THE MEASUREMENT AND INTERPRETATION OF STRUCTURAL BUDGET BALANCES*

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Abstract

To calculate structural budget balances, outlays and revenues have to be adjusted for transitory swings in economic activity. Two critical inputs are required: A measure of potential output, and elasticity estimates to adjust revenues and outlays for the business cycle. A simple filtering technique is described for decomposing output into potential and cyclical components. The estimates of budget elasticities are based on time-varying parameter regression models. An application to Austrian data illustrates the suggested procedures.

Zusammenfassung

Die Berechnung struktureller Budgetsalden basiert auf der Bereinigung von Budgetausgaben und -einnahmen um die zyklischen Schwankungen in der wirtschaftlichen Aktivität. Für diesen Zweck werden zwei wichtige Inputs benötigt: Eine Zeitreihe für den potentiellen Output und Schätzwerte für die Elastizitäten von Budgeteinnahmen und -ausgaben bezüglich der Lücke zwischen potentiellem und tatsächlichem Output. Die Arbeit beschreibt eine einfache Filtertechnik für die Berechnung des Potentialoutputs. Die Budgetelastizitäten werden mit Hilfe von Regressionsmodellen mit zeitvariablen Parametern geschätzt. Eine Anwendung auf österreichische Daten illustriert die vorgeschlagenen Techniken.

1. Introduction

During the 1980s, a striking change in fiscal policy orientation took place in most industrialized countries. Following the ascent of Keynesian macroeconomics, the stabilization of cyclical movements in output and unemployment through manipulation of fiscal instruments was widely considered a socially desirable and technically feasible task. As budget deficits increased substantially in most countries after the first two oil shocks, the reduction of budget deficits along target paths took precedence over the goal of dampening swings in economic activity. The widespread adoption of budget consolidation programs has raised a number of questions: What measure of the budget deficit should be targeted? What is the appropriate target path for the deficit? What budget components should bear the brunt of the consolidation efforts? How can fiscal policy makers bind themselves to a deficit reduction plan without facing time inconsistency problems? What are the effects of a consolidation program on economic activity? And finally, how can the success of deficit reduction efforts be monitored over time?

This paper is mainly concerned with the last question. Observed budget data provide inadequate information on the

progress of a consolidation program because part of the changes in budget revenues and outlays are due to transitory ups and downs in economic activity. If the budget deficit drops because the economy is experiencing a transitory boom, consolidation efforts may erroneously be judged successful, and vice versa. Cyclically-adjusted or structural budget balances are, of course, a routine product of applied macroeconomic research. The OECD regularly publishes changes in structural budget balances for its member countries. But while the need to adjust actual budget balances for business cycle movements appears to be uncontroversial, the measurement and interpretation of structural budget balances are by no means settled issues.

For measuring structural budget balances, two inputs are required: A series for potential output and elasticities to adjust the budget for the deviations of actual from potential output. The determination of both inputs touches on difficult questions raised by recent macroeconomic research. Potential output measurement is closely linked to the intensively debated issue on the relative importance of permanent and transitory movements in output (see Campbell - Mankiw, 1987). The estimation of elasticities may be difficult because many budget data series exhibit structural breaks over time. Moreover, as an immediate corollary of the Lucas critique, the relationship between budget components and economic activity

is unlikely to remain invariant under a regime change in fiscal policy.

The paper has four aims: First, to clarify the interpretation of movements in structural budget balances. Second, to describe a simple technique for calculating a potential output series. Third, to introduce time-varying parameter regression models for estimating budget elasticities. And fourth, to apply the suggested procedures to Austrian data.

The rest of the paper is organized as follows: Section 2 first describes the approach for calculating structural budget balances in use at the OECD. After that, the section outlines an unobserved components framework for adjusting budget balances. The interpretation of movements in structural budget balances is clarified within this framework. Sections 3 and 4 discuss potential output measurement and the estimation of budget elasticities, respectively. Section 5 reports cyclically-adjusted budget balances for Austria. Section 6 summarizes the paper.

