Has Sweden’s government budget policy been too discretionary? Evidence from a generalization of the tax smoothing hypothesis

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Abstract
Barro's (1979) tax smoothing hypothesis (TSH) assumes that the government is always subject to an "optimal" degree of discretion in budget policy, i.e., optimal in the sense that the welfare costs from taxation are minimized. This paper proposes a generalization of the TSH that relaxes this crucial assumption. Postwar evidence for Sweden indicates that in contrast to the TSH, the generalized model provides close to a perfect fit: Tax smoothing behavior in combination with *more* discretion in budget policy relative to what is optimal, can explain all shifts in the central government's budget balance, including the dramatic shifts during the period 1970-96.

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1. Introduction

As noted by Jonung (2000, p. 3), “The stabilisation policy record of Sweden during the period 1970-1995 is unique. No other OECD-country experimented with as many policy switches or policy reversals as Sweden or did it so drastically.” During this period, there were no restrictions on the budget policy, and the Swedish budget balance displayed the largest volatility of all the OECD countries. There were several examples of extreme “tighten and loosen the belt” policies. For instance, the late 1970s was characterized by drastically growing budget deficits as a result of an expansionary fiscal policy aimed at “bridging over” the economic downturn that followed from the first oil price shock. By contrast, in the late 1980s, following a period of high growth and fiscal consolidation, the government ran large budget surpluses. In fact, each year during the period 1987-89, the government had one of the largest budget surpluses in the OECD. But then, once again, the situation changed drastically. In the early 1990s, a severe economic crisis and a major tax reform resulted in growing budget deficits, and in 1993, the central government displayed its largest budget deficit ever. In just four years, Sweden went from having the OECD’s strongest government finances to having the weakest. The Swedish government then adopted one of the strictest programs of fiscal consolidation in the OECD. Just a few years later, the budget was back into a surplus where it remained for the rest of the 1990s.

The purpose of this paper is to propose a generalization of Barro’s (1979) tax smoothing hypothesis (TSH) and then empirically test whether it can explain the shifts in the Swedish central government’s budget balance during recent decades. According to the TSH, it can be optimal for a government to run budget surpluses as well as deficits as long as they are justified by future expectations of changes in government expenditure. In its basic form, the TSH implies that when a government expects a future increase in its expenditure, it increases the tax rate today and runs a budget surplus. Conversely, when the government expects a future decrease in expenditure, it lowers the tax rate today and runs a budget deficit. The rationale for this behavior is that the government wishes to smooth the tax rate over time in order to minimize the implied distortionary welfare costs from taxation. As a consequence, when the TSH is true, the expected tax rate is constant over time, or, put in more formal terms, the tax rate follows a martingale.

Huang and Lin (1993) and Ghosh (1995) draw on research done by Campbell (1987) and Campbell and Shiller (1987) in order to explore a useful property of the TSH: By means of a vector autoregression (VAR) for government expenditure and the budget surplus, it is possible to calculate a predicted time path of the budget surplus that, given the validity of the TSH, is optimal for the government to pursue. The optimal budget surplus time series can then be compared to the actual budget surplus time series in order to visually evaluate the fit and the economic significance of the model. If the model is true, the two series should be identical. In addition, the theoretical properties of the TSH translate into cross-equation restrictions on the VAR, and standard statistical testing is therefore easily implemented to formally test the validity of the hypothesis.

Empirical evidence for the TSH is mixed. Huang and Lin (1993) apply a log-linear version of the model to the United States for the period 1929-88. For the full sample period, the TSH is rejected, but it is not rejected for the period 1947-88.[1] Ghosh (1995) applies the model to Canada and the United States for the periods 1962-88 and 1961-88 respectively, and the TSH cannot be rejected for either country. Olekalns (1997) rejects the TSH when applied to Australian data for the period 1964/65 to 1994/95. The TSH has also been applied to a couple of developing countries in Asia (see Cashin et al., 1998, 1999), and here also, evidence is mixed.[2]

A striking feature of the TSH is that it implicitly assumes that the government's

[1] According to Huang and Lin, the rejection for the full sample period is due to sharp differences in the statistical properties of the data rather than the invalidity of the hypothesis itself.

[2] The same goes for several studies on U.S. data, including Barro (1981) and Sahasakul (1986), that, in contrast to the VAR approach, test the TSH by evaluating the martingale property of the tax rate.

budget policy is always subject to an "optimal" degree of discretion, i.e., optimal in the sense that the welfare costs from taxation are minimized. But given the nature of the budget-making process, it is difficult to imagine that this assumption generally holds. It is often argued that not only expectations about future government expenditure, but also politico-institutional factors such as budgetary institutions and budget laws, are crucial to understanding budget deficits and fiscal policy (Alesina and Perotti, 1995). For instance, Olekalns (1997) finds that the actual Australian budget surplus fluctuates more than its optimal counterpart and argues that "fiscal policy has been too volatile to be consistent with optimal tax smoothing." However, in general, because the model implies that several hypotheses are tested jointly, it is not possible to attribute model failure specifically to the deviation from the optimal degree of discretion without having relaxed this assumption in the first place.

To overcome this shortcoming, this paper proposes a generalization of the TSH that allows for degrees of discretion in budget policy that can differ from the degree that is optimal according to the TSH. As such, the proposed *generalized* tax smoothing hypothesis (GTSH) should be regarded as a specific alternative to the TSH.[3] It is assumed that a specific degree of discretion in budget policy translates into a specific constraint on the government's borrowing and lending capabilities. The constraint can either be stricter or softer than the constraint that corresponds to the degree of borrowing and lending that is optimal according to the TSH. A government that is restricted to sticking very closely to a balanced budget rule does not have much discretion in budget policy, i.e., it is restricted in its borrowing and lending. By contrast, a government with much discretion in budget policy can usually borrow and lend with few restrictions, and can therefore deviate from the balanced budget rule to any extent that it wishes. However, maintaining the assumption of at least some degree of tax smoothing behavior implies that for a government with much discretion, there will be no bias toward letting a budget deficit grow forever.

