Stochastic Fiscal Projections with Cyclical and Long-Term Uncertainty

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Abstract

Several recent efforts to improve budget forecasting techniques have emphasized the uncertainties inherent in projections of economic behavior and demography. Previous attempts to present stochastic budget projections for the U.S. have successfully incorporated sources of long-run uncertainty but have not attempted to model business cycle fluctuations realistically. While perhaps reasonably accurate in the long run, stochastic models that ignore cyclical uncertainty offer relatively few insights into the short-run uncertainties that may be of greater concern to policymakers. This paper develops a new and parsimonious framework for incorporating both cyclical and long-run uncertainty into a single, consistent set of stochastic budget projections, and it presents new long-term budget forecasts for the U.S. federal government and combined state and local governments that highlight the role of short-term uncertainty.

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1 Introduction

As the product of an array of uncertain components, fiscal projections are inherently fraught with uncertainty. Within U.S. policymaking circles, decisions concerning fiscal policies have typically been informed by less than a full accounting of the uncertainty, however.

Still, budget forecasting has come a long way over the past decade. There is heightened awareness of the long-run implications of current fiscal policies, which are concisely expressed by Auerbach, Gokhale and Kotlikoff (1994) and which echo back to themes originally raised by the Greenspan Commission on Social Security reform in the early 1980s. Robust economic growth and the concomitant surge in federal tax receipts during the 1990s combined with complex political conditions to foster interest in longer-term fiscal planning (Elmendorf, Liebman and Wilcox, 2001).

New probabilistic methods of demographic forecasting were introduced by Lee and Carter (1992) and Lee and Tuljapurkar (1994), and Lee and Tuljapurkar (1998) subsequently applied these methods to long-term forecasts of the Social Security system. These techniques incorporate uncertainty into projections by building them from the ground up with a set of stochastic processes chosen to represent fundamental components of economics and demography, typically fertility, mortality, productivity growth, and real interest rates. Later efforts have generalized the application of these techniques. Lee, Tuljapurkar and Edwards (1998) and Lee and Edwards (2002) project the entire federal budget and an aggregate state and local budget for the U.S., while Lee, Edwards and Miller (2002) examine budget pressures faced by the state of California.

Along with a more general sense of the uncertainties underlying fiscal projections, these stochastic forecasting techniques have been slowly infiltrating policymaking circles over the past several years. While stopping far short of adopting these new techniques for their own projections, the U.S. Congressional Budget Office (CBO), charged with providing short and long-term fiscal forecasts to Congress, has occasionally presented probabilistic projections alongside its long-range scenario forecasts. Beginning in January 2001, CBO (2001, 2002) has added a probability fan to its five-year federal deficit forecast made at the start of each calendar year. The probability fan is based on CBO's past record of forecast errors.[1] Although never a centerpiece of the

[1] Auerbach (1999) discusses the quality of CBO's revenue forecasts and finds much room

legislative battle in the summer of 2001 over the Bush tax package, CBO's probabilistic assessment of short-run fiscal balance marked an important step in the refinement of policy advising. With only a very limited array of past forecasts available, however, the CBO approach is significantly restricted in its applicability, however.[2] Constructing forecasts based instead on stochastic components is the more flexible approach.

This paper reformulates the "ground-up" stochastic forecasts of U.S. federal and state and local budgets in Lee and Edwards (2002) in order to explicitly account for sources of short-run uncertainty as well as long-run uncertainty. In so doing, it establishes a closer link between academic research on fiscal uncertainties, which has tended to be more long-term in focus, and current methods of expressing fiscal uncertainties to policymakers, which are by nature better attuned to current political priorities. Earlier research extending probabilistic techniques to fiscal pressures faced by the U.S. Social Security system could sidestep any direct treatment of uncertainty deriving from business cycle fluctuations due to nature of the program.[3] Most other forms of taxes and spending are considerably more sensitive to such variability, however; prime examples include sales tax receipts of state and local governments, various types of cash and in-kind assistance programs, and the unemployment compensation program. Thus an explicit treatment of the effects of business cycle uncertainty is warranted in the case of government budgets in general.

The sections that follow describe short-run variability in government finances, discuss its sources, and propose a flexible framework for incorporating short-run and long-run uncertainty in fiscal projections. Section 2 explores theoretical arguments why government finances ought to display short-run deviations from trend growth, and Section 3 presents the empirical patterns

for improvement, although there appear to be few differences in the quality of forecasts made by CBO versus those made by private groups. The argument can be succinctly summarized in the observation that forecast errors are not ex post IID, as one would expect if the forecast were efficient.

[2]Since 10-year CBO forecasts were only made beginning in 1996, the larger set of past 5-year forecasts offers a more precise look at forecasting error.

[3]Inflows are based on payroll taxes, which fluctuates cyclically as does payroll employment. To the extent that variation in labor productivity, which is explicitly accounted for by Lee and Tuljapurkar (1998) adequately captures this effect, this point is not a major concern. Although workers who have not yet retired will time their retirement somewhat on the basis of business cycle fluctuations, most research indicates that retiring at the earliest age or the normal retirement age is most likely.

of fiscal fluctuations in the U.S. Section 4 shows how a simple linear filtering technique can layer realistic short-run fluctuations over top of a more familiar model of long-run uncertainty. Section 5 provides a new set of stochastic fiscal projections for the U.S. that accounts for both short-run and long-run sources of uncertainty in a simple and consistent framework, and Section 6 provides concluding remarks.