2. Conceptual issues

2.1. The OECD approach

The current OECD approach for calculating structural budget balances is summarized by the equation (see OECD, 1989, pp. 77-81)

$$SBC_{it} = BC_{it}[1 - \epsilon_i \ln(Y_t/Y_t^P)]. \qquad (1)$$

In (1), BC_{it} is the actual nominal value of budget component i in time period t, and SBC_{it} its cyclically-adjusted or structural value. The elasticity of budget component i with respect to the real potential output-gap $\ln(Y_t/Y_t^P)$ is denoted by ϵ_i. If, for example, the economy is operating at 3.0 percent below potential output and the elasticity with respect to the potential output-gap is 2.0, the value of the structural budget component will be 6.0 percent larger than the observed value. Summing over the cyclically-adjusted budget components gives the structural budget balance which, is usually expressed in percent of nominal potential output.

The OECD bases its estimates of potential output on a measure of mid-cycle trend output. Technically, potential output is assumed to follow a shifting linear time trend where the shifts in trend output are fixed exogenously. The values

of the budget elasticities for broad revenue and outlay categories are partly based on econometric model simulations and partly on separate studies of tax revenue elasticities (see OECD, 1989, methodological annex).

2.2. An unobserved components framework

I assume that the logarithm of budget component i can be decomposed as

$$\ln(BC_{it}) = \ln(SBC_{it}) + \ln(CBC_{it}) + u_{it}, \qquad (2)$$

where CBC_{it} is the cyclical component, and u_{it} is a regression error. The determination of the structural budget component is modelled as a linear function of nominal potential output (YN_t^P) with time-dependent fiscal policy parameters

$$\ln(SBC_{it}) = \alpha_{it} + \beta_{it}\ln(YN_t^P). \qquad (3)$$

Nominal potential output is calculated as the product of real potential output and the actual price level (see note 1). The cyclical budget component depends on the potential output gap

$$\ln(CBC_{it}) = \delta_{it}\ln(Y_t/Y_t^P). \qquad (4)$$

If appropriate, the cyclical budget component may also depend

on lagged output-gap terms.

The unobserved components system for budget component i given by equations (2), (3), and (4) allows for changes in fiscal policy parameters over time. In view of the persuasive structural changes in tax and expenditure policies typically observed in industrial countries, the rationale for the time-varying parameter assumption may be self-evident. Moreover, budget consolidation programs will almost certainly change the relationship between economic activity and the budget. Hence, the Lucas critique is likely to be relevant. In fact, Lucas (1976) refers to the success of time-varying parameter models suggested by Cooley and Prescott (1973) as the major empirical support for the relevance of his critique.

Equation (3) may be interpreted as a "structural reaction function" of the fiscal policy authority. Policy actions are reflected in variations of the parameters α_{it} and β_{it}. Equation (4) specifies the reaction of budget component i to deviations of observed output from potential output. The value of δ_{it} reflects three distinct factors: Built-in stabilizers, anti-cyclical fiscal policy, and the idiosyncratic characteristics of business cycles. The first two factors are clearly policy-dependent. The third factor refers to the fact that output-gaps of the same size could reflect different patterns in aggregate demand or of the distribution of income.

If, for example, the business cycle is largely export-driven, the cyclical component of value added tax revenues may behave differently than in a situation where the cycle is driven by private consumption demand. Hence, the value of δ_{it} may also be influenced by non-policy factors.

The OECD approach constitutes a special case of the unobserved components framework considered in this subsection. Taking logarithms of equation (1) and using the well-working approximation $\ln(1-x)\approx -x$ for x small gives

$$\ln(SBC_{it}) = \ln(BC_{it}) - \epsilon_i \ln(Y_t/Y_t^P). \qquad (5)$$

A comparison of equation (5) with equations (2), (3) and (4) shows that the two approaches are equivalent if $\epsilon_i=\delta_{it}$ and $u_{it}=0$ in each time period. Thus, the following discussion on the interpretation of movements in structural budget deficits is also relevant for the calculations published by the OECD.