[3] The inspiration for the GTSH is drawn from Flavin (1993) who applies the analogous generalization to the theory of individual consumption smoothing behavior.

More specifically, regardless of the degree of discretion, under the assumption of tax smoothing behavior, budget policy implies a symmetrical view of the budget balance. For instance, just as a relatively discretionary budget policy implies a large budget deficit when government expenditure is expected to fall, it also implies a "tighten the belt" policy and a large budget surplus when expenditure is expected to rise.

This paper is organized as follows. Section 2 derives some basic results of the TSH and then shows how the model can be generalized in a way that allows for degrees of discretion in budget policy that can differ from the degree that is optimal according to the TSH, i.e., the GTSH. In Section 3, the empirical method for evaluating the model is outlined. Section 4 tests the TSH and the GTSH on Swedish central government data for the periods 1952-99 and 1970-96. Sweden appears to be an ideal candidate for comparing the TSH to the GTSH. A strong Keynesian tradition has resulted in many available policy instruments when implementing fiscal policy, especially before the budget law that took effect in 1997. Furthermore, so far there appears to be no study that has tested an economic hypothesis empirically in order to try to explain the shifts in Sweden's budget balance during the past decades.[4]

The empirical results presented in Section 4 indicate that for the full period 1952-99, it is not possible to statistically distinguish the GTSH from the TSH. However, for the subperiod 1970-96, the TSH is rejected while the GTSH is not. Visually, for both sample periods, the model when the GTSH is assumed provides close to a perfect fit as the predicted and actual path of the budget surpluses almost always coincide. Section 5 provides some concluding remarks.

[4] Jonung (1999, 2000) tries to explain Swedish stabilization policy during the period 1970-95 by viewing it as the result of a learning process among the politicians. He also recognizes that the theory of tax smoothing can be used to explain the budget policy record of Sweden during the same period, but he undertakes no formal theoretical or empirical analysis to verify it. Hansson and Hansson (2001) use Bohn's (1998) framework and annual data for the period 1885-1996 in order to test whether the debt-to-GDP ratio in Sweden and five other countries is stationary. For Sweden, it is only when they allow for a structural break in 1973 that the debt-to-GDP ratio is found to be stationary. They argue that their results provide "modest evidence in favor of the tax-smoothing hypothesis".

2. A generalization of the tax smoothing hypothesis

Consider first the basic version of the TSH as derived by Ghosh (1995). The government faces the dynamic budget constraint

$$D_{t+1} = (1+r)D_t + G_t - \tau_t Y_t, \tag{1}$$

where D_t is the stock of real government debt; G_t is real government expenditure; τ_t is the average tax rate; Y_t is real output; and r is the fixed real interest rate. If output grows at a fixed rate equal to n, the dynamic budget constraint can be expressed as

$$(1+n)d_{t+1} = (1+r)d_t + g_t - \tau_t, \tag{2}$$

where each lowercase letter denotes the ratio of the corresponding uppercase letter to output. In the model that follows, the ratio of government expenditure to output, g_t, is assumed to be exogenously given. For simplicity, g_t and d_t are hereafter referred to as government expenditure and debt, respectively. In a stochastic setting, the intertemporal budget constraint states that if a transversality condition on debt is imposed, the sum of the present discounted value of expected government expenditure and initial debt must equal the present discounted value of expected tax rates. That is, solving (2) forward, taking expectations and imposing the transversality condition

$$\lim_{T\to\infty} \left(\frac{1}{1+R}\right)^{T+1} E_t d_{t+T+1} = 0, \tag{3}$$

gives

$$\sum_{s=t}^{\infty} \left(\frac{1}{1+R}\right)^{s-t} E_t g_s + (1+r)d_t = \sum_{s=t}^{\infty} \left(\frac{1}{1+R}\right)^{s-t} E_t \tau_s, \tag{4}$$

where $R = (r-n)/(1+n)$ is the effective net interest rate faced by the government and $E_t = E(\cdot|I_t)$ is the expectations operator, conditional on the government's information set at time t, I_t.

The levying of taxes is assumed to impose distortionary costs such as collection costs and deadweight losses incurred when individuals substitute away from market work. Assuming that these costs are proportional to the square of the tax rate, the government's objective function is

$$V = -(1/2) \sum_{s=t}^{\infty} \beta^{s-t} E_t \tau_s^2 \qquad 0 < \beta < 1, \tag{5}$$

where β is the government's subjective discount rate. The problem is then to maximize (5) subject to (2) and (3). Assuming that $\beta = 1/(1+R)$, the Euler equation implies that for any $s > t$,

$$E_t \tau_s = \tau_t, \tag{6}$$

i.e., the tax rate follows a martingale, or stated less formally, a random walk. This is a first basic implication of the TSH, which has been tested in several empirical studies including those by Barro (1981) and Sahasakul (1986).

Although (6) neatly captures the notion of tax smoothing, there are several reasons for going beyond it (Campbell, 1987). First of all, the random walk of the tax rate can be the result of a political process that is unrelated to the tax smoothing objective. That is, it is possible that the tax rate follows a random walk yet does not satisfy the TSH. Another reason is that it is difficult to assess the economic significance of a statistical rejection of (6). A third reason is that there are useful time series properties that are not explored when focusing solely on (6). To overcome these shortcomings, Huang and Lin (1993) and Ghosh (1995), among others, apply Campbell's (1987) and Campbell and Shiller's (1987) VAR approach in order to explore and test *all* time series implications of the TSH. In short, the approach is to formulate the TSH as a statement about the *budget surplus,* as it takes into account the full structure of the model, and then use a VAR for government expenditure and the budget surplus to evaluate the implied restrictions. The same approach is used in this paper, and it allows us to assess both the statistical and economic significance of the model.

