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Causality and Sustainability of Federal Fiscal Policy in the United States

von

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Abstract

Since the 1980s the U.S. has experienced unprecedented fiscal deficits which caused concern about the sustainability of fiscal policy. Under the first Reagan administration cuts in federal revenue took place which some observers interpreted as part of a supply-side oriented policy experiment aimed at diminishing government's role in the economy. In this paper quarterly data on federal revenue and expenditure from the U.S. national income and product accounts are used to shed some light on the federal government's fiscal policy during the past 30 years and during the 1980s in particular. Applying time series analyses answers to two questions about causality and sustainability of U.S. federal fiscal policy are sought: (1) Is there evidence of a causal relation among revenue and expenditure which supports the policy experiment? (2) Is fiscal policy sustainable?

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1. Introduction

In all market-oriented economies both the levels and the changes of public expenditure, revenue and deficits are closely watched by politicians, economists and the general public. A high level of fiscal acitivity by the (aggregate) government is often seen as an indicator for too large an involvement of the state in the private economy. Large fiscal deficits are considered damaging through their effects on interest rates, or even dangerous for a nation's financial stability. At the same time, people keep an eye on current account balances and on their country's (net) international lending or borrowing position because they affect welfare relative to other countries at least in the long run.

On both accounts - internal, i.e. fiscal, and external balance - the United States did not do too well recently. Current account deficits reached unprecedented heights, and the U.S. turned from the world's biggest lender into its biggest borrower. From the national income identity we know that the sum of private saving and government saving must equal the sum of a nation's domestic investment and its net foreign investment which is identical to its current account balance. Internal and external balance are therefore related via an accounting identity. Economists who go one step further and accept low national saving as a major cause of a weak current account point to a decline both in private saving which had already been notoriously weak, and in public saving where the federal government's deficits have made the headlines for many years in a row. It should be noted that not only the U.S. experienced a decline of both saving and investment ratios in the 1980s. As *Bosworth (1990)* and *Tease et al. (1991)* pointed out, similar patterns can be found for the largest industrialized nations. What is particular about the United States, however, is that the fall in saving exceeded the fall in investment which is reflected in the current account deficits since the 1980s.

In an attempt to express the alleged ties between public saving and national saving vis-a-vis the rest of the world more figuratively, fiscal and current account deficits were termed the "twin deficits". In this paper I want to focus on one of those unwanted twins - the U.S. federal government's budget deficit and its two components, revenue and expenditure. This research interest is motivated by the publicity this deficit gained inside and outside the U.S. and by what below will be interpreted as the fiscal policy experiment of the Reagan-Bush administrations. There are several reasons for looking at the federal government as opposed to aggregate government: (1) State and local governments were not responsible for the deficits of aggregate government, they even ran surpluses. (2) The federal government dominates the pattern of revenue and expenditure, i.e. the time series for the aggregate of federal, state and local governments

look very similar to the ones for the federal government. (3) The federal government is most interesting because it allows one to focus on a single decision-maker.

Consider figure 1 for an idea how the federal government's budget balance as a share of GNP evolved over the past 30 years.

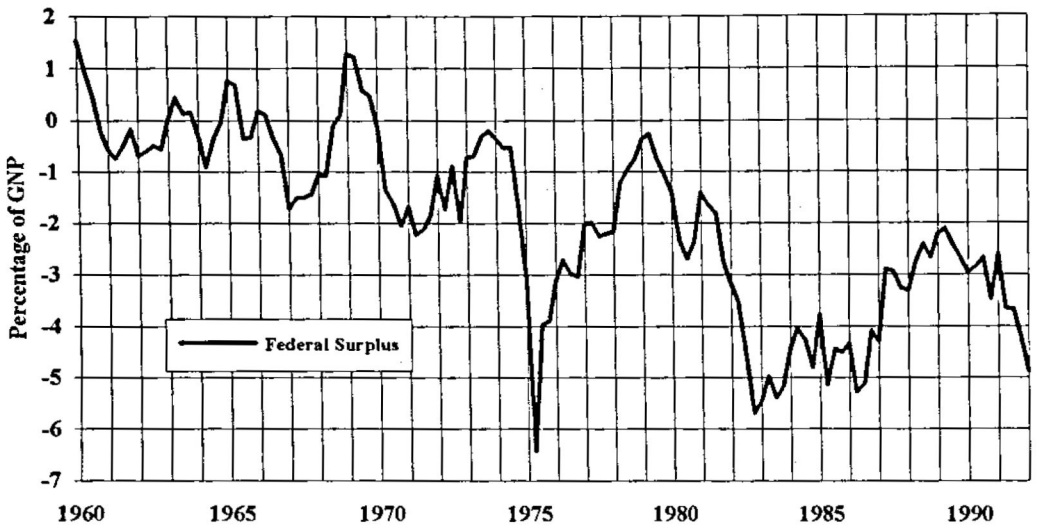

Figure 1: Budget surplus of U.S. federal government

There is a clear downward trend indicating increasing budget deficits relative to GNP.[1] Notice that for the years prior to the 1980s the data shown in figure 1 are roughly in line with the notion of an anti-cyclical Keynesian fiscal policy, a fact which is probably due to a large extent to built-in-stabilizers: At the peak of the business cycle government saves a positive amount, at the trough government dissaves.[2] This pattern changed, however, in the 1980s. Despite many years of favorable economic conditions the government ran deficits.