2.3. Interpretation of structural budget balances

To monitor the success of a budget consolidation program over time, the following question appears to be relevant: "Of the observed changes in budget revenues and outlays, which part reflects permanent changes and which part reflects transitory changes in economic activity?" If permanent changes

in economic activity are assumed to reflect movements in potential output, the calculation of structural budget balances will provide a useful answer to the question. But movements in structural budget balances are also often used to answer a conceptually different question: "Of the observed changes in budget revenues and outlays, what part is due to changes in the state of the economy and what part is due to discretionary changes in fiscal policy?" Under this interpretation, movements of structural budget balances are thought to reflect the contribution of changes in fiscal policy to movements in actual budget balances.

The unobserved components framework clarifies why structural budget balances may result in poor summary measures of discretionary fiscal policy actions. Non-policy factors including shifts in output composition, income distribution, or demographic variables could affect the parameters α_{it} and β_{it} and thereby the value of the associated structural budget component. But these factors are likely to have small effects from an empirical point of view. More important, notice that in equation (3) the value of the structural budget component does not only depend on the policy parameters α_{it} and β_{it} but also on potential output. If potential output is a deterministically growing series, this dependency should not be a major source of concern. But if significant changes in potential output growth take place, the structural budget

balance will reflect the combined effects of fiscal policy actions and shifts in potential output growth. In particular, if potential output growth accelerates, it is likely that part of the resulting change in the structural deficit will erroneously be attributed to discretionary fiscal policy action.[1]

1 The interpretation of movements in structural budget balances as indicators of fiscal stance has been harshly criticized by some authors on the grounds of mismeasurement of budget components (see Eisner, 1986), no reference to intertemporal behavior of private households and firms (see Blanchard, 1989), and the principle objection that conventionally defined budget balances are meaningless economic concepts (see Kotlikoff, 1986).

3. Potential output measurement

Potential output is conventionally defined as the output level consistent with stable wage- and price inflation. Growth of potential output depends on growth in factor inputs (capital, energy, and labor), the relative prices of the factor inputs, and the rate of technical progress. In standard textbooks, potential output is determined on the aggregate supply side of the economy, and the business cycle is identified with persistent shifts in aggregate demand. A variety of methods is used in practice to measure potential output, ranging from trend interpolation to elaborate calculations based on production functions and factor demand equations.[2]

For the purpose of cyclical adjustment of budget balances a different perspective on potential output measurement is useful. Observed output is assumed to be the sum of two components: (a) a component that is driven by shocks that change the level of output permanently, and (b) a component that is driven by shocks that change the level of output

2 Breuss (1982) applies a production function approach to calculate a potential output series for Austria. Torres - Martin (1990) discuss aspects of the OECD approach to potential output measurement; Adams - Fenton - Larsen (1987) present a survey of the current IMF approach.

transitorily. After all, the goal is to adjust the budget only for movements in economic activity that will be reversed over time. The distinction between permanent and transitory output components does not necessarily coincide with the traditional distinction between potential output and business cycle. Aggregate demand shocks might well have permanent effects on output, if for example hysteresis effects are present in the economy. In this paper, I use the notion of potential output to denote that component of output which is driven by permanent shocks.

From a statistical point of view, the problem of measuring potential output can be approached as a filtering problem. Hodrick and Prescott (1980) have suggested a filtering procedure, henceforth called the HP-filter, that has found a wide range of applications both in academic and applied research.[3]

The basic idea of HP-filtering is to decompose the logarithm of real output (y_t) into a smooth non-stationary potential output component (y_t^p) and a stationary cyclical component (y_t^c)

3 Kydland - Prescott (1990) report business cycle regularities for the U.S. economy based on the HP-filtered data. Brandner - Neusser (1990) use the HP-filter to study the correlation between macroeconomic fluctuations in Austria and Germany.