Using (6) in (4), the TSH can be written as

$$\tau_t = (r-n)d_t + \frac{R}{1+R}\sum_{s=t}^{\infty}\left(\frac{1}{1+R}\right)^{s-t} E_t g_s = g_t^P. \tag{7}$$

According to (7), the only martingale that satisfies the TSH is the martingale that sets the tax rate exactly equal to the annuity value of the sum of government debt and the present discounted value of expected government expenditure. Thus, the right hand side of (7) is the constant flow of expenditure that is expected to sustain for the remainder of the government's time horizon, i.e., it is the *permanent* government expenditure, g_t^P. Optimal budget policy would then imply to always equal the tax rate to permanent government expenditure.

Define the budget surplus as $sur_t = (1+n)(d_t - d_{t+1})$. The dynamic budget constraint (2) can then be rearranged such that

$$sur_t = \tau_t - (g_t + (r-n)d_t). \tag{8}$$

After substituting (7) into the right hand side of (8), the TSH can be stated as

$$\begin{aligned} sur_t &= \tau_t - (g_t + (r-n)d_t) \\ &= (r-n)d_t + \frac{R}{1+R}\sum_{s=t}^{\infty}\left(\frac{1}{1+R}\right)^{s-t} E_t g_s - (g_t + (r-n)d_t) \\ &= \frac{R}{1+R}\sum_{s=t}^{\infty}\left(\frac{1}{1+R}\right)^{s-t} E_t g_s - g_t \\ &= \sum_{s=t+1}^{\infty}\left(\frac{1}{1+R}\right)^{s-t} E_t \Delta g_s. \end{aligned} \tag{9}$$

Equation (9) states that when the TSH is true, optimal budget policy implies that the budget surplus is always set to equal the present discounted value of expected changes in government expenditure. Whenever expenditure is expected to increase, the government runs a budget surplus, i.e., it saves for "a rainy day" (Campbell, 1987). Conversely, when expenditure is expected to fall, the government runs a budget deficit.

Using (9), the TSH can now be restated as

$$\tau_t = g_t^{TOT} + \sum_{s=t+1}^{\infty} \left(\frac{1}{1+R} \right)^{s-t} E_t \Delta g_s, \tag{10}$$

where g_t^{TOT} is total government expenditure, i.e., the sum of current expenditure, g_t, and the effective interest payment on government debt, $(r-n)d_t$. In contrast to (6) and (7), (10) explicitly shows that whenever government expenditure is expected to rise, the tax rate increases above total government expenditure by the amount the government lends, i.e., by the amount of the budget surplus. Conversely, when government expenditure is expected to fall, the tax rate falls below total government expenditure by the amount that is borrowed, i.e., by the amount of the budget deficit.

Note that the budget surplus is always set *exactly* equal to the present discounted value of expected changes in government expenditure. As (6) shows, this is the amount needed to smooth the tax rate *perfectly* and, accordingly, it is the amount that minimizes the distortionary welfare costs from taxation. However, a more general and realistic tax setting scheme would be one that reflects the underlying wish of the government to smooth the tax rate *and* at the same time also recognizes that, given the nature of the budget making process, the government may be subject to a degree of discretion in budget policy that differs from the degree that is optimal according to the TSH. It seems natural to assume that a specific degree of discretion in budget policy translates into a specific constraint on the government's borrowing and lending capabilities. The constraint can either be stricter or softer than the constraint that corresponds to the TSH optimal degree of borrowing and lending.[5]

[5] As Alesina and Perotti (1995) point out, when considering whether to limit a government's degree of discretion in budget policy, one usually considers regulations that limit the ability to run budget deficits. However, note that for a tax smoothing government, the optimal constraint (rule) is symmetric in the sense that the inclination to borrow (and run a budget deficit) when an expected change in expenditure is negative is as large as the inclination to lend (and run a budget surplus) when the expected change is positive. Maintaining the assumption of tax smoothing

For instance, a government that has little discretion in budget policy cannot borrow or lend the full amount that is needed in order to smooth the tax rate perfectly. Put differently, a government that must stick close to a balanced budget rule is subject to a relatively strict borrowing and lending constraint. Then, an expected future decrease in government expenditure, say, cannot be accommodated by the full cut in the tax rate and, accordingly, by the full budget deficit that is necessary in order to minimize the welfare costs from taxation. Since the government wishes to smooth taxes, the tax rate will however be cut and the budget will show a deficit, but, due to the "partial" balanced budget rule, not by the full amount that is needed to smooth the tax rate perfectly. On the other hand, a government that has *more* discretion in budget policy relative to what is optimal according to the TSH, is subject to a relatively soft constraint on borrowing and lending. A relatively soft constraint can be a reflection of politico-institutional factors, such as weak budgetary institutions and weak budget laws, and it can open up for influence from interest groups with objectives other than optimal tax smoothing. As a result, given, say, an expected future decrease in government expenditure, a government with relatively much discretion can cut the tax rate by *more* and generate a larger budget deficit than a government that smooths the tax rate perfectly. Unfortunately, although both governments in this example have an underlying wish to smooth the tax rate, the TSH can capture neither the government that sticks close to a balanced budget rule, nor the government with more discretion in budget policy relative to what is optimal. The TSH can only capture the specific intermediate case of a government with a budget policy that is subject to an optimal degree of discretion, i.e., optimal in the sense that it minimizes the distortionary welfare costs from taxation.