To get an idea where the federal government's money came from and where it went, we would want to disaggregate revenue and expenditure into some broad fiscal categories. In terms of GNP ratios there was a secular decline of revenue from corporate profit taxation and from indirect business taxes. As for personal taxes, the years of the

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1 Notice that not everyone agrees with the numbers presented. *Eisner (1989)* claims that due to the pecularities of the government accounting system the deficit problem is at least exaggerated in official statistics.

2 The Citibase database includes the following dates on a quarterly basis for the peaks (p) and troughs (t) of U.S. business cycles since 1960: 60.2 (p), 61.1 (t), 69.4 (p), 70.4 (t), 73.4 (p), 75.1 (t), 80.1 (p), 80.3 (t), 81.1 (p), 82.4 (t), 90.3 (p).

first Reagan administration saw a marked drop which, however, did no more than eliminate the increase that had taken place during the second half of the 1970s. Contributions to social security show a strong upward trend over the whole sample period. On the expenditure side government spending for purchases of goods and services decreased over the sample period as a share of GNP. The Reagan-Bush years, however, saw an increase rather than a decrease. The federal government's grants to state and local governments exhibit the opposite pattern. If spending on national defense is considered separately, government purchases net of defense spending exhibit an upward sloping trend over the full sample period and a slight decrease in the 1980s. Defense spending had reached a minimum in the late 1970s and increased by more than 1% of GNP during the 1980s. Net transfers which can be considered a proxy for spending on social policy more than doubled over the sample period. The increase, however, came to a halt under the Reagan-Bush administrations. The fiscal deficits of the 1980s finally show their effect in a considerable increase in net interest payments which increased by more than 1% of GNP. To summarize, tax cuts both for households and businesses, and both non-interest and interest spending contributed to the budget deficits of the 1980s. The tax breaks apparently were not self-financing in the way the supply-side theorists had thought.[3]

Given that federal budget deficits increased over the past 30 years, the time series of revenue and expenditure will be used in this paper to empirically examine two questions:

- Is there a causal relation among federal revenue and expenditure?
- Can U.S. federal fiscal policy be sustained?

As will be argued below, the first question is of interest both for theoretical and political reasons. The second question derives its relevance from the fiscal deficits of the 1980s. Can a government keep on running such a policy? Combining and extending earlier work by *Miller and Russek (1990)* and *Hakkio and Rush (1991)* I use methods from time series analysis to answer both questions in a unified framework.

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3 On a deeper level the question of where the money came from and where it went to is the question about the distributive effects of U.S. fiscal policy. This was fiercely debated throughout the 1980s and still in the 1992 presidential campagne. *McIntyre (1991, p. 27)*, for example, claims that "... the tax cuts for the richest 1 percent can explain the entire increase in the size of the federal budget deficit."

The plan of the paper is as follows: In section 2, I give a brief outline of the theoretical background used to analyze causality and sustainability of federal revenue and expenditure during the past 30 years. In section 3, results from time series analyses are presented. Section 4 sums up. Throughout the paper seasonally adjusted quarterly data from the Citibase database for the periods 60.1-92.1 are used.

2. Causality and Sustainability - Theoretical Background

2.1. Tax and Spend or Spend and Tax? - The Question of Causality

While most of the public interest is focused on government deficits per se, the components of these deficits - revenue and expenditure - also raise interesting questions. One of them concerns the distinction between a so-called "tax and spend"- and a "spend and tax"-hypothesis. Is there a causal relationship between revenue and expenditure? Will government use its power to tax its citizens in order to collect funds which it will spend no matter whether or not spending is a sensible thing to do? Or, will government decide on a level of spending, and will it then use taxation to acquire the funds needed?