$$y_t = y_t^p + y_t^c. \qquad (6)$$

The decomposition is achieved by setting the potential output series such that it solves the minimization problem

$$\sum_{t=1}^{T} (y_t - y_t^p)^2 + \mu[(y_{t+1}^p - y_t^p) - (y_t^p - y_{t-1}^p)]^2. \qquad (7)$$

In words, the potential output series is the series that minimizes the sum of squared deviations from actual output subject to the constraint that the sum of the squared second differences of the potential output series is not "too large". The constraint multiplier μ has to be fixed exogenously. The larger the μ that is chosen, the smoother the resulting potential output series. Hodrick and Prescott (1980) have suggested a value of 1600 as reasonable for quarterly data and this value is also used below in the empirical application for Austrian data.[4]

The HP-filter has several advantages as a method for calculating potential output compared to more conventional

4 The details of the formal solution to the minimization problem given in equation (6) can be found in Danthine - Girardin (1989, appendix 2). The econometric time series package RATS version 3.10 contains a procedure based on the HP-filter. King - Rebelo (1989) provide an in-depth study of the formal properties of the HP-filter both from a time- and a frequency-domain perspective.

methods. First, approaches based on estimating production functions are often plagued by the poor quality of input factor data in particular with respect to the capital stock. Furthermore, the question of interest, "What is potential output?", is replaced by a number of new questions, such as "What is the level of potential employment?", which may even be harder to answer than the original question. Second, the persuasive non-stationarity of the mean growth rate in most output series raises difficult econometric issues. The HP-filter automatically allows for smooth changes in mean growth rates. And third, the HP-filter procedure is relatively judgement free since only the multiplier μ has to be fixed, and is moreover cheaply reproducible.

4. Estimation of budget elasticities

Given a series for potential output, the problem of estimating the time-dependent parameters α_{it}, β_{it}, and δ_{it} of the fiscal policy reaction functions can be solved by using a maximum likelihood procedure. I assume that the three parameters follow independent random walk processes. For estimation purposes, it is convenient to cast the problem into state-space form (see Harvey, 1981). The three state-space equations are given by

$$\begin{bmatrix} \alpha_{it} \\ \beta_{it} \\ \delta_{it} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \alpha_{it-1} \\ \beta_{it-1} \\ \delta_{it-1} \end{bmatrix} + \begin{bmatrix} e_{it} \\ v_{it} \\ w_{it} \end{bmatrix}, \qquad (8)$$

where e_{it}, v_{it}, and w_{it} denote serially and mutually uncorrelated normal disturbances. The measurement equation based on equations (2), (3), and (4), can be written

$$\ln(BC_{it}) = \begin{bmatrix} 1 & \ln(YN_t^P) & \ln(Y_t/Y_t^P) \end{bmatrix} \begin{bmatrix} \alpha_{it} \\ \beta_{it} \\ \delta_{it} \end{bmatrix} + u_{it}. \qquad (9)$$

The parameters to be estimated are the variances of the disturbances e_{it}, v_{it}, w_{it}, and u_{it}. A convenient route to

derive the maximum-likelihood estimates for these variances is to use the prediction error decomposition method. The one-step ahead prediction errors for budget component i can be calculated by the Kalman filter based on the state-space formulation (8) and (9). Harvey (1981, chapter 4) is a straightforward guide for setting up the prediction and updating equations of the Kalman filter. Given the estimated prediction errors and their variance, the log-likelihood is maximized by using a numerical optimization methods, for example the method of scoring with modified step size. GAUSS version 1.49b provides built-in routines for programming an appropriate estimation routine.

5. An application: Structural budget balances in Austria

In the first half of the 1980s, Austria's budgetary positions deteriorated at an unsustainable pace. Gross public debt in percentages of nominal output rose from 39.6 percent (1980) to 54.0 percent (1986). Net lending by the general government stood at 3.7 percent of nominal output in 1986, up from 1.7 percent in 1980. The federal net deficit of the central government climbed to 5.2 percent in 1986 and was projected to increase quickly over future years. The newly elected coalition government drafted an agreement in January 1987 that named budget consolidation the overriding fiscal policy goal for the years ahead. The agreement envisaged a reduction of the actual net deficit of the federal government to 2.5 percent in 1992.