2 Fiscal fluctuations in theory

In order to motivate the discussion of short-term fluctuations in government activities, it is useful first to consider long-term growth trends. Government spending is primarily based on the demand for certain types of activities, while taxation is best interpreted as the cost of that demand but can also be viewed more mechanistically as a function of economic activity.

Most government spending can be broken down into two broad categories: public purchases of goods and services, and transfer payments. It is reasonable to expect that the demand for public goods ought to grow with income, along with the demand for private goods. This line of reasoning assumes that there are political solutions to the standard agency problems that can confound the optimal provision of public goods, and that the consumption of public goods complements the use of private goods. Transfer payments are resources directed toward particular citizens generally because of need or age. If one is willing to assume a fairly stable distribution of need by age and in proportion to per-capita income, then transfer payments are likely to grow in the long run according to the age distribution of the population and per-capita income. Taxation generally impacts either income flows or consumption. Given stable tax rates and behavior, taxes will therefore tend to grow with income over time. To the extent that consumption behavior or income trajectories may be tied to age, it is also reasonable to expect that certain categories of taxation may grow more with specific age groups and per-capita income rather than aggregate income. Long-term budget projections such as those presented by CBO (2000) and Lee and Edwards (2002) use essentially these assumptions.

In the short run, it is abundantly clear that business cycle considerations will affect taxes and spending in other ways. Demand for publicly provided goods is likely to ebb and flow according to the business cycle just as demand for private goods does, to the extent they are complementary. Need-based transfer payments ought to increase as the level of need rises during recessions. Taxes typically are based on economic activity and so will fluctuate alongside it. In particular, the progressivity of marginal income taxes means that real rates fall during periods of temporarily lower income, and falling marginal tax rates may spur economic activity as well as increasing disposable incomes.[4] Although the effect is ambiguous, a recession may also see shrinking capital income taxes, which are triggered on realization rather than accrual, to the extent that asset prices are procyclical and investors are "loss-averse." These phenomena have been collectively dubbed "automatic stabilization" because such increases in government spending and decreases in taxes during periods of macroeconomic weakness will tend to have countercyclical effects on economic activity.[5]

Traditional forecasting methods, employed by government and private forecasters alike, do not attempt to predict recessions, let alone project their likely effects on revenues and expenditures.[6] Without a doubt, this one of the primary reasons why official fiscal projections tend to exhibit serially correlated errors as reported by Auerbach (1999). Since the effects of business cycles on fiscal pressures will surely die out in the long run, previous efforts in stochastic forecasting focusing on long-term fiscal pressures have likewise omitted any overt treatment of business cycle uncertainty impinging tax receipts or spending. The next section illustrates how empirically important the operation of automatic stabilizers, as described in this section, actually is in fully accounting for short-run uncertainty in fiscal projections.

[4]Theoretically speaking, falling marginal tax rates have an ambiguous effect on labor supply due to countervailing income and substitution effects. The empirical question is which effect tends to dominate; this remains a point of ongoing debate.

[5]Auerbach and Feenberg (2000) discuss the response of federal taxes and spending to business cycle fluctuations. They report that federal income taxes and payroll taxes offset almost 10 percent of a GDP shock.

[6]Economists generally do attempt to separate cyclical and trend components of economic and fiscal developments, however, in order to present forecasts based on trend or "potential" growth rates rather than on temporary cyclical developments. When the economy is growing faster than its potential, forecasters typically predict a gradual deceleration to a sustainable rate, and conversely, a gradual acceleration back to potential is usually forecast when in the middle of a recognizable recession.

3 Empirical short-run fluctuations

As recent history indicates, business cycles have large and frequently unexpected effects on revenues and expenditure across multiple levels of government. At the federal level, the recession dated at having begun in March 2001 by the National Bureau of Economic Research (NBER) has contributed significantly to the diminution of the huge multi-year cumulative surplus that was earlier foreseen by the CBO. States and localities are also widely reported to be facing huge budget shortfalls as an result of the downturn.[7]

Some care must be taken when choosing the data and specifying the relationship between cyclical shocks and government activity. In particular, two issues complicate the empirical analysis. First, accounting conventions vary widely, most noticeably across levels of government but also in regard to the purpose. Second, since part of government spending is also economic activity, namely the purchase of goods and services, any comparison of government expenditure to economic activity must resolve the issue of endogenous feedbacks between them.[8]

At the federal level, flows are available back to the beginning of the 20th

[7]To be sure, many political events were correlated with this most recent business cycle, underlining the complications involved in disentangling and categorizing the various competing budget influences. Tax cuts at the state and local level during the 1990s boom were surely prompted by that period's abnormally bursting state coffers. The large federal tax cut of 2001 was similarly engendered by the cyclical bonanza. Even the welfare reform act of 1996 could potentially be interpreted as tied to cyclical developments; certainly any pain felt by potential welfare recipients at the time may have been partially mitigated by the robust labor markets of the period.

Such a "political motive force" that alters taxes or spending can be viewed as an additional source of uncertainty beyond the four traditional sources — mortality, fertility, productivity, and interest rates — and the one new source considered here, the business cycle. Traditional methods of creating fiscal projections treat political behavior as fixed at current levels, much as economic and demographic variables are assumed to follow predictable steady-state growth. But disentangling the effect of political uncertainty from business cycle uncertainty is bound to be excessively costly, if it is even possible. As a result, the concept of business cycle uncertainty used in this paper includes that component of political uncertainty that is similarly correlated with the business cycle.