A large number of theoretical approaches can be imagined. Think of the idea of incrementalism in the process of setting budgets over time. A branch of government will only get an increase over this year's budget next year, if it spent all of this year's budget. If people working in this organisation have an interest in higher budgets, they will spend their funds towards the end of the budget year irrespectively of the usefulness of this spending. Government as a whole will need more revenue next year. This rule therefore creates a causal relation from expenditure to revenue. Approaches in the theory of bureaucracy could also be used, however, to derive the opposite theoretical prediction under the assumption that government and its bureaucrats serve as selfless agents of the electorate. Given these contradictory results from theory, one might want to have a look at the data. Do the time series of the federal government's expenditure and revenue show any signs of a causal relation? The concept of Granger-causality and an extension based on cointegration of revenue and expenditure will be used below to answer this question. Previous work by *Anderson, Wallace and Warner (1986)*, *Manage and Marlow (1986)*, *Furstenberg, Green and Jeong (1986)*, *Ram (1988)*, and *Miller and Russek (1990)* did not lead to a unanimous conclusion about causality. *Miller and Russek* whose approach will be used below find bi-directional causality among federal revenue and expenditure.

The "tax and spend" vs. "spend and tax" debate is of particular interest for the U.S. under the Reagan-Bush administrations. The early "supply-side revolutionaries" had the objective of diminishing the role of the state by cutting taxes in order to put, via increased deficits, political pressure on government spending. To be fair: driving down expenditure by cutting revenue first was only a secondary objective, or - as *Blanchard (1987, p. 17)* called it - a "political bet" that remained after the initial goal of starting a supply-side boom with smaller government and higher growth turned out to be more difficult to reach than previously thought. However, if this strategy of reducing public spending through cutting public revenue was going to be workable, the data should exhibit a causal relationship between government revenue and expenditure with revenue causing expenditure.

2.2. How Long Can it Last? - The Question of Sustainability

At times of unusually high fiscal deficits, not only causality but also sustainability of fiscal policy is an issue of considerable interest. As it turns out, causality and sustainability can be treated in a unified empirical framework. Suppose a government has been running budget deficits over a number of years. For how long and under what conditions can this fiscal policy be continued? The need to finance the deficit imposes a constraint. Economists derive a government's intertemporal budget constraint in order to shed some more light on sustainability. Assume for the sake of simplicity that all government debt has a one-period maturity. The one-period budget constraint can then be written as

$$P_t + (1+i_t)B_{t-1} = R_t + B_t, \tag{1}$$

where P_t denotes government spending for purchases of goods and services and for net transfers, i_t is the (one-period) interest rate, R_t is the government's revenue, and B_t is the value of funds raised in period t. Notice that P_t does not include payments for interest and principal. P_t-R_t therefore represents what is sometimes called the primary deficit which together with interest payments must equal the value of new debt. The budget constraint in (1) holds as an identity no matter whether we express the variables in nominal or in real terms, or as shares of GNP. However, the interest rate has to be interpreted appropriately as nominal or as real rate, or as difference between real GNP growth and the real interest rate.

The one-period constraints for t, t+1, t+2, and so on, can be solved forward to infinity to yield the intertemporal budget constraint as of time t (cf. *Hakkio and Rush, 1991*):

$$B_t = \sum_{\tau=1}^{\infty} r_{t+\tau}(R_{t+\tau} - P_{t+\tau}) + \lim_{n\to\infty} r_{t+n}B_{t+n}, \qquad \text{where} \qquad r_{t+\tau} = \prod_{s=1}^{\tau} \frac{1}{1+i_{t+s}}. \tag{2}$$

Under the conventional definition of sustainability a fiscal policy is called sustainable from the perspective of time t, if government debt which may increase for some time eventually converges back to B_t (see *Blanchard et al., 1990*, who also provide some alternative measures of sustainability). In (2) this calls for the limit term on the righthand side to equal zero. If this is the case, the intertemporal budget constraint states that the stock of debt B_t outstanding at time t must equal the present value of the primary budget surpluses. If, on the other hand, the limit term does not equal zero, the government is bubble-financing, issuing new debt to finance old debt that matures.

An empirical test of the sustainability of fiscal policy would have to test for the limit term in (2) to be zero. *Hamilton and Flavin (1986)* pioneered direct empirical testing of the present-value borrowing constraint and concluded that for the U.S. there is no evidence for a violation of the constraint. *Kremers (1988, 1989)* and *Wilcox (1989)* extended this work and found evidence for a violation of the present-value borrowing constraint. The empirical papers mentioned differ in the interpretations they apply to evidence that the limit value in (2) is not equal to zero. Whereas *Hamilton and Flavin (1986)* would conclude from such evidence that the borrowing constraint need not be satisfied, *Wilcox (1989)* regards the borrowing constraint as established on theoretical ground. Evidence for a limit value different from zero then indicates a fiscal policy which is unsustainable in the sense that it is expected to change. More recently, *Hakkio and Rush (1991)* using a slightly different approach also found evidence that at least recent fiscal policy violated the U.S. government's intertemporal budget constraint. *Hakkio and Rush* employed some other algebraic manipulations on the one-period budget constraint (1) to derive the following version of the intertemporal constraint:

$$P_t + i_t B_{t-1} = G_t = \omega + R_t + \lim_{\tau \to \infty} r_\tau B_{t+\tau} + \upsilon_t, \qquad \text{where} \qquad r_\tau = \left(1/(1+i)\right)^{\tau+1}. \tag{3}$$

i denotes the (unconditional) mean of the (stationary) interest rate.[4] ω is a function of i and of two parameters from the (non-stationary) stochastic processes generating R_t and G_t, respectively. υ_t is an error term which depends on i and on the errors in the processes generating R_t and G_t. Assuming the limit term in (3) to be zero, *Hakkio and Rush* write the intertemporal constraint as a (cointegration) regression equation

$$R_t = a + bG_t + \varepsilon_t, \tag{4}$$

where they test for the errors ε_t to be white noise, i.e. to contain no information, and for $b = 1$. Below I follow the lead of *Hakkio and Rush* because by going beyond previ-

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[4] The assumption of a stationary interest rate provides a strong argument for the use of real magnitudes or GNP shares since nominal interest rates are not stationary. See *Hakkio and Rush (1991, p. 435)*.

ous techniques of testing for the stationarity of government debt and looking at the cointegration of revenue and expenditure instead, both the issues of sustainability and causality can be treated in a unified framework.

The empirical analysis in the next section proceeds in several steps: First, stationarity of R_t and G_t in levels and in first differences is examined. Second, I use the original concept of Granger-causality to analyze causal relations between R_t and G_t. Third, cointegration tests on R_t and G_t are run which provide information on sustainability. And finally, if R_t and G_t are cointegrated, an error-correction representation is estimated which allows for an addition test for causality among revenue and expenditure.

A choice has to be made between the use of seasonally adjusted or non-adjusted data. Time series analysts sometimes propagate the use of non-adjusted data because seasonal adjustment could alter the dynamics of the stochastic processes to be estimated (cf. *Muscatelli and Hurn, 1992, p. 16*). On the other hand, it could be argued that decision-makers probably think in terms of seasonally adjusted data which will therefore be used in the sequel.

3. Causality and Sustainability - Empirical Results

3.1. Stationarity of Revenue and Expenditure

The tests for temporal causality and cointegration applied below impose conditions on the stationarity of the time series.[5] Augmented *Dickey-Fuller* (ADF) tests are used to determine whether federal revenue and expenditure are stationary in levels or in first differences. Denote by R_t the time series of revenue and by Δ the operator for first differences, for example $\Delta R_t = R_t - R_{t-1}$. Using the test equation

$$\Delta R_t = \alpha + \beta R_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta R_{t-i} + \varepsilon_t, \tag{5}$$

I test for the null hypothesis $\beta = 0$ which corresponds to a unit root, i.e. to non-stationarity (see e.g. *Muscatelli and Hurn, 1992, pp. 5-6*). The null hypothesis can be rejected, if the estimated value of β is significantly negative. Since the test statistic is not the standard t-statistic, *MacKinnon*'s critical values were used.[6] The parameter p in (5) and in later test equations has to be chosen such that the residuals are white noise. Throughout the paper I used both *Akaike*'s information criterion (cf. *Judge et al., 1985,*

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5 A time series x_t is stationary if its expected value and its τ-period covariances $\mathrm{Cov}(x_t, x_{t+\tau})$ are independent of the time index t.

6 All calculations were run on Micro TSP 7.03.

pp. 244-245) and the iterative method proposed by *Downes and Leon (1987)* to determine p. The results presented proved to be highly robust against changes in p which preserved acceptance of the null hypothesis of the *Breusch-Godfrey* (BG) Lagrange multiplier test. Trend variables were included when they were significant.

(5) applies for tests for stationarity in levels. If stationarity in first differences is to be tested, all R_t in (5) have to be replaced by ΔR_t. To test for the stationarity of expenditure G_t, (5) has to be rewritten in terms of G_t.

* and ** are used throughout the paper to denote significance at the 5%- and 1%-level, respectively. The quarterly series for the federal government's revenue and expenditure are drawn from the Citibase database. I use two versions of the data set: (1) real revenue and expenditure, denoted by "real"; (2) real revenue and real expenditure as shares of real GNP, denoted by "per GNP". To identify potential changes over time, all tests were run for three sample periods: for the full sample with 129 observations covering 60.1-92.1, for a subsample 60.1-75.4 denoted by "(1)", and for a subsample 76.1-92.1 denoted by "(2)". In the following tables I also report for each test equation the number p of lags used and the test statistic of the *Breusch-Godfrey* (BG) test which tests the null hypothesis that the residual in a test equation are white noise. Table 1 contains the results of the stationarity tests.