The approach outlined in sections 2-4 is applied to calculate structural budget balances based on Austrian national income and product account (NIPA) data for the general government. The use of NIPA data for the general government sector instead of federal budget data, which form the declared target of the central budget consolidation efforts, can be motivated by several reasons. NIPA figures are more closely integrated with the savings and investment streams of the overall economy than the federal budget

figures. Moreover, NIPA data allow for calculating structural budget balances based on public savings and government net lending. Furthermore, from a macroeconomic point of view, the effects of the budget consolidation program on the budgetary positions of the general government are of primary interest. Finally, some accounting principles used for constructing federal budget figures are at best questionable. For example, revenues from asset sales are routinely included among current revenues.

An estimate of the annual potential output-gap series for Austria over 1964-1989 is plotted in figure 1, whereas figure 2 plots the growth rates of real and potential output. These series were constructed as follows: The HP-filter was first applied to the seasonally adjusted quarterly real gross domestic product series for the time period 1964.1-1989.4. After decomposing the quarterly series in potential and cyclical component, the data were aggregated to annual values. Two stylized facts emerge from the two figures: First, cyclical fluctuations in Austrian real output appear to be relatively small. The gap exceeds 2 percentage points in absolute values in 1975 only. The standard deviation for the Austrian cyclical component is 1.02 percent. For comparison, the standard deviations of the annual cyclical component over the same time period for the U.S.A. is 1.67 percent and for

Germany 1.40 percent.[5] Second, from figure 2, growth of potential output has varied considerably over time. In particular, after the low-growth experience at the beginning of 1980s, potential output growth picked up again between 1986 and 1989 reaching about 3 percent in 1989. Also note from figure 1 that the potential output-gap is relatively small over the budget consolidation period 1987-1989. Thus, most of the faster actual output growth during this period is assigned to potential output growth.

Next, consider the budget elasticities in table 1 for the most important budget components. The table reports averages of the elasticities with respect to nominal potential output and with respect to the real output gap over the time period 1986-1989. A minus sign in front of the output-gap elasticity indicates that the component moves countercyclically. Long-run and short-run elasticities of some revenue elasticities differ substantially. For example, the long-run elasticity of value added taxes is about 1.20 but only about 0.50 with respect to the output-gap. Typically, fluctuations in Austria's economic activity take place simultaneously with heavy fluctuations in exports which are not subject to value added taxes. Wage tax revenues, income and profit taxes, and income from property exhibit short-run revenue elasticities larger than their long-

5 Calculations for the U.S.A. and Germany are based on data series from the OECD Main Economic Indicator data base.

run counterparts. The imputed pension position on the revenue side is an off-setting book-keeping item for part of public consumption. On the expenditure side, both public consumption and public investment move countercyclically with elasticities of 0.50 and 0.40, respectively. Transfers and subsidies appear to move somewhat less countercyclically. Interest payments on the public debt are assumed to be independent of the business cycle a priori.

Table 2 contains the results for structural public savings and structural government net lending both expressed in percentages of nominal potential output over the time period 1985-1989. The appendix lists the corresponding figures for the whole sample period 1965-1989. I first turn to the results for public savings. The structural public savings ratio deteriorated from 1.55 in 1986 to 0.62 in 1989. Thus, the budget consolidation efforts combined with the speed-up of potential output growth did not succeed in stabilizing the structural public savings ratio. The results for structural net lending in column (5), however, suggest that this ratio was stabilized at its 1986 value. The contrasting results for public savings and net lending suggest that the consolidation efforts targeted public investment disproportionately.