In order to capture a tax smoothing government with a degree of discretion that can differ from the degree that is optimal according to the TSH, one needs

behavior, it is therefore natural to consider any other constraint as also being symmetric, i.e., as applying to *both* borrowing (budget deficits) and lending (budget surpluses) capabilities. Formally, the TSH's symmetric view of the budget balance follows from the transversality condition (3) that rules out overborrowing as well as oversaving.

a *specific* alternative to the TSH rather than the completely general alternative "any other behavior than that predicted by the TSH" (cf. Flavin, 1993). The alternative hypothesis should be a generalization along the particular dimension that allows for degrees of borrowing and lending that can differ from the degree that is optimal according to the TSH. To construct such an alternative, consider a linear combination of the balanced budget rule (no degree of discretion) in which $\tau_t = g_t^{TOT}$, and the optimal rule (the optimal degree of discretion) in which $\tau_t = g_t^P$. The *generalized* tax smoothing hypothesis (GTSH) can then be written as

$$\tau_t = (1 - \lambda) g_t^P + \lambda g_t^{TOT}, \tag{11}$$

where λ is an estimable parameter. Obviously, the GTSH incorporates both the balanced budget rule ($\lambda = 1$) and the optimal degree of discretion ($\lambda = 0$) as special cases. However, it should be emphasized that, under the assumption of tax smoothing behavior, one should not view both the optimal degree of discretion and the balanced budget rule as two polar cases. Intuitively, the balanced budget rule should be a polar case as it implies that there is no borrowing or lending whatsoever in response to expected future changes in government expenditure. By contrast, because the optimal degree of discretion just happens to reflect a situation where the amounts of borrowing and lending are just large enough to minimize the welfare costs from taxation, there is nothing that says that it should be a polar case. To formally verify these claims, use the definitions of permanent and total government expenditure and rewrite the GTSH (11) as

$$\tau_t = g_t^{TOT} + (1 - \lambda) \sum_{s=t+1}^{\infty} \left(\frac{1}{1+R} \right)^{s-t} E_t \Delta g_s. \tag{12}$$

Thus, when the GTSH is true, the budget surplus is given by

$$sur_t = (1 - \lambda) \sum_{s=t+1}^{\infty} \left(\frac{1}{1+R} \right)^{s-t} E_t \Delta g_s. \tag{13}$$

It follows directly from (13) that the assumption of tax smoothing behavior is *only* consistent with *any* value of λ that is less than unity. That is, whenever $\lambda < 1$, an expected increase in expenditure implies that the government increases the tax rate and runs a budget surplus; and an expected decrease in expenditure implies that the government cuts the tax rate and runs a budget deficit. By contrast, when $\lambda = 1$, there is no tax smoothing and the budget is always in balance. When $\lambda > 1$, an expected decrease in government expenditure, for example, implies a budget surplus. It is evident that *increasing* the tax rate and saving in response to an expected future expenditure *decrease* can never be consistent with at least some degree of tax smoothing behavior. Hence, under the assumption of tax smoothing behavior, an estimate of λ that is equal or larger than unity cannot be justified.

Equations (12) and (13) explicitly formalize the idea that a tax smoothing government may be subject to a degree of discretion in budget policy that differs from the degree that is optimal according to the TSH. Assume, for instance, that government expenditure is suddenly expected to decrease in the future so that the present discounted value of expected changes in expenditure becomes negative. From (12), regardless of the degree of discretion, tax smoothing behavior implies that the tax rate is cut and set below total government expenditure in order to generate a budget deficit. If the government has relatively little discretion in budget policy, it cannot implement the full cut in the tax rate that is needed in order to smooth the tax rate perfectly and minimize the distortionary welfare costs. Specifically, in (13), λ becomes positive in order to reflect the fraction of the optimal budget deficit that cannot be implemented due to the "partial" balanced budget rule. The less discretion in budget policy, the higher the λ, and the less the resulting budget deficit. In the extreme and borderline case of no discretion in budget policy, i.e., in the case of a balanced budget rule, $\lambda = 1$ and the government cannot cut and smooth the tax rate at all. By contrast, when $\lambda < 0$, the resulting budget deficit is larger than the budget deficit that would have occurred if the TSH had been true. That is, when government expenditure is expected to decrease, tax smoothing behavior in combination with more discretion in budget policy relative to what is optimal according to the TSH, lead to budget deficit overshooting. In this case, $-\lambda$ reflects the overshooting fraction of the budget deficit that is optimal according to the TSH.[6] If $\lambda = 0$, there is no overshooting of the optimal budget deficit and, thus, the result is the TSH. One can use analogous reasoning to conclude that an expected increase in government expenditure implies a relatively small budget surplus when $\lambda > 0$, and a relative large budget surplus when $\lambda < 0$.

Thus, in summary, the extent to which the degree of discretion in budget policy differs from the degree that is optimal according to the TSH, should be captured by λ. Specifically, λ is inversely related to the degree of discretion and has an upper bound equal to unity. In the benchmark TSH case, optimal discretion implies that $\lambda = 0$, because then the welfare costs from taxation are minimized. The interval $0 < \lambda < 1$ captures a government with less discretion (more rules) in budget policy relative to what is optimal according to the TSH.[7] By contrast, $\lambda < 0$ reflects a government with more discretion (less rules) in budget policy relative to what is optimal according to the TSH.

It should be emphasized that the case when λ takes on a value that is positive and less than unity does not necessarily reflect a government that in reality is bounded by more rules in budget policy than a government that is subject to an optimal degree of discretion. The reason is that it is theoretically possible for a government with much discretion to stick close to a balanced budget rule. Such a government, however, behaves *as if* it were bounded by relatively more rules in budget policy. In this sense, λ captures the *effective* degree of discretion for that government.