	R	lags	G	lags	ΔR	lags	ΔG	lags
real								
$\beta = 0$	-3,43	0	-3,44	0	-12,51**	0	-12,00**	0
BG-test	6,40		3,60		1,91		3,56	
real (1)								
$\beta = 0$	-2,45	0	-2,12	0	-7,85**	0	-5,97**	0
BG-test	7,03		7,36		2,82		3,24	
real (2)								
$\beta = 0$	-1,47	0	-2,87	0	-9,85**	0	-9,80**	0
BG-test	4,23		1,92		1,21		1,14	
per GNP								
$\beta = 0$	-4,09**	0	-3,33	2	-13,79**	0	-10,83**	0
BG-test	5,37		4,85		1,74		3,08	
per GNP (1)								
$\beta = 0$	-2,73	0	-3,03	3	-8,88**	0	-5,56**	0
BG-test	5,46		2,53		5,56		2,00	
per GNP (2)								
$\beta = 0$	-2,40	1	-1,16	0	-11,49**	0	-10,56**	0
BG-test	2,32		1,87		1,52		2,30	

Table 1: Stationarity of federal revenue and expenditure

For all three sample lengths real revenue and real expenditure are non-stationary in levels and stationary in first differences. This implies that first differences can be used

to analyze Granger-causality, and that estimation of cointegration equations, i.e. testing for sustainability, is possible. GNP ratios yield almost the same results. However, for the full sample period revenue as a share of GNP is also stationary in levels, which precludes cointegration tests for this sample length.

3.2. Temporal Causality Among Revenue and Expenditure

The notion of causality most commonly applied in econometrics originates from *Granger (1969)*. Expenditure G_t is said to *Granger*-cause revenue R_t, if previous values of expenditure in addition to previous values of revenue can help to explain current values of revenue. This statistical concept of causality clearly does not cover the full understanding of causal relations we normally use in theoretical analysis or in our everyday language. Instead it measures precedence and information content.To use this approach both time series have to be stationary. In the previous subsection we found revenue and expenditure to be stationary in first differences. The appropriate test equation then is

$$\Delta R_t = \alpha + \sum_{i=1}^{p} \beta_{Ri} \Delta R_{t-i} + \sum_{i=1}^{p} \beta_{Gi} \Delta G_{t-i} + \varepsilon_i \,. \tag{6}$$

Under the null hypothesis ΔG_t does not *Granger*-cause ΔR_t. This can be rejected, if an F-test indicates joint significance of the β_{Gi}'s, i.e. if not all coefficients β_{Gi} are equal to zero. Notice that *Granger*-causality has to be examined in two directions. I.e., in (6) R_t and G_t have to be substituted for each other in order to test for the reverse null hypothesis that ΔR_t does not *Granger*-cause ΔG_t. There are four possible results of a test for temporal causality: (a) no causal relation; (b) one-sided causality from R_t to G_t; (c) one-sided causality from G_t to R_t; (d) two-sided causality among R_t and G_t.

	$\Delta R \not\Rightarrow \Delta G$	lags	$\Delta G \not\Rightarrow \Delta R$	lags		$\Delta R \not\Rightarrow \Delta G$	lags	$\Delta G \not\Rightarrow \Delta R$	lags
real					per GNP				
F-test	3,15*	2	0,73	1	F-test	1,51	3	0,71	1
BG-test	1,09		2,02		BG-test	3,67		1,37	
real (1)					per GNP (1)				
F-test	0,09	1	1,47	1	F-test	1,21	5	1,01	1
BG-test	3,47		1,79		BG-test	3,36		5,53	
real (2)					per GNP (2)				
F-test	2,12	4	0,07	1	F-test	1,83	2	0,01	1
BG-test	2,07		4,75		BG-test	0,61		1,12	

Table 2: *Granger*-causality among federal revenue and expenditure

$\Delta R \not\Rightarrow \Delta G$ in table 2 denotes the null hypothesis "revenue does not *Granger*-cause expenditure". The reverse hypothesis "expenditure does not *Granger*-cause revenue" is written as $\Delta G \not\Rightarrow \Delta R$. The null hypothesis is rejected, if the value of the F-statistic is

significantly high. For the full sample period real revenue *Granger*-causes real expenditure. This is in line with the result in *Miller and Russek (1990, p. 226)* and appears to be favorable to the supply-siders' idea of reducing public spending by first cutting revenue. However, since neither of the two subsamples confirms this result, I do not find it very convincing. In all other cases the null hypothesis of no temporal causality cannot be rejected. The *Granger*-tests therefore seem to support neither the "tax and spend"- nor the "spend and tax"-hypothesis, nor do they provide a strong basis for reducing public spending by first cutting revenue.