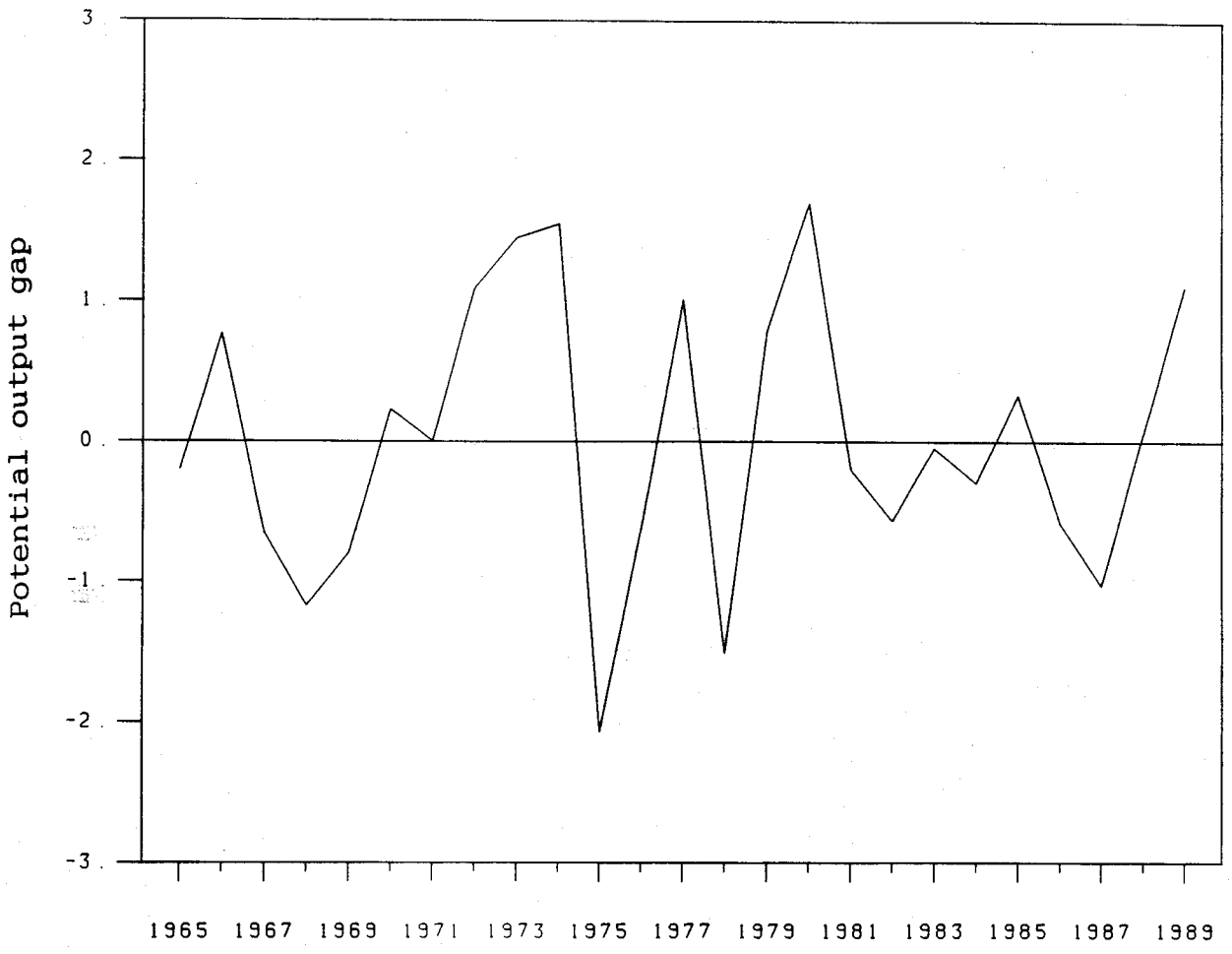
6. Summary

This paper considered four issues concerning the calculation of structural budget balances: First, the interpretation of movements in structural budget balances. Second, the determination of potential output. Third, the estimation of budget elasticities under fiscal policy regime changes. And fourth, the level of Austrian structural budget balances over the budget consolidation period 1987-1989.