[8]At both levels of government, most of the contribution to GDP takes the form of consumption expenditures. In particular, the value of services as measured by the compensation of government employees. The implications for the cyclicality of government spending are unclear. On the one hand, it seems unlikely that government employees face as large a threat of layoffs as private workers do. But compensation patterns may be far more easily frozen during periods of economic malaise.

Century and earlier on a fiscal-year basis from the Office of Management and Budget. The U.S. Census Bureau presents fiscal-year estimates of state and local budgets at annual frequencies that are based on periodic censuses of governments. The definition of the fiscal year varies widely across these two data sources, and there are undoubtedly many latent effects of changes in accounting conventions over time. The Bureau of Economic Analysis (BEA) within the U.S. Department of Commerce provides annual data for federal and aggregated state and local levels on a calendar-year basis back to 1929 as part of its National Income and Product Accounts (NIPA). As described by the BEA (1988), the NIPA government finance data have been drawn largely from the other two sources, but they are presented on a single, consistent basis that conforms to the measurement of the nation's gross domestic product.[9] Although the NIPA data are more aggregated and far less detailed than the original source data, they are preferred for their consistent format and ease of comparison to measures of economic activity.

Figures 1–4 depict real per-capita levels of federal and state and local spending and taxes based on annual NIPA aggregates. In each figure, vertical lines demarcate years in which the NBER has dated the onset of recessions. Figure 1 displays fluctuating federal expenditures and receipts since 1929, with the massive increase of real spending during World War II the most visible characteristic. Since 1970, spending has tended to outstrip revenues considerably, a trend that was briefly reversed in the late 1990s due jointly to a plateau in spending and a long period of growth in taxes. By focusing on a smaller timespan, Figure 2 better demonstrates the federal automatic stabilizers at work. Following each recession, revenues tumbled while spending either jumped up slightly or continued on an upward trend. Cyclical movements in receipts appear to be stronger than in expenditures, which is consistent with previous findings.

State and local finances, as shown in Figures 3 and 4, exhibit similar but much more muted cyclical dynamics. Part of the smoothness of state and local aggregates may be due to the quality of the data and the interpolation

[9] As described in the reference, government accounting standards typically record cash flows rather than, for example, deliveries of goods and services. The NIPA accounts, which adopt the latter standard in relevant cases, therefore record the timing of government finance differently. There are also significant differences between NIPA accounting and financial accounting regarding the netting of amounts. An example is a user fee such as a Medicare Part B premium, which the NIPAs record as a revenue with a mirror image expenditure and which the U.S. Budget records as an offset against expenditure.

methods that BEA uses to fill in gaps between censuses of state finances. The fact that spending tracks revenues much more closely at the state and local level also tends to visually obscure some of the cyclicality in revenues. This is undoubtedly due to the widespread use of balanced-budget rules at the state and local level in the U.S.

For expository purposes, Figure 5 displays expenditures and receipts per GDP at both levels of government over the entire period covered by the NIPAs. Federal spending and taxes began the period at lower shares of GDP than their state and local counterparts, but the New Deal and World War II quickly reversed that relationship as federal activities crowded out state and local activities. Since the 1950s, the size of the federal government relative to the economy has remained roughly stable, while the size of state and local government grew steadily until 1975 before reaching a plateau.

4 A simple linear filtering technique

Many insights can be garnered from applying a simple linear filter to the data displayed in Figures 1–5. As suggested by Figure 5 and the loglinearity of real GDP over time, a good choice for a linear regression model of taxes and spending is one of changes in log real per-capita levels. In particular, a pair of simple linear models for revenues, R, and expenditures, E, can be written as

$$\Delta \log \frac{E_t^g}{N_t} = \alpha_E^g + \sum_{s=\tau}^{T} \beta_{E,s}^g \Delta \log \frac{Y_{t-s}}{N_{t-s}} + \epsilon_{E,t}^g \tag{1}$$

$$\Delta \log \frac{R_t^g}{N_t} = \alpha_R^g + \sum_{s=\tau}^{T} \beta_{R,s}^g \Delta \log \frac{Y_{t-s}}{N_{t-s}} + \epsilon_{R,t}^g, \tag{2}$$

for $g = f, s$ representing the level of government, where N is the population, Y is GDP, and the ϵ's are assumed to be normal and IID. The distributed lag structure includes up to T lags and can include contemporaneous effects if $\tau = 0$. It is reasonable to impose several constraints on (1) and (2). Requiring $\sum_s \beta_s = 1$ and setting $\alpha_E = \alpha_R = 0$ forces spending and taxes to maintain a constant share of GDP in the long run. Based on Figure 5, these appear to be justifiable restrictions.

Based on the workings of automatic stabilizers, one would expect to see real growth in spending to have a zero or small negative response to a positive output shock in the early going. Growth in revenues should have a large positive response in the short run, greater than 1-for-1 owing to the progressivity of the tax system, followed by some smaller declines that pull the long-run effect back to 1-for-1. Formally, one expects $\beta_{E,s} < 0$ and $\beta_{R,s} > 1$ for s near zero, and $\beta_{E,s} > 0$ and $\beta_{R,s} < 0$ for larger s, so that $\sum \beta_E = \sum \beta_R = 1$.

As mentioned in Section 3, the parts of E^f and E^s that represent government purchases of goods and services are also part of GDP $= C + I + G + X - IM$. This is clearly not an issue with revenues. But to avoid problems of endogenous feedbacks in (1), either Y must be defined as GDP excluding G, or E^g must be constructed to exclude G.