3.3. Cointegration and Sustainability

Our previous examination of the intertemporal budget constraint led to a simple linear relation between revenue and expenditure (4). There is yet another idea yielding a similar conclusion. *Granger (1986, p. 213)* pointed out that "... at the least sophisticated level of economic theory lies the belief that certain pairs of economic variables should not diverge from each other by too great an extent, at least in the long-run." Given the political process of setting government budgets, public revenue and expenditure should be among these variables. Looking at federal revenue and expenditure as shares of GNP in figure 2, we see that at least in the past they seemed to follow a common trend. More recently, however, they are in fact diverging which raises the question of sustainability.

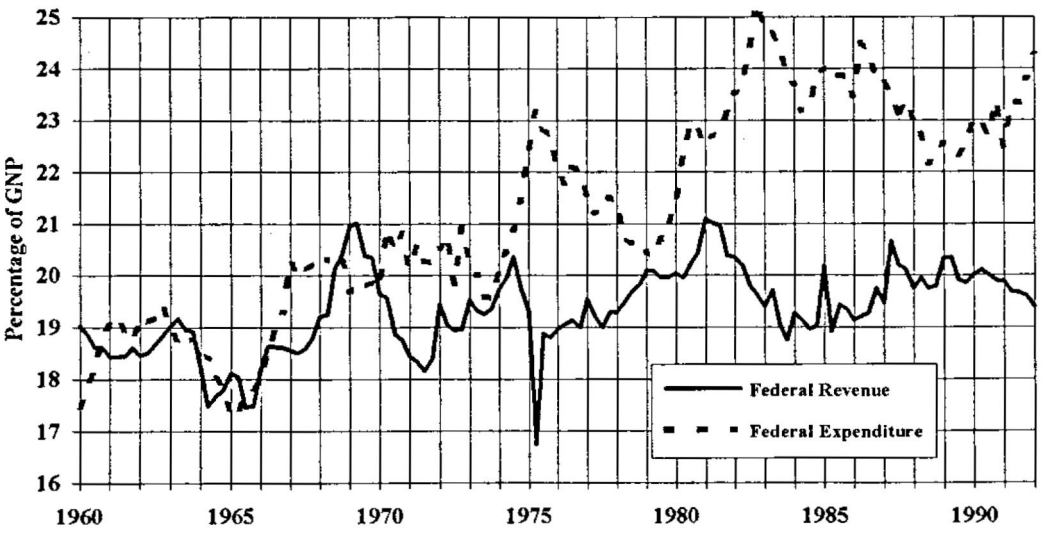

Figure 2: Revenue and expenditure of U.S. federal government

In the 1980s the methods of cointegration analysis were developed for empirical work with pairs of non-stationary variables (cf. *Engle and Granger, 1987*). They allow for exploiting both short-run and long-run information included in time series. If two non-stationary series R_t and G_t are both stationary in first differences, a linear combination of R_t and G_t is also stationary in first differences. If, however, there exists a vector (a,b) such that the linear combination

$$e_t = R_t - a - bG_t \tag{7}$$

is stationary, R_t and G_t are called cointegrated. The concept of cointegration is an attempt to capture a long-run equilibrium relationship among R_t and G_t which can be violated in the short-run. e_t can then be interpreted as deviation from the long-run equilibrium $R_t = a + bG_t$. Notice that a priori both directions of the cointegration equation are equally valid, i.e. there are two potential cointegrating vectors (a,b) and $(-a/b, 1/b)$. For that reason I estimate both the regression

$$R_t = a + bG_t + \varepsilon_t \tag{8}$$

and

$$G_t = a' + b'R_t + \varepsilon'_t. \tag{9}$$

Given the theoretical approach outlined earlier, we have to test for cointegration of R_t and G_t, and for $b,b' = 1$. In the bivariate model the product of the two estimates of b and b' is equal to R^2. If R^2 is high, i.e. near one, almost identical estimates of b will result (cf. *Hendry, 1986, p. 206*). The null hypothesis of no cointegration can be rejected, if the estimated errors e_t and e'_t from (8) and (9) are stationary which is again tested with an ADF test.

Cointegration is a necessary condition for the present-value budget constraint to hold. The condition $b,b' = 1$ is called "almost necessary" by *Hakkio and Rush (1991)*, since a violation in the form of $0 < b < 1$ implies that the incentive for government to default becomes large which creates increasing difficulty for government to market its debt. Table 3 shows the results of the tests for sustainability of the federal government's fiscal policy. R^2 and the Durbin-Watson (DW) statistic for the cointegration equations are presented in addition to the estimated values of b and b', and the t-statistic for one-sided tests of the null hypotheses $b < 1$, $b' > 1$. Since the cointegration equations have a regressor with a unit root, the standard errors of the coefficients were corrected as suggested by *West (1988)*. Furthermore, the t-statistic of the ADF-test for stationarity of the residuals ($\beta = 0$), and the BG-test on the residuals of the ADF equation are shown. *R* denotes the use of (8), *G* the use of (9).