[6] That is, when $\lambda < 0$, $(1-\lambda)\sum_{s=t+1}^{\infty}\left(\frac{1}{1+R}\right)^{s-t} E_t \Delta g_s < \sum_{s=t+1}^{\infty}\left(\frac{1}{1+R}\right)^{s-t} E_t \Delta g_s < 0$, where $-\lambda > 0$ is the overshooting fraction of the optimal budget deficit.

[7] In their log-linear version of the model, Huang and Lin (1993) briefly formulate an alternative hypothesis that is analogous to the GTSH when $0 < \lambda < 1$. They evaluate this alternative by using preset values of λ. This paper goes further, as the next section shows how to obtain an estimate of λ.

By contrast, because a partially rule-bound government can never deviate from a balanced budget rule to any extent that it wishes, the case when $\lambda < 0$ can only reflect a government with more discretion relative to what is optimal according to the TSH.

Finally, it should be noted that the GTSH retains the symmetric view of the budget balance. For instance, a government with a relatively discretionary budget policy ($\lambda < 0$) generates a large budget deficit in response to an expected decrease in its expenditure, but it also implements a tough "tighten the belt" policy and generates a large budget surplus in response to an expected increase in its expenditure. Intuitively, then the budget surplus time series should be stationary. This and other time series properties of the model are discussed in the next section.

3. Empirical method

As pointed out by Campbell (1987), even though expectations about future expenditure is conditional on the government's information set, I_t, it is still possible for an econometrician with access to only a subset of I_t to calculate the predicted path of the budget surplus from (13). This is because the budget surplus itself contains all information about future changes in government expenditure that is superior to the econometrician. As a consequence, the budget surplus should Granger-cause changes in government expenditure. Hence, by incorporating the budget surplus and changes in expenditure in the econometrician's information set, H_t, (13) *can* be estimated and, as shown below, the GTSH can be tested taking the government's superior information into account. The predicted path of the budget surplus is

$$\begin{aligned} \widehat{sur}_t &= E(sur_t|H_t) = E\left\{E\left\{(1-\lambda)\sum_{s=t+1}^{\infty}\left(\frac{1}{1+R}\right)^{s-t}\Delta g_s\middle| I_t\right\}\middle| H_t\right\} \\ &= (1-\lambda)\sum_{s=t+1}^{\infty}\left(\frac{1}{1+R}\right)^{s-t} E(\Delta g_s|H_t), \end{aligned} \tag{14}$$

since $H_t \subseteq I_t$.

The GTSH formulated as a statement about the budget surplus reveals another important time series property. If government expenditure, g_t, contains a unit root, its first difference will be stationary. Accordingly, the budget surplus, sur_t, will be stationary because it is a linear combination of expected changes in expenditure. As noted by Ghosh (1995), although it is entirely possible that g_t in reality is a stationary time series, standard econometric tests generally cannot reject the null hypothesis that it contains a unit root. This is also the case for the Swedish data used below.

Furthermore, if τ_t and g_t^{TOT} are both individually I(1), the stationarity of sur_t implies that (8) defines a cointegration relation. Campbell (1987) shows that the implied error correction model can be expressed in VAR form as

$$\begin{bmatrix} \Delta g_t \\ sur_t \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \Delta g_{t-1} \\ sur_{t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_{\Delta gt} \\ \epsilon_{surt} \end{bmatrix}, \tag{15}$$

where the means of Δg_t and sur_t have been removed.[8] After verifying that g_t is I(1), and that τ_t and g_t^{TOT} are both individually I(1) and cointegrated such that $\tau_t - g_t^{TOT} = sur_t$ is I(0), the VAR can be estimated in order to evaluate the GTSH. The procedure is as follows. Write the VAR in matrix notation as

$$X_t = AX_{t-1} + \varepsilon_t. \tag{16}$$

The forecast of a one period change in government expenditure is

$$E(\Delta g_s | H_t) = \begin{bmatrix} 1 & 0 \end{bmatrix} A^{s-t} X_t. \tag{17}$$

Substituting (17) into (14) gives

[8] For the annual data used in this paper, a one lag VAR is sufficient to capture the time series properties. If necessary, the VAR can easily be extended to incorporate several lags.

$$
\begin{aligned}
\widehat{sur}_t &= (1-\lambda)\sum_{s=t+1}^{\infty}\left(\frac{1}{1+R}\right)^{s-t}\begin{bmatrix}1 & 0\end{bmatrix}A^{s-t}X_t \\
&= \begin{bmatrix}1 & 0\end{bmatrix}(1-\lambda)\frac{1}{1+R}A\left(I-\frac{1}{1+R}A\right)^{-1}X_t \\
&= \Lambda_1\Delta g_t + \Lambda_2 sur_t. \qquad (18)
\end{aligned}
$$

If the GTSH is true, the predicted budget surplus, $\widehat{sur}_t$, is equal to the actual budget surplus, sur_t, i.e., $\Lambda_1 = 0$ and $\Lambda_1 = 1$. Accordingly, the following overidentifying restrictions must hold for (18):

$$
\begin{bmatrix}1 & 0\end{bmatrix}(1-\lambda)\frac{1}{1+R}A\left(I-\frac{1}{1+R}A\right)^{-1} = \begin{bmatrix}0 & 1\end{bmatrix}. \qquad (19)
$$

The restrictions in (19) represent the formally testable implications of the overall model, and for both the GTSH and the TSH below, they are evaluated by means of Wald and Likelihood ratio tests.[9] For the GTSH, an estimate of λ is obtained from the restricted model obtained in the calculation of the likelihood ratio statistic (Flavin, 1993). As indicated above, besides formal statistical testing, the fit of the model is also evaluated by calculating the predicted budget surplus according to (18) and then visually comparing it to the actual budget surplus.