Tables 1 and 2 report estimates of linear filter coefficients in the spending regression (1) using the former specification; the dependent variable is the log change in total federal spending, and the independent variables are lagged log changes in non-government GDP. Table 1 presents coefficient estimates in four different specifications arrayed in columns that differ according to the length of the distributed lag. Signs and magnitudes fluctuate considerably across the four specifications, with the one constancy being a large positive estimate of $\beta^f_{E,2}$ that ranges between roughly 0.6 and 0.8. Much smaller negative coefficients do appear in the earlier lags, but individually these are not statistically different from zero. Table 2 confirms this result by showing the effect of repeating the calculations after dropping the contemporaneous effect. Other coefficient estimates do not change much.

Table 3 reformulates the analysis of federal spending responses with contemporaneous coefficients by netting out federal government purchases of goods and services and using full GDP rather than GDP excluding government spending. Although fairly similar to Tables 1 and 2, Table 3 demonstrates that there is somewhat more evidence of automatic stabilization among federal government spending outside of goods and services. Point estimates of $\beta^f_{E,0}$ drop to -0.3 when spending is limited to transfer payments, although they remain very imprecise.

Federal receipts display exactly the kind of excess sensitivity to GDP fluctuations that is predicted, as is shown in Table 4. Revenues initially rise by about 1.5 percent for every percentage increase in GDP, rise by another small amount after one year, and then recede by about 0.5 percent over the next three years. The contemporaneous effect is quite robust across lag specification.

Tables 5–7 extend the same analysis to state and local finances, finding fairly different results. Table 5, which depicts the relationship between total state and local spending and GDP excluding government, finds fairly little evidence for automatic stabilizers at the state and local level. Early coefficients are positive and sometimes significant, suggesting little offset to economic fluctuations. In Table 6, state and local spending is netted of its productive component and regressed on full GDP with fairly incoherent results. It seems likely that some misspecification is present, perhaps concerning the secular growth in state spending per GDP between 1950 and 1975.

State and local receipts do appear to behave more as one would predict, however. While showing little evidence of a stabilizing effect, Table 7 does suggest that revenues respond fairly quickly to GDP shocks, with a contemporaneous rise in revenues of about two-thirds of a percent for each percentage increase in GDP, and the remaining third of a percent spread fairly evenly across the next several years.

The results presented in this section confirm a stabilizing role for fiscal policy in general, and for federal taxes in particular. A simple linear filtering technique applied to data on federal and state and local finances suggests that federal spending may rise slightly in immediate response to an adverse output shock, but tends to fall substantially by the second year after the shock. Federal taxes provide more stabilization, immediately falling by 1.5 percent in response to fall in output of 1 percent, and gradually rising 0.5 percent over several years. State and local spending seems to respond negatively but gradually to an output shock, while state and local receipts respond more quickly but do not exhibit much stabilization.

5 New forecasts of short- and long-run fiscal pressures in the U.S.

Using the linear filter coefficients described in Section 4, forecasts of fiscal aggregates can branch off a simple projection of GDP per capita while exhibiting realistic short-run fluctuations. Such forecasts are able to address policymakers' concerns about short-run volatility in fiscal targets while not sacrificing the ability to make long-term predictions.

The linear filter could also be applied with an additional stochastic element, namely the forecast errors $\epsilon^g_{E,t}$ and $\epsilon^g_{R,t}$ in (1) and (2). There have been differences in how fiscal aggregates have responded to economic fluctuations over time, and applying the linear filter complete with its error term reflects the inherent uncertainty about exactly how an output shock will impinge upon government finances. This uncertainty may derive from the uneven incidence of hard times on the population, or by nonlinear feedbacks perhaps operating through countervailing income and substitution effects.

Figure X displays a ten-year projection of the federal unified budget deficit by layering the linear filter without error terms on top of a standard projection of the population by age, productivity, and real interest rates. Figure Y adds in the additional uncertainty relating to the linear filter estimates. There is not much / a lot of difference between them.

Figure XY compares CBO's five-year probability fan around its federal deficit estimates with the results of the new model. CBO's fan is larger / smaller than the new fan.

Figure Z projects the federal unified deficit from the present day until 2100 using the new model incorporating both short-run and long-run uncertainty. Compared with Figure AA, which depicts a deficit projection over the same time period using the old technique with only long-run uncertainty, it is plain to see that business cycle volatility does not significantly alter long-run fiscal pressures. This is not at all a surprising result, of course. The view taken here is that business cycles exert only transitory effects, a conclusion based on the preponderance of historical patterns.

6 Conclusion

There is considerable uncertainty surrounding budget projections in both the short run and in the long run. Previous efforts to apply new methods of stochastic forecasting to traditional fiscal policy studies have focused on long-run sources of uncertainty while inadequately addressing fluctuations in taxes and spending arising from business cycle volatility, traditionally referred to as automatic fiscal stabilizers.

This paper builds on earlier research into probabilistic methods for long-term forecasting, offering a parsimonious augmentation of the basic stochastic model that layers business cycle fluctuations on top of trend growth in government revenues and spending. This simple model bridges the gap between models of long-run fiscal uncertainties and models that analyze forecasting errors retrospectively, which are less flexible but offer insights into the near-term questions that may be of greater concern to policymakers.

