure would appear to pose a conceptual difficulty.[38] This is why we consider that the fact that we detect a relation on 55 occasions (out of 74) on the basis of estimated error correction models (incorporating a relationship in levels) as a validation of our arguments or at least as proof of the importance of analysing revenue and expenditure in levels.

If we stick with the notion that a long-term relationship between revenue and expenditure necessarily exists, then an explanation must be found for the fact that, based on the test results, there appears to be no relation between revenue and expenditure in 19 cases (out of 74). One reason for this finding probably lies in the relatively short duration of the period studied: on the one hand, the low number of observations increases the risk of incorrectly concluding that one variable does not influence another (or making type II error) and, on the other hand, imbalances assume a more important relative significance in a short period than in a long one. As a result, we would expect that an analysis based on a longer period would result in a stronger confirmation of a long-term relation between revenue and expenditure.[39]

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[37] They actually apply it to the differences in revenue and differences in expenditure in logarithmic form.

[38] On the one hand, the constraints imposed by the norm of fiscal equilibrium and the irreducible nature of expenditure and debt servicing explain why permanent and extensive deficits cannot persist indefinitely. Thus, measures such as increasing revenue and/or reducing expenditure are implemented in the case of deficits. On the other hand, the constraint imposed by the different actors involved in the process of the production of public services, among whom the citizen-taxpayers feature most prominently, explains why the governments reduce their revenue and/or increase their spending in the case of repeated and significant surpluses.

[39] *A priori*, a long-term relation exists between two cointegrated series. Thus, it is highly probable that by extending the period studied, a conclusion that supports the co-integration of revenue and expenditure would be reached. It should be noted, however, that depending on the period studied, these series sometimes emerge as cointegrated and sometimes not. This observation makes it possible to foresee the possibility that revenue and expenditure do not emerge as cointegrated following standard co-integration tests even if longer periods were considered.

Obviously, the implications with regard to fiscal equilibrium and the theoretical explanation of the growth of the public sector depend on the direction of the relation observed between revenue and expenditure. Thus, they may vary from one canton to another. Here it is worth examining the implications that can be derived for governments for whom the relation extends from revenue to expenditure given that this is the one most frequently encountered.

From the point of view of fiscal equilibrium, governments can reduce their deficits more efficiently by reducing expenditure than by increasing revenue. In fact, for these governments an increase in revenue would also give rise to an increase in expenditure and thus a smaller reduction in their deficits than that which would have been achieved with an equivalent reduction in spending. We stress that this observation is based, of course, on the hypothesis that the fiscal behaviour observed for governments still involves a relation extending from revenue to expenditure in the future. Such a hypothesis would not appear to be excessive, however, given that only a significant change in behaviour would lead to a change in the direction of the relation observed.

Regarding the size of the State, according to Mueller (1977), it is not possible to explain the differences observed on the basis of just one theory. We believe that the same is true of the cantons. More precisely, we believe that a combination of explanations exists for each canton and that among these explanations it is equally possible to find some involving a relation extending from revenue to expenditure as others arguing for a relation in the opposite direction. Obviously, the direction of the relation actually observed for a government reveals the relative weight of explanations that go in one direction as opposed to the other.

Thus, for the governments for which the relation extends from revenue to expenditure, the direction of the relation is probably mainly explained by the sequence proposed by Oates (1975) according to which expenditure increases following a rise in revenue due to economic growth. It should be said that this is the only theory that predicts a positive relation extending from revenue to expenditure apart from that proposed by Guex (1998) according to which right-wing regimes manage to reduce revenue so as to create deficits and then legitimize reductions in expenditure.[40] Now the revenue and expenditure of all cantons grew during the periods studied irrespective of the political inclination of the government.[41] As a result, this last theory which predicts a reduction in revenue and expenditure cannot apply. Nonetheless, the fact that the

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However, it seems unlikely to us that these series would not emerge as cointegrated following some form of non-linear co-integration that are currently being analysed such as threshold cointegration.