4. Estimation and results

The data are taken from the *Statistical Yearbook of Sweden* (various issues), the International Monetary Fund's *International Financial Statistics* and *Government Finance Statistics* databases, and refer to the consolidated central government, i.e.,

[9] When testing the TSH (i.e., when testing the restrictions in (19) with λ forced to zero), one can postmultiply (19) by $\left(I - \frac{1}{1+R}A\right)$ in order to obtain a simpler, linear expression to evaluate. In general, as noted by Campbell and Shiller (1987) and Gregory and Veall (1985), such a transformation can change the values and power of Wald statistics, and it may therefore be important to consider. However, for the data used in this paper, no conclusions are altered by focusing solely on testing the restrictions as expressed in (19). Test results based on the transformation yield very similar results and are available from the author upon request. Note that the likelihood ratio test statistic is invariant to any transformation of the restrictions.

the central government units covered by the general budget, and central government units with individual budgets, including the National Debt Office, the Swedish National Social Insurance Board, and regional agencies of the Public Health Insurance Society. Further details regarding the data and the construction of the variables are provided in the Appendix. The sample period is 1952-99, but separate estimation is also made for the sample period of 1970-96 as it is characterized by a relatively volatile budget surplus compared to the 1950s and 1960s. The choice of studying the period 1970-96 rather than the period 1970-99 is based on the fact that in the beginning of 1997, a new budget law aimed at strengthening the budget-making process, took effect.

The first step is to verify that g_t is I(1), and that τ_t and g_t^{TOT} are I(1) and cointegrated such that $\tau_t - g_t^{TOT} = sur_t$ is I(0). Table 1 displays results from augmented Dickey-Fuller (ADF) tests of the null hypothesis that the variables under consideration contain a unit root (for details, see Dickey and Fuller, 1981). It is well-known that the regression that the ADF test is derived from depends critically on the assumption of serially uncorrelated residuals. In order to verify this assumption, each ADF test statistic in Table 1 is supplemented by a Lagrange multiplier test statistic for the null hypothesis of no residual autocorrelation. The null hypothesis of a unit root cannot be rejected for τ_t, g_t and g_t^{TOT}. By contrast, for sur_t, the null is rejected, which suggests that τ_t and g_t^{TOT} are cointegrated. ADF tests are then performed for τ_t, g_t and g_t^{TOT} when they are expressed in their first differences. The null hypothesis of a unit root in the first difference of each series is rejected.

Table 1
Augmented Dickey-Fuller (ADF) tests

	1952-99		1970-96	
Variable	ADF	LM	ADF	LM
τ_t	-1.60	0.33	-1.86	0.97
g_t	-1.92	2.11	-1.69	1.02
g_t^{TOT}	-1.95	2.24	-1.69	1.00
sur_t	-4.36^{**}	0.13	-3.36^{**}	0.22
$\Delta\tau_t$	-6.03^{**}	0.42	-4.05^{**}	1.03
Δg_t	-5.07^{**}	0.59	-3.85^{**}	0.71
Δg_t^{TOT}	-4.94^{**}	1.09	-3.86^{**}	0.71

Notes: ADF is the test statistic for the null hypothesis of a unit root. LM is the Lagrange multiplier test statistic for the null hypothesis of no residual correlation from lags 1 to 2. "**" indicates rejection at the 1 percent level of significance.

The ADF test for sur_t, τ_t and g_t^{TOT} is supplemented by a restricted cointegration analysis of the linear combination $(\delta_1, \delta_2)(\tau_t, g_t^{TOT})'$, by means of the Johansen (1988) procedure. In contrast to the ADF test, the Johansen (1988) procedure specifies I(0) as the null hypothesis. The results are summarized in Table 2. The first two columns of the table specify the restriction on the elements of the vector (δ_1, δ_2). The other columns report the test statistic and its corresponding p-value from the test of the null hypothesis that the specified vector belongs to the cointegrating space. Accordingly, the first row displays the test results of the null hypothesis that the vector $(1, -1)$ belongs to the cointegrating space such that $(1, -1)(\tau_t, g_t^{TOT})' = sur_t$ is I(0). As indicated, the null cannot be rejected in either period. The last two rows contain test results of the null hypothesis of stationarity of τ_t and g_t^{TOT}. For each variable in each time period, the null is rejected at the five percent level of significance or better. Thus, in sum, the results indicate that g_t is I(1), and that τ_t and g_t^{TOT} are I(1) and cointegrated such that $\tau_t - g_t^{TOT} = sur_t$ is I(0).

Table 2

Tests on the cointegrating space

$\mathbf{H}_0$:		1952-99		1970-96	
δ_1	δ_2	$\chi^2(1)$	p-value	$\chi^2(1)$	p-value
1	-1	0.04	0.846	0.20	0.658
1	0	15.94	< 0.001	3.91	0.048
0	1	15.98	< 0.001	5.76	0.016

Notes: The null hypothesis is that the vector (δ_1, δ_2) belongs to the cointegrating space such that $(\delta_1, \delta_2)(\tau_t, g_t^{TOT})' = \delta_1 \tau_t + \delta_2 g_t^{TOT}$ is I(0). In the prior VAR estimation, for both sample periods, three lags were used in order to capture the time series properties and to assure no serial correlation among the residuals.

Next, the VAR for Δg_t and sur_t is estimated, and the results are shown in Table 3. Diagnostic checking and lag-length selection tests indicated that a one-lag VAR was sufficient to capture the time series properties. The null hypothesis that sur_{t-1} non-Granger causes Δg_t can be rejected at the 2.6 percent level of significance for the full sample period, and at the 1.8 percent level for the period 1970-96. Thus, for both periods, there is statistical evidence that the government has superior information.