	R	R^2	DW	lags	*G*	R^2	DW	lags
real								
b, b'	0,74	0,96	0,32		1,30	0,96	0,31	
b<*1, b'*>1	-8,12**				5,20**			
$\beta = 0$	-3,54*			2	-3,40*			2
BG-test	1,53				1,06			
real (1)								
b, b'	0,77	0,89	0,48		1,15	0,89	0,45	
b<*1, b'*>1	-3,97**				1,82*			
$\beta = 0$	-4,00*			2	-4,09**			2
BG-test	5,34				5,05			
real (2)								
b, b'	0,69	0,82	0,24		1,20	0,82	0,22	
b<*1, b'*>1	-3,17**				1,11			
$\beta = 0$	-1,99			0	-1,64			0
BG-test	3,91				3,15			
per GNP (1)								
b, b'	0,19	0,08	0,53		0,45	0,09	0,20	
b<*1, b'*>1	-5,69**				-1,33			
$\beta = 0$	-3,00			0	-2,09			2
BG-test	6,91				0,11			
per GNP (2)								
b, b'	-0,05	0,01	0,49		-0,27	0,01	0,12	
b<*1, b'*>1	-8,47**				-1,72*			
$\beta = 0$	-2,36			1	-1,38			0
BG-test	2,62				0,99			

Table 3: Cointegration among federal revenue and expenditure

Since revenue as a share of GNP was stationary in levels for the full sample period, no cointegration equations can be estimated for GNP ratios over that sample length. For real revenue and expenditure both cointegration equations provide strong evidence of cointegration for the full sample period 60.1-92.1 and for the first subsample 60.1-75.4. For the second sub-sample 76.1-92.1, however, neither of the two cointegration equations leads to a rejection of the null hypothesis of no cointegration. The DW values presented tend to confirm these results. For the cointegration property to hold, they have to be significantly greater than zero.[7] Given that cointegration was shown to be a necessary condition for the sustainability of fiscal policy, the interpretation is straightforward: In the course of the past 30 years the federal government's pattern of revenue and expenditure has changed. In recent years it no longer meets a necessary condition for sustainability. As for the ratios of revenue and expenditure to GNP, the condition for sustainability is violated for both sub-samples. These results are in line

7 The supply of critical values for this cointegrating regression *Durbin-Watson* test (CRDW) is rather unsatisfactory. However, the values presented by *Engle and Yoo (1987)* for sample sizes of 50 and 100 observations seem to confirm my conclusions.

with the estimations by *Hakkio and Rush (1991)* who used a slightly different dataset and other sample periods. Notice finally that the t-statistics presented for a test of the null hypotheses $b<1$, $b'>1$ rather strongly reject the condition that *Hakkio and Rush* considered to be almost necessary for the sustainability of fiscal policy.

3.4. Error-Correction Model and Causality

Having found real revenue and expenditure to be cointegrated for two of our three sample periods, I return one more time to the question of causality. If two time series R_t and G_t are cointegrated, there exists an error correction model (ECM) of the following form (cf. *Engle and Granger, 1987*):

$$\Delta R_t = \alpha + \sum_{i=1}^{p} \beta_{Ri} \Delta R_{t-i} + \sum_{i=1}^{p} \beta_{Gi} \Delta G_{t-i} + \gamma e_{t-1} + \nu_t \tag{10a}$$

$$\Delta G_t = \alpha' + \sum_{i=1}^{p} \beta'_{Gi} \Delta G_{t-i} + \sum_{i=1}^{p} \beta'_{Ri} \Delta R_{t-i} + \gamma' e_{t-1} + \nu'_t \tag{10b}$$

e_{t-1} is the "equilibrium error" from cointegration equation (8). Given its similarities to (6), the model can be considered an additional approach to test for temporal causality in the presence of cointegrated variables. As opposed to the concept of *Granger*-causality, in (10a) changes in R_t are not only explained by previous changes in R_t and G_t but also by the observed deviation e_{t-1} from the longterm equilibrium relationship between R_t and G_t. Substitution of e_{t-1} shows that for values of γ different from zero G_{t-1} influences R_t. Both an F-test on the β_{Gi}'s and a t-test on γ have to be performed to test for temporal causality. The null hypothesis that R_t is not *Granger*-caused by G_t can be rejected, if the β_{Gi}'s are jointly different from zero, or if γ is different from zero. Notice that G_t can cause R_t even if lagged changes in G_t do not influence the current change in R_t. Furthermore, cointegration and the existence of an error correction model imply that there is temporal causality at least in one direction. For two time series to follow a common trend there has to be temporal causality among them in order to yield the necessary dynamics (see *Granger, 1988, p. 203*). The second equation (10b) of the ECM is treated analogously. If γ' is different from zero, R_{t-1} influences G_t. Finally, the same procedure is applied for equilibrium errors based on (9).