[40] It is not impossible that one or more explanations yet to be found could provide a better justification of the direction of the observed relation.

[41] In terms of both revenue and expenditure, the growth observed in all cantons is significant, with the exception of BS, whose revenue and expenditure grew by a factor ranging from 1.22 to 1.30 depending on the series studied, and UR, whose revenue and expenditure remain stable if series 3 and 4 are considered (factors ranging between 1.02 and 1.06, as compared with factors of between 1.60 and 1.70 for series 1 and 2).

relation extends from revenue to expenditure does not exclude the possibility of pressure groups succeeding in influencing the process of the allocation of supplementary revenue so as to satisfy their interests. Neither does it exclude the fact that right-wing regimes managed to slow down the growth in public spending by tackling revenue. Finally, there are other approaches that provide explanations for the development of the State, which cannot be tested using the analyses carried out in this study. These include those proposed by Wagner (1893) which are compatible with all of the relations presented (with the exception of the zero relation) and that proposed by Baumol (1967) which has no implications in terms of the relation between revenue and expenditure.

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Annex I

Table 3
Acronyms used to denote the Swiss cantons

canton	Acronym
Zurich	ZH
Bern	BE
Lucerne	LU
Uri	UR
Schwyz	SZ
Obwalden	OW
Nidwalden	NW
Glarus	GL
Zug	ZG
Freiburg	FR
Solothurn	SO
Basel-Stadt	BS
Basel-Landschaft	BL
Schaffhausen	SH
Appenzell A.Rh.	AR
Appenzell I.Rh.	AI
St Gallen	SG
Graubünden	GR
Aargau	AG
Thurgau	TG
Ticino	TI
Vaud	VD
Valais	VS
Neuchâtel	NE
Geneva	GE
Jura	JU

Annex II

Table 4
Series that are mostly unexpectedly non-cointegrated

	Real series minus transfers and adjusted, from 1977 to 2002, series (1)	Real series minus transfers and not adjusted, from 1977 to 2002, series (2)	Real series including transfers and adjusted, from 1973 to 2002, series (3)	Real series including transfers and not adjusted, from 1973 t0 2002, series (4)
Zurich	Nc	Same	C1	Same
Bern	Nc	Nc	Nc	Nc
Lucerne	C1	Same	C1	Same
Uri	Nc	Nc	C1	C1
Schwyz	C1	Same	C1	Same
Obwalden	Nc	Same	Nc	Same
Nidwalden	Nc	Same	Nc	Same
Glarus	C1	Same	C1	Same
Zug	Nc	Same	Nc	Same
Freiburg	Nc	Same	Nc	Same
Solothurn	Nc	Nc	C1	C1
Basel-Stadt	Nc	Same	Nc	Same
Basel-Landschaft	C1	Same	C1	Same
Schaffhausen	C1	Same	Nc	Same
Appenzell A.Rh.	C1	C1	C1	C1
Appenzell I.Rh.	C1	Same	C1	Same
St Gallen	C1	Nc	C1	C1
Graubünden	Nc	Same	Nc	Same
Aargau	C1	Same	C1	Same
Thurgau	Nc	Same	Nc	Same
Ticino	Nc	Nc	Nc	Nc
Vaud	Nc	Same	Nc	Same
Valais	Nc	Nc	C1	C1
Neuchâtel	Nc	Same	Nc	Same
Geneva	Nc	Nc	Nc	Nc
Jura (a)	C1	Nc	C1	C1

(a) indicates that the analysis applies to the period 1979-2002 (cf. footnote 28).
Same indicates that there is no adjustment for the canton in question. Thus, the result is identical to that obtained for the 'adjusted' series.
C1 cointegrated of order (1,1)
Nc not cointegrated

Annex III

Three cases are presented below so as to substantiate the procedure adopted to assess the direction of the relations between the growth rates of revenue and expenditure. These cases all result from the application of autoregressive models to the growth rates of revenue and expenditure minus transfers and adjusted. They were selected on the basis of the order in which they appear in Table 2. Thus, UR is the first canton for which the conclusion on the existence and direction of the relation is unequivocal, ZH is the first canton for which this conclusion is not unequivocal but clear and AR the first for which the decision is uncertain.