The main points and results of the paper include: Structural budget balance measures as calculated in this paper as well as by the OECD are useful to distinguish between permanent and transitory movements in budget outlays and revenues. Movements in structural budget balances may provide poor measures of discretionary fiscal policy action because the movements may be due to significant changes in potential output growth. An application of the procedures outlined in the paper to Austrian national income and product account data indicated that the budget consolidation efforts over the period 1987-1989 in combination with the speed-up in potential output growth at best stopped the downward trend in public savings and government net lending but did not succeed in an improvement of structural budget positions.

Figure 1

Potential output gap for Austria; 1965 - 1989

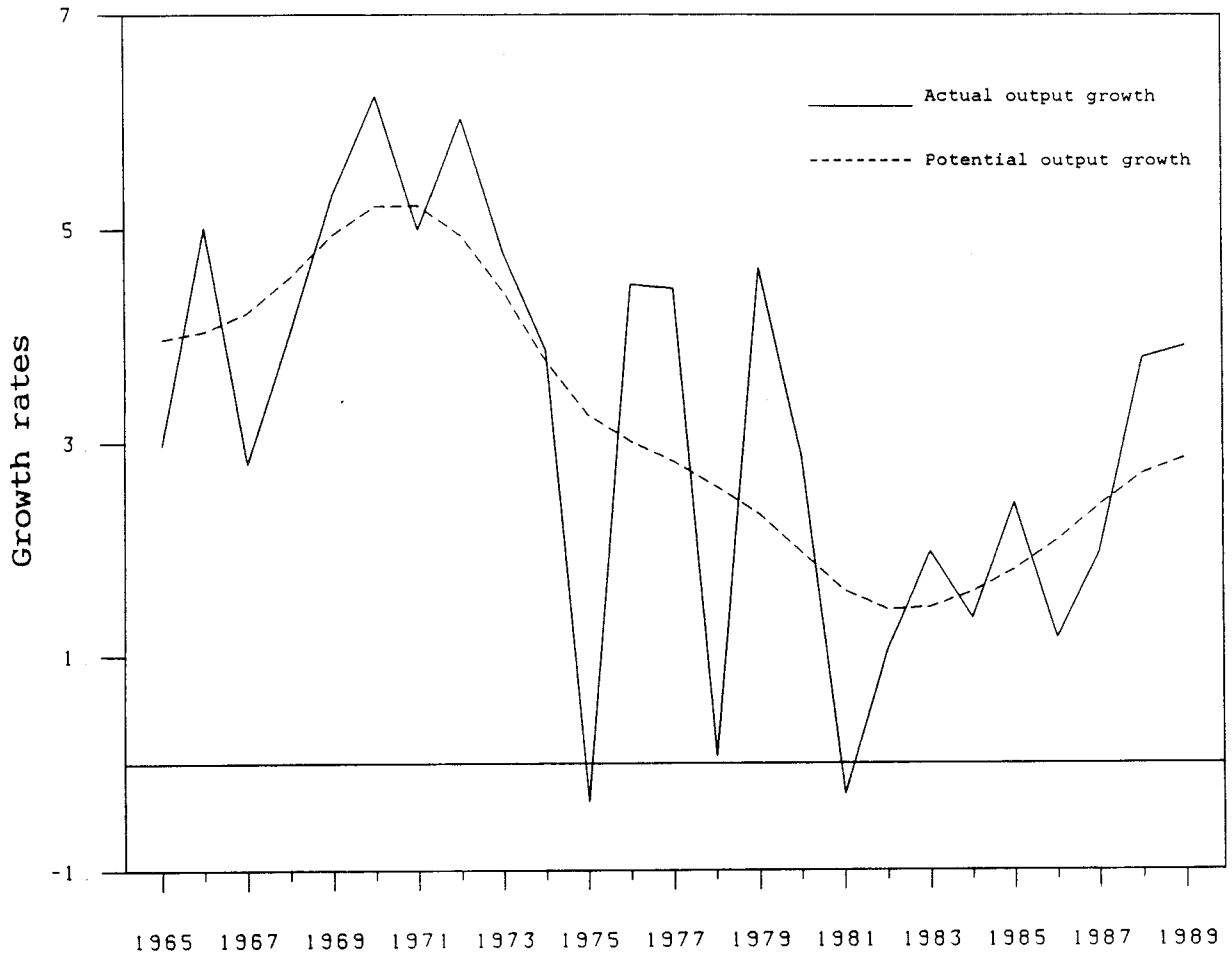


Sources: WIFO data base, own calculations.