Table 4 presents the results. R denotes an ECM with errors from (8), G denotes a model with errors from (9). $\Delta R \not\Rightarrow \Delta G$ ($\Delta G \not\Rightarrow \Delta R$) denotes a test whether revenue (expenditure) causes expenditure (revenue).

	$\Delta R \not\Rightarrow \Delta G$	lags	$\Delta G \not\Rightarrow \Delta R$	lags		$\Delta R \not\Rightarrow \Delta G$	lags	$\Delta G \not\Rightarrow \Delta R$	lags
real, R					real, G				
F-test	3,51*	2	0,54	2	F-test	3,43*	2	0,53	2
t-test	0,87		-3,46**		t-test	-0,77		3,37**	
BG-test	0,99		3,47		BG-test	0,98		3,41	
real (1), R					real (1), G				
F-test	1,71	2	1,10	2	F-test	1,71	2	1,64	2
t-test	1,21		-3,67**		t-test	-1,20		3,77**	
BG-test	2,66		5,57		BG-test	2,71		6,54	

Table 4: Error correction models for cointegrated variables

Notice first the near perfect symmetry of the results based on (8) and (9). We get very similar outcomes for both specifications of the cointegration equation. Furthermore, the results from our previous analysis of *Granger*-causality are confirmed by the F-tests on the ECMs which identify temporal causality of revenue for expenditure for the full sample period. Recall, however, the caveat stated earlier: Since revenue was found to *Granger*-cause expenditure for the full sample period, but for neither of the sub-samples, this result is not fully convincing. In addition, there is now temporal causation of revenue by expenditure which originates from the influence of the equilibrium error term.

If we are willing to ignore the caveat and focus on the full sample period, the results confirm *Miller and Russek (1990)* and support bi-directional causality among real revenue and expenditure. If we use the first sub-sample instead, expenditure is identified to cause revenue. Since we previously did not find expenditure to be caused by revenue for the second sub-sample, neither of these results looks very supportive to a policy which attempts to drive expenditure down by first cutting revenue.

4. Conclusion

In the previous sections data from the U.S. national income and product accounts were used to shed some light on the issues of causality and sustainability of the federal government's fiscal policy during the past 30 years and during the 1980s in particular. Previous work by *Miller and Russek (1990)* and *Hakkio and Rush (1991)* was combined to treat causality and sustainability in a unified framework. As for a causal relation among federal revenue and expenditure, the data did not indicate the kind of temporal causation that supply-siders in the 1980s would have liked to see, i.e. the support to a policy of reducing expenditure through cuts in revenue turned out to be weak in general and non-existent for the 1980s. As for sustainability, recent U.S. federal fiscal policy violates a condition which is necessary for the government's intertemporal budget constraint to hold. This condition was met in the first half of our sample, but was vio-

lated in the second. In addition, fiscal policy over the whole sample period is in conflict to a second condition which looks almost necessary for sustainability.

Similar calculations with German quarterly data for 74.1 to 90.3 show that on the federal level revenue causes expenditure (see *Welzel, 1993*). Germany might have been a more favorable habitat for U.S. supply-siders and their fiscal policy experiment of the 1980s. Furthermore, the two conditions for sustainability hold in the case of Germany. However, these are results for Germany before unification. More recently, after unification Germany also began to run unusually high budget deficits as did the United States in the 1980s. There is a second similarity: Both the U.S. in the 1980s and Germany in the years since unification had a mix of loose fiscal and tight monetary policy. This can be interpreted as a collective dilemma situation of the well-known prisoners' dilemma type between government and the central bank (see *Dixit and Nalebuff, 1991, pp. 116-118*). In both cases the players involved were committed or made commitments to follow their dominant strategies of the static game. The central banks by law or statute and by their "corporate culture" are obliged to put low inflation in the first place. President Bush and Chancellor Kohl on the other hand publicly and rather credibly declared that they would not raise taxes which given the practical difficulties with cutting public spending amounts to a commitment to loose fiscal policy. In the U.S. it took an election and a new president to overcome the "read my lips" promise. The German version of "read my lips" appears more flexible. Recent agreements on a "solidarity contract" to pay the cost of German unity include tax increases. Germans hope that their main macroeconomic policy institutions will do a better and a faster job in resolving this dilemma, thereby preserving sustainability of fiscal policy despite the recent surge in public spending.

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