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Table 1: Linear filter coefficients for federal expenditures

$\beta^f_{E,0}$	−0.0585	−0.0147	0.0038	−0.0206
	(0.2062)	(0.1608)	(0.1549)	(0.1734)
$\beta^f_{E,1}$	0.4863*	−0.0324	−0.0217	−0.0102
	(0.2109)	(0.1716)	(0.1602)	(0.1672)
$\beta^f_{E,2}$	0.5722*	0.8583*	0.6195*	0.6247*
	(0.1868)	(0.1558)	(0.1587)	(0.1638)
$\beta^f_{E,3}$		0.1889	0.3135*	0.2673
		(0.1451)	(0.1449)	(0.1620)
$\beta^f_{E,4}$			0.0849	0.1168
			(0.1398)	(0.1527)
$\beta^f_{E,5}$				0.0219
				(0.1555)

Notes: See notes to Table 2.

Table 2: Linear filter coefficients for federal expenditures, no contemporaneous effect

$\beta^f_{E,1}$	0.4504*	−0.0398	−0.0203	−0.0156
	(0.1674)	(0.1495)	(0.1474)	(0.1589)
$\beta^f_{E,2}$	0.5496*	0.8557*	0.6201*	0.6230*
	(0.1674)	(0.1517)	(0.1551)	(0.1614)
$\beta^f_{E,3}$		0.1841	0.3142*	0.2658
		(0.1342)	(0.1406)	(0.1596)
$\beta^f_{E,4}$			0.0860	0.1123
			(0.1314)	(0.1461)
$\beta^f_{E,5}$				0.0146
				(0.1411)

Notes to Tables 1 and 2: Numbers are results of estimating (1) using federal government total spending, GDP, prices, and population data from the National Income and Product Accounts. The data are annual from 1948 through 2001. Columns represent separate regressions. The independent variable is the change in log real total federal expenditures per capita, while the dependent variables are (lags of) the change in log real GDP *excluding government consumption and gross investment* per capita: $\beta^f_{E,0}$ is the contemporaneous effect, while $\beta^f_{E,1}$ is the first lag, etc. Standard errors are in parentheses. Asterisks denote significance at the 5% level. In each regression, the sum of β's is constrained to be 1. There is no constant term in the regressor set.

Table 3: Linear filter coefficients for federal expenditures excluding consumption and gross investment

$\beta^f_{E,0}$	−0.0837	−0.1347	−0.3194	−0.3730
	(0.2538)	(0.2422)	(0.2372)	(0.2508)
$\beta^f_{E,1}$	0.0013	0.0754	0.0915	0.0477
	(0.2687)	(0.2589)	(0.2466)	(0.2568)
$\beta^f_{E,2}$	1.0824*	0.6196*	0.7037*	0.6903*
	(0.2372)	(0.2534)	(0.2472)	(0.2546)
$\beta^f_{E,3}$		0.4397	0.0997	0.0847
		(0.2253)	(0.2377)	(0.2518)
$\beta^f_{E,4}$			0.4246	0.3664
			(0.2202)	(0.2467)
$\beta^f_{E,5}$				0.1840
				(0.2333)

Notes: Numbers are results of estimating (1) using federal government total spending, GDP, prices, and population data from the National Income and Product Accounts. The data are annual from 1948 through 2001. Columns represent separate regressions. The independent variable is the change in log real federal expenditures *excluding consumption and gross investment spending* per capita, while the dependent variables are (lags of) the change in log real GDP per capita: $\beta^f_{E,0}$ is the contemporaneous effect, while $\beta^f_{E,1}$ is the first lag, etc. Standard errors are in parentheses. Asterisks denote significance at the 5% level. In each regression, the sum of β's is constrained to be 1. There is no constant term in the regressor set.

Table 4: Linear filter coefficients for federal receipts

$\beta^f_{R,0}$	1.3734*	1.4101*	1.4659*	1.5865*
	(0.1895)	(0.1918)	(0.2046)	(0.2073)
$\beta^f_{R,1}$	0.1831	0.1530	0.1728	0.2655
	(0.2006)	(0.2051)	(0.2127)	(0.2123)
$\beta^f_{R,2}$	−0.5565	−0.3013	−0.2878	−0.2515
	(0.1771)	(0.2007)	(0.2132)	(0.2105)
$\beta^f_{R,3}$		−0.2618	−0.1900	−0.1447
		(0.1785)	(0.2050)	(0.2081)
$\beta^f_{R,4}$			−0.1609	−0.0476
			(0.1899)	(0.2040)
$\beta^f_{R,5}$				−0.4082*
				(0.1929)

Notes: Numbers are results of estimating (2) using federal government total receipts, GDP, prices, and population data from the National Income and Product Accounts. The data are annual from 1948 through 2001. Columns represent separate regressions. The independent variable is the change in log real total federal receipts per capita, while the dependent variables are (lags of) the change in log real GDP per capita: $\beta^f_{R,0}$ is the contemporaneous effect, while $\beta^f_{R,1}$ is the first lag, etc. Standard errors are in parentheses. Asterisks denote significance at the 5% level. In each regression, the sum of β's is constrained to be 1. There is no constant term in the regressor set.

Table 5: Linear filter coefficients for state and local expenditures

$\beta^s_{E,0}$	0.3552*	0.2408*	0.1887	0.1498
	(0.0963)	(0.0952)	(0.1000)	(0.1114)
$\beta^s_{E,1}$	0.1467	0.1675	0.1315	0.1299
	(0.0986)	(0.1016)	(0.1034)	(0.1074)
$\beta^s_{E,2}$	0.4981*	0.3480*	0.3511*	0.3466*
	(0.0873)	(0.0923)	(0.1024)	(0.1052)
$\beta^s_{E,3}$		0.2437*	0.1907*	0.1555
		(0.0859)	(0.0936)	(0.1040)
$\beta^s_{E,4}$			0.1379	0.1528
			(0.0902)	(0.0980)
$\beta^s_{E,5}$				0.0655
				(0.0999)

Notes: Numbers are results of estimating (1) using state and local government total spending, GDP, prices, and population data from the National Income and Product Accounts. The data are annual from 1948 through 2001. Columns represent separate regressions. The independent variable is the change in log real total state and local expenditures per capita, while the dependent variables are (lags of) the change in log real GDP *excluding government consumption and gross investment* per capita: $\beta^s_{E,0}$ is the contemporaneous effect, while $\beta^s_{E,1}$ is the first lag, etc. Standard errors are in parentheses. Asterisks denote significance at the 5% level. In each regression, the sum of β's is constrained to be 1. There is no constant term in the regressor set.