Table 3

Estimated VAR coefficients

	1952-99	1970-96
$\widehat{a}_{11}$	0.327	0.257
	(0.137)	(0.187)
$\widehat{a}_{12}$	0.164	0.209
	(0.071)	(0.082)
$\widehat{a}_{21}$	-0.553	-0.717
	(0.172)	(0.280)
$\widehat{a}_{22}$	0.739	0.708
	(0.089)	(0.123)
t_{NG}	2.31	2.54
p-value	0.026	0.018

Notes: Standard errors in parentheses. t_{NG} is the test statistic for the null hypothesis that sur_{t-1} non-Granger causes Δg_t.

Table 4 summarizes the results from the overall tests of the model under each hypothesis. The left panel relates to Wald and likelihood-ratio tests of the TSH, i.e., tests of the restrictions in (19) with λ forced to zero, and the right panel relates to the corresponding tests of the GTSH. The test statistics indicate that it is not possible to statistically distinguish the GTSH from the TSH for the full sample period; neither hypothesis can be rejected. However, this is not the case for the period 1970-96. For this subperiod, the Wald statistic for the test of TSH is equal to 16.14, which implies that the null can be rejected at any conventional level of significance. The corresponding likelihood-ratio statistic is equal to 6.39, which implies that the null can be rejected at the 4.1 percent level of significance. By contrast, for the GTSH, both the Wald and likelihood-ratio statistics imply that the null cannot be rejected at any conventional level of significance.

Table 4
Tests of restrictions and estimates of λ

TSH:	1952-99	1970-96	GTSH:	1952-99	1970-96
$\chi^2_W(2)$	3.29	16.14	$\chi^2_W(1)$	0.03	1.07
p-value	0.193	< 0.001	p-value	0.863	0.302
$\chi^2_{LR}(2)$	2.82	6.39	$\chi^2_{LR}(1)$	0.05	2.27
p-value	0.244	0.041	p-value	0.821	0.132
			$\widehat{\lambda}$	-0.614	-0.899
			s.e. of $\widehat{\lambda}$	0.462	0.482

Notes: χ^2_W is the Wald statistic for the test of the restrictions in (19); χ^2_{LR} is the corresponding likelihood-ratio statistic.

The right panel of Table 4 also displays estimates of λ, which are generated in the estimation of the restricted models that are used in the calculations of the likelihood-ratio test statistics. For both periods, the estimated λ is negative and, accordingly, this suggests that there has been *more* discretion in Swedish budget policy *relative* to what is optimal according to the TSH. For the sample period 1952-99, the estimated λ is equal to -0.614, and is only weakly negative as it falls below 1.5 standard errors from zero. For the sample period 1970-96, the estimated

λ is equal to -0.899, which is 1.87 standard errors from zero.

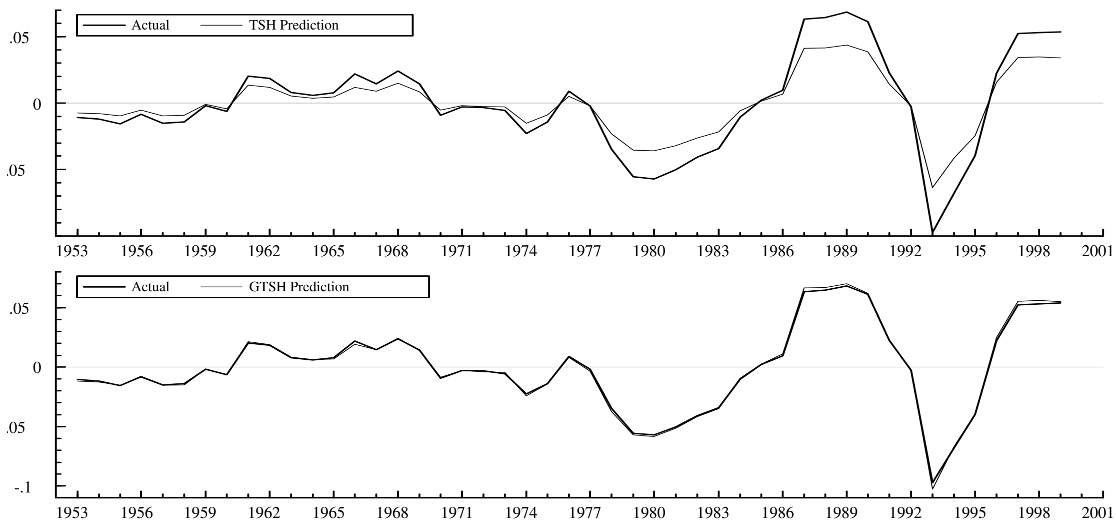

Fig. 1. *Predicted and actual budget surpluses, 1953-99.*
Notes: Upper panel: TSH; lower panel: GTSH.

Figure 1 plots the predicted and actual budget surplus time series for the full period. Although it is not possible to statistically distinguish between the two hypotheses, it is evident from the figure that the GTSH provides a better fit. In fact, the fit of the model when the GTSH is assumed is almost perfect. It is virtually impossible to see any difference between the actual and the predicted surpluses. By contrast, when the TSH is assumed, the actual budget surplus fluctuates more than the predicted surplus. Still, as suggested by the statistical tests, the predicted TSH budget surplus captures all shifts of the actual budget surplus.

Figure 2 plots the predicted and actual budget surpluses for the subperiod, and it can be interpreted in more or less the same way as Figure 1. It is worth noting that although the TSH is statistically rejected and the actual budget surplus fluctuates more than the predicted surplus, the latter can at least capture the major shifts in the former.