If the choice of lags for each variable is limited to 0 and 1, 16 combinations may be constructed based on the system composed of equations (1) and (2). These systems can be identified using different designations, ranging from eqR00eqE00 to eqR11eqE11. "eqR" refers to the equation for the revenue (equation (1)) and "eqE" the equation for expenditure (equation (2)). The first number in these designations indicates the number of lags taken by the revenue and the second indicates that taken by the expenditure. Tables 4 to 6 present the results of Granger tests for the 12 systems for which it is possible to carry out this test. In each case, the column on the right gives the different relations that can exist between revenue and expenditure. For example, for the system eqR00eqE10, it is possible to observe that there is no relation (----) or that there is a relation extending from revenue to expenditure (→).

Note:

/	indicates the alternative to the result judged as most probable.
?	indicates that it is difficult to comment on the existence or direction of the relation.
*	indicates that the coefficient is not zero at the 95% confidence level.
**	indicates that the coefficient is not zero at the 99% confidence level.
u	indicates that all of the tests carried out result in an unequivocal relation between revenue and expenditure.

Table 5 :
Tests for Uri , an unequivocal conclusion

System estimated	Relation	Possible relations
eqR00eqE10	→**	---- / →
eqR00eqE11	→**	---- / →
eqR01eqE00	----	---- / ←
eqR01eqE01	----	---- / ←
eqR01eqE10	→**	---- / → / ←/ ↔
eqR01eqE11	→**	---- / → / ←/ ↔
eqR10eqE10	→**	---- / →
eqR10eqE11	→**	---- / →
eqR11eqE00	----	---- / ←
eqR11eqE01	----	---- / ←
eqR11eqE10	→**	---- / → / ←/ ↔
eqR11eqE11	→**	---- / → / ←/ ↔
Conclusion	**→ u**	---- / → / ←/ ↔

The conclusion is considered as unequivocal because the relation always extends in the same direction and it is always significant at the 5% level.

Table 6 :
Tests for Zurich, a clear conclusion

System estimated	Relation	Possible relations
eqR00eqE10	----	---- / →
eqR00eqE11	----	---- / →
eqR01eqE00	←*	---- / ←
eqR01eqE01	←*	---- / ←
eqR01eqE10	←*	---- / → / ←/ ↔
eqR01eqE11	←*	---- / → / ←/ ↔
eqR10eqE10	----	---- / →
eqR10eqE11	----	---- / →
eqR11eqE00	←*	---- / ←
eqR11eqE01	←*	---- / ←
eqR11eqE10	←*	---- / → / ←/ ↔
eqR11eqE11	←**	---- / → / ←/ ↔
Conclusion	←	

This case is considered as clear because the relation observed always goes in the same direction. It is not considered as unequivocal because the majority of the relations are only significant at the 10% level.

Table 7
Tests for Appenzell I.Rh., an uncertain conclusion

System estimated	Relation	Possible relations
eqR00eqE10	→**	---- / →
eqR00eqE11	----	---- / →
eqR01eqE00	----	---- / ←
eqR01eqE01	----	---- / ←
eqR01eqE10	→**	---- / → / ←/ ↔
eqR01eqE11	---	---- / → / ←/ ↔
eqR10eqE10	→**	---- / →
eqR10eqE11	→**	---- / →
eqR11eqE00	←**	---- / ←
eqR11eqE01	----	---- / ←
eqR11eqE10	**↔**	---- / → / ←/ ↔
eqR11eqE11	↔	---- / → / ←/ ↔
Conclusion	**---- / ?**	---- / → / ←/ ↔