Table 6: Linear filter coefficients for state and local expenditures excluding consumption and gross investment

$\beta^s_{E,0}$	0.1005	0.0326	−0.0956	−0.2532
	(0.3830)	(0.3382)	(0.3507)	(0.3601)
$\beta^s_{E,1}$	−0.8358*	−0.6658	−0.8058*	−0.9544*
	(0.4054)	(0.3615)	(0.3646)	(0.3687)
$\beta^s_{E,2}$	1.7354*	0.8816*	0.7012	0.6830
	(0.3580)	(0.3538)	(0.3655)	(0.3655)
$\beta^s_{E,3}$		0.7516*	0.7059*	0.7012
		(0.3146)	(0.3515)	(0.3615)
$\beta^s_{E,4}$			0.4942	0.2638
			(0.3257)	(0.3543)
$\beta^s_{E,5}$				0.5596
				(0.3350)

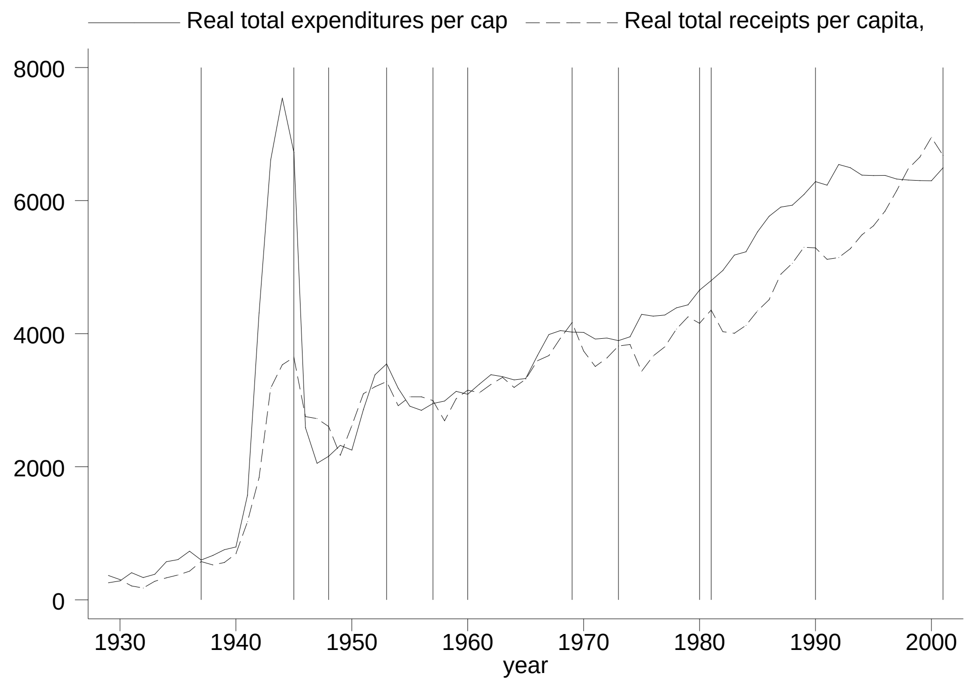
Notes: Numbers are results of estimating (1) using state and local government total spending, GDP, prices, and population data from the National Income and Product Accounts. The data are annual from 1948 through 2001. Columns represent separate regressions. The independent variable is the change in log real state and local expenditures *excluding consumption and gross investment spending* per capita, while the dependent variables are (lags of) the change in log real GDP per capita: $\beta^s_{E,0}$ is the contemporaneous effect, while $\beta^s_{E,1}$ is the first lag, etc. Standard errors are in parentheses. Asterisks denote significance at the 5% level. In each regression, the sum of β's is constrained to be 1. There is no constant term in the regressor set.

Table 7: Linear filter coefficients for state and local receipts

$\beta^s_{R,0}$	0.7563*	0.7227*	0.6539*	0.5988*
	(0.1190)	(0.1190)	(0.1236)	(0.1281)
$\beta^s_{R,1}$	−0.0296	−0.0194	−0.0476	−0.0820
	(0.1259)	(0.1272)	(0.1285)	(0.1311)
$\beta^s_{R,2}$	0.2733*	0.0968	0.0741	0.0490
	(0.1112)	(0.1244)	(0.1288)	(0.1300)
$\beta^s_{R,3}$		0.1999	0.1164	0.0799
		(0.1107)	(0.1238)	(0.1286)
$\beta^s_{R,4}$			0.2031	0.1753
			(0.1148)	(0.1260)
$\beta^s_{R,5}$				0.1790
				(0.1192)