Figure 2

Growth rates of actual and potential Austrian output

Percent



Sources: WIFO data base, own calculations.

Table 1

Estimates of budget elasticities (Averages 1986-1989)

Budget component	Elasticity with respect to Potential output	Output gap
A. Revenues		
Wage tax	1.48	1.98
Income and profit taxes	0.79	2.22[a]
Other direct taxes	1.12	0.51
Value added tax	1.17	0.51
Other indirect taxes	0.89	0.20
Social security contributions	1.21	0.46
Income from property	1.23	1.58[a]
Imputed pensions	1.15	-0.55
B. Expenditures		
Public consumption	1.18	-0.55
Subsidies	1.12	-0.70
Public investment	0.77	-0.40
Transfers	1.18	-0.62
Interest on public debt[b]	———	———

[a] Output gap lagged once.
[b] No estimates.

Data sources: Austrian Statistical Office, WIFO data base, own calculations.

Table 2

Actual and structural budget balances

Year(s)	Public savings			Government net lending		
	Actual[a]	Struct.[b]	▲Struct.	Actual[a]	Struct.[b]	▲Struct.
	(1)	(2)	(3)	(4)	(5)	(6)
1985	2.44	2.30	——	-2.47	-2.64	——
1986	1.27	1.55	-0.75	-3.71	-3.39	-0.76
1987	0.25	0.87	-0.68	-4.27	-3.59	-0.20
1988	1.23	1.30	0.43	-3.02	-2.95	0.64
1989	1.17	0.62	-0.68	-2.73	-3.34	-0.39
1987-1989	0.88	0.93	-0.31	-3.34	-3.29	0.02

[a]Actual budget balance in percent of nominal gross domestic product.
[b]Structural budget balance in percent of nominal potential output.

Data sources: Austrian Statistical Office, WIFO data base, own calculations.

Appendix

Structural budget balances for Austria: 1965-1989

	Public Savings		Government net lending	
Year	Actual[a]	Structural[b]	Actual[a]	Structural[b]
1965	7.12	7.07	1.55	1.51
1966	7.49	7.28	1.87	1.60
1967	5.81	5.92	-0.40	-0.24
1968	5.14	5.58	-0.77	-0.24
1969	5.43	5.82	0.08	0.46
1970	6.64	6.66	1.31	1.31
1971	7.15	7.12	1.71	1.68
1972	8.29	7.94	2.17	1.74
1973	8.62	7.96	1.39	0.60
1974	7.88	7.12	1.42	0.54
1975	4.30	4.90	-2.43	-1.66
1976	2.27	2.78	-3.74	-3.19
1977	3.37	2.98	-2.35	-2.82
1978	2.87	3.48	-2.77	-2.05
1979	2.88	2.67	-2.40	-2.66
1980	3.63	2.71	-1.50	-2.54
1981	3.70	3.58	-1.76	-1.87
1982	1.51	1.82	-3.39	-3.05
1983	1.18	1.27	-3.99	-3.90
1984	2.38	2.53	-2.57	-2.40
1985	2.44	2.30	-2.47	-2.64
1986	1.27	1.55	-3.71	-3.40
1987	0.25	0.87	-4.27	-3.59
1988	1.23	1.30	-3.02	-2.95
1989	1.17	0.62	-2.73	-3.34

[a]Actual budget balance in percent of nominal gross domestic product.
[b]Structural budget balance in percent of nominal potential output.

Data sources: Austrian Statistical Office, WIFO data base, own calculations.

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