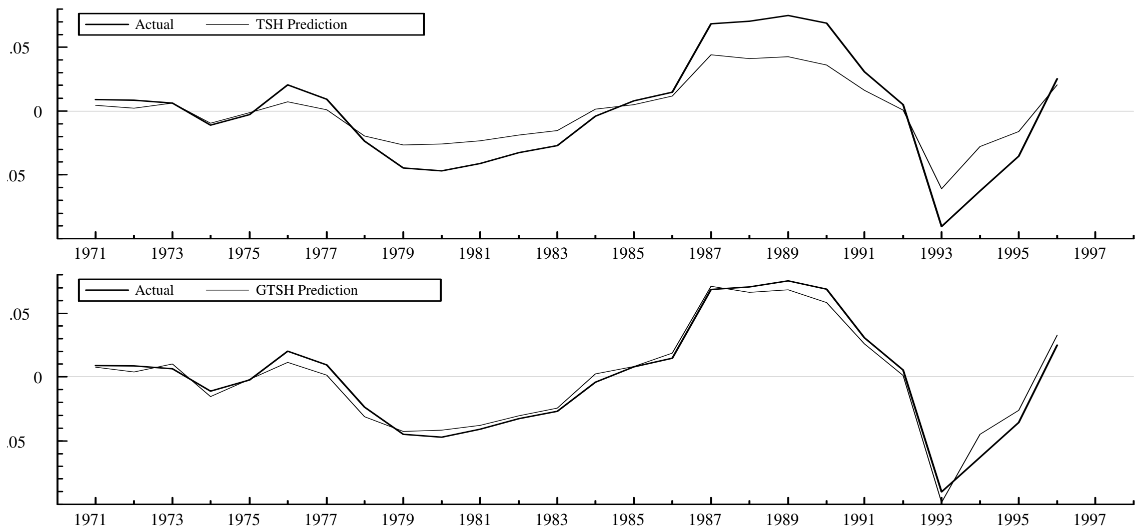

Fig. 2. *Predicted and actual budget surpluses, 1971-96.*
Notes: Upper panel: TSH; lower panel: GTSH.

5. Concluding remarks

Barro's (1979) tax smoothing hypothesis (TSH) assumes that the government is always subject to an "optimal" degree of discretion in budget policy, i.e., optimal in the sense that it minimizes the welfare costs from taxation. By contrast, the *generalized* tax smoothing hypothesis (GTSH) proposed in this paper takes into account the possibility that a tax smoothing government may be subject to a degree of discretion in budget policy that differs from the degree that is optimal according to the TSH.

The results indicate that the GTSH can go a remarkably long way in explaining the shifts in Sweden's central government budget balance. Formally, the GTSH cannot be rejected for either of the periods 1952-99 and 1970-96. The TSH cannot be rejected for the period 1952-99; however, it can be rejected for the period 1970-96. Hence, the result for the period 1970-96 indicates that the statistical power of the tests is high; even though the sample size is reduced, it is possible to distinguish the GTSH from the TSH. Estimates of the parameter that reflect the degree of discretion, λ, suggest that there has been *more* discretion in budget policy relative to what is optimal according to the TSH. The visual results indicate that the GTSH provides close to a perfect model fit as the predicted and actual budget surpluses are almost identical. Hence, in summary, tax smoothing behavior in combination with more discretion in budget policy relative to what is optimal according to the TSH, can explain all shifts in the central government's budget balance. Accordingly, given a pure objective to smooth the tax rate perfectly, the budget law that was passed in 1997 appears to be a policy measure in line with the results obtained in this paper.

The GTSH should serve as a good platform for future studies on tax smoothing behavior among a wide range of governments. For instance, Strazicich (1996) notes that state governments in the U.S. that stick close to a balanced budget rule could still smooth their tax rates. Nevertheless, he rejects the TSH and concludes that state governments do not smooth tax rates. However, it is entirely possible that state governments *do* smooth their tax rates, but the TSH cannot capture this. By contrast, the GTSH can capture tax smoothing governments that stick close to a balanced budget rule. Thus, testing the GTSH on U.S. state governments and on similar cases may provide new insights and may even alter existing conclusions.

Appendix

All data are annual, and the full sample period is 1950-99. For the period 1950-94, each year refers to the fiscal year ending in June of the same year. For instance, 1950 refers to the budget year starting on July 1, 1949, and ending on June 30, 1950. For the period 1995-99, each year refers to the fiscal year starting on January 1 and ending on December 31.

Data for government expenditure, taxation receipts, GDP, and consumer price index were taken from the International Monetary Fund's *International Financial Statistics* and *Government Finance Statistics* (GFS) for consolidated central government databases. Calendar year GDP was converted to fiscal year GDP by taking geometric means. Debt and interest payment on debt were taken from various issues of *Statistical Yearbook of Sweden.* Government expenditure is measured by the sum of total expenditure and lending minus repayment minus interest payment on the debt. Taxation receipts is measured by the sum of total revenue and grants. Outstanding debt, government expenditure, and taxation receipts were all divided by GDP in order to obtain d_{t+1}, g_t, and τ_t.

The real interest rate, r, was constructed in a similar manner as in Olekalns (1997). First, the nominal rate on the debt was calculated by dividing interest payment on debt by outstanding debt. Then, the corresponding time period change in the consumer price index was subtracted from the nominal interest rate in order to obtain the budget year real interest rate. The real rate used in the calculations, r, was then set to equal the average of all budget year real interest rates. Following Ghosh (1995) and Olekalns (1997), the growth rate used in the calculations, n, was set to the average of the real GDP growth rates. Total government expenditure, g_t^{TOT}, was calculated as $g_t + (r - n)d_t$, and the budget surplus, sur_t, was calculated in accordance with (8) as $\tau_t - g_t^{TOT}$.

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