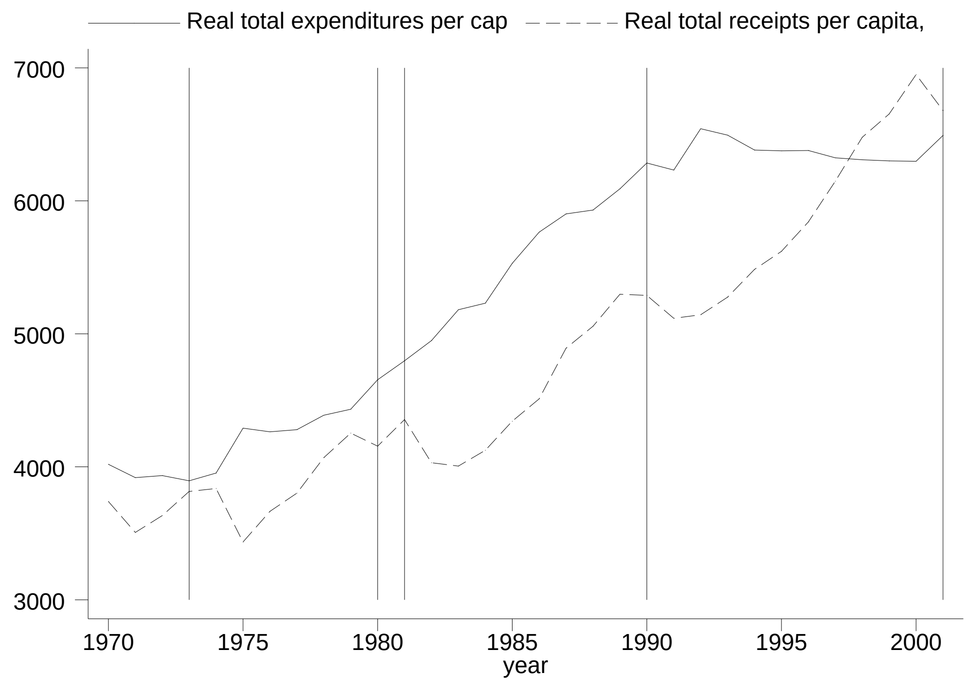
Notes: Numbers are results of estimating (2) using state and local government total receipts, GDP, prices, and population data from the National Income and Product Accounts. The data are annual from 1948 through 2001. Columns represent separate regressions. The independent variable is the change in log real total state and local receipts per capita, while the dependent variables are (lags of) the change in log real GDP per capita: $\beta^s_{R,0}$ is the contemporaneous effect, while $\beta^s_{R,1}$ is the first lag, etc. Standard errors are in parentheses. Asterisks denote significance at the 5% level. In each regression, the sum of β's is constrained to be 1. There is no constant term in the regressor set.

Figure 1: Real per-capita federal expenditures and receipts



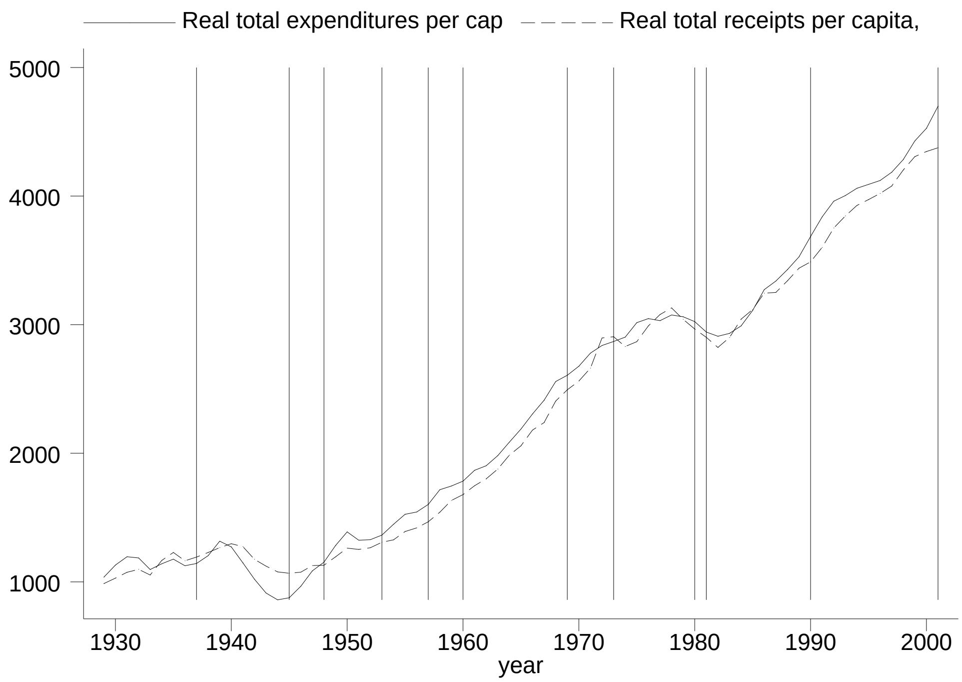
Notes: Data are constructed from annual government aggregates from NIPA Table 3.2, mid-year population estimates from NIPA Table 2.1, and annual estimates of the chain-type implicit price deflator for federal government consumption and gross investment spending from NIPA Table 7.1. Spending and receipts are deflated using the same price index. Total expenditures are total current expenditures plus gross investment plus net purchases of nonproduced assets, while total receipts are total current receipts plus consumption of fixed capital and net capital transfers. Their difference is net borrowing or lending. Vertical lines denote years in which the National Bureau of Economic Research dated the beginning of a recession.

Figure 2: Real per-capita federal expenditures and receipts after 1970



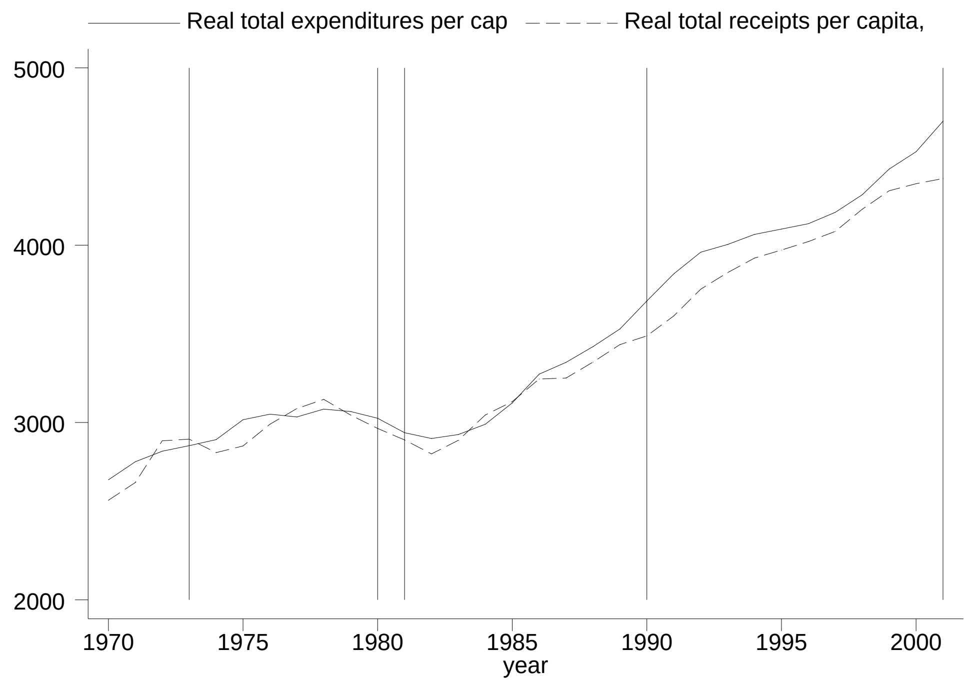
Notes: See notes to Figure 1.

Figure 3: Real per-capita state and local expenditures and receipts



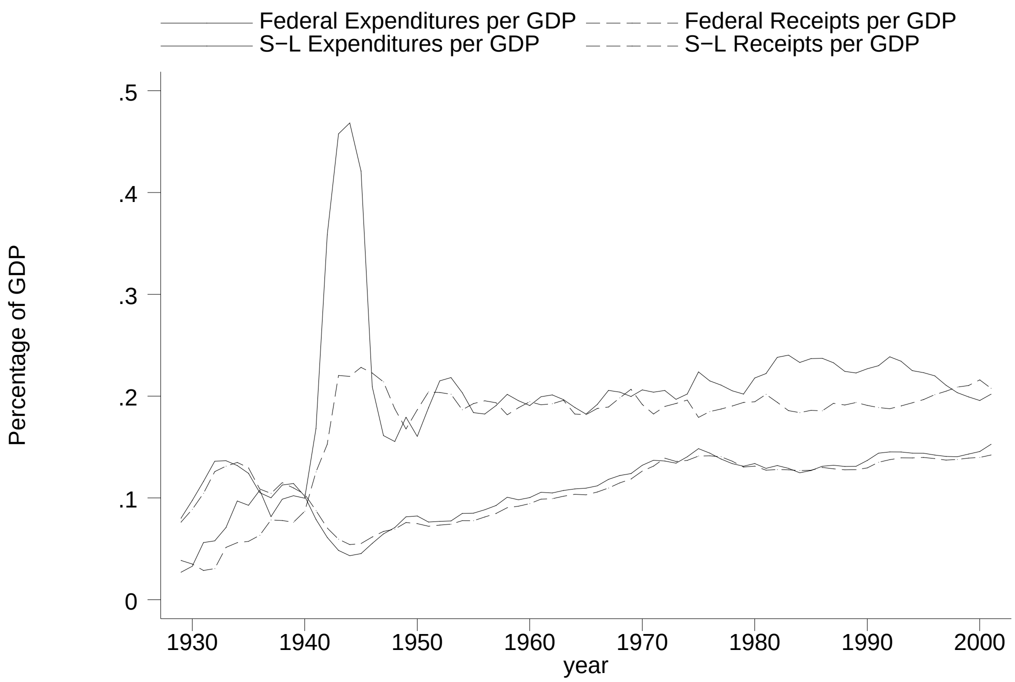
Notes: Data are constructed from annual government aggregates from NIPA Table 3.3, mid-year population estimates from NIPA Table 2.1, and annual estimates of the chain-type implicit price deflator for state and local government consumption and gross investment spending from NIPA Table 7.1. Spending and receipts are deflated using the same price index. Total expenditures are total current expenditures plus gross investment plus net purchases of nonproduced assets, while total receipts are total current receipts plus consumption of fixed capital and net capital transfers. Their difference is net borrowing or lending. Vertical lines denote years in which the National Bureau of Economic Research dated the beginning of a recession.

Figure 4: Real per-capita state and local expenditures and receipts after 1970



Notes: See notes to Figure 3.

Figure 5: Government expenditures and receipts per GDP



Notes: See notes to Figures 1 and 3. Nominal figures are used without deflating. The GDP data come from NIPA Table 1.1. Each number is to be interpreted as the size of government relative to the economy, not government's contribution to GDP in the form of goods and services produced, which is a smaller amount.