

Comparing Alternative Methods of Adjusting U.S. Federal  
Fiscal Deficits for Cyclical and Price Effects

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## **Abstract:**

The modifications of the measurement of the federal deficit proposed by Eisner and others raise the question of whether the enhanced deficit measures, which are improvements in the sense of assessing the fiscal stance of the federal government at any given moment, also improve the results in time-series studies with the deficit as an exogenous variable. Eisner and Pieper, and Eisner alone, have claimed that their “price-adjusted high-employment deficit” (PAHED) performs better in econometric studies than do less sophisticated measures. My recent paper came to the same conclusion for measurements of the fiscal deficit at the federal level.

This paper begins by investigating the robustness of that conclusion; but this investigation leads quickly into an analysis of two related questions: whether the two government-generated structural deficit series are related to output and unemployment in statistically different ways, and whether the two most prominent methods of price adjustment for the “inflation tax” are different in their statistical properties. I use standard multiple regression analysis, Granger-causality tests, unrestricted vector-autoregressions (VAR's), and block exogeneity tests of restricted VAR's to assess the different measures of the fiscal deficit.

The four general conclusions that one can tentatively draw from the empirical analysis summarized here are: 1) the claim that price-adjusted high-employment deficits are statistically superior to non-price-adjusted structural deficits is supported (albeit somewhat weakly in some tests); 2) the two official structural deficit series, despite several key differences in their definition and derivation, produce surprisingly similar regression results, 3) different methods of computing the “inflation tax” or “price effects” *do* appear to affect the level of statistical significance of price-adjusted deficits in tests of output and unemployment relationships, and 4) the strength of the results is notably dependent on the choice of time periods. These results have some ambiguities, however, depending on the statistical test one uses.

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## **I. Introduction**

The federal budget deficit has become the economic issue of central concern for U.S. policy makers in the mid-1990's. Among the leading spokesmen for the two major parties, there is unanimous agreement that the continuing deficits are a significant problem that must be solved by the year 2002, with the only disagreement being over the means of eliminating the deficit.

Moreover, Congress failed by a single vote in the Senate to pass a balanced-budget amendment to the U.S. Constitution in 1995, and by two votes in mid-1996; but there is every indication that the amendment will not go away. After the 1996 elections, at the latest, yet another vote will almost certainly be taken. The Balanced-Budget Amendment may well spend the last years of the twentieth century (and, quite possibly, the first years of the twenty-first) wending its way through the state legislatures, although it is by no means clear that the necessary thirty-eight states will ever pass it.

Given the overwhelming political support for a balanced federal budget (if not an amendment requiring annual balance), it is worth considering the very different current state of the fiscal policy debate among macroeconomists. The numerous measurement problems associated with fiscal deficits and the public debt have been the subject of intensive study and debate among economists for over a decade. Perhaps the single most important work on this subject was Eisner and Pieper [1984], which

brought to light some important failings in the conventional measures of the public sector's accounts. Virtually every economist who has analyzed the federal balance sheets has reached similar conclusions: that the numbers most often called "the deficit" and "the debt" are poor measures of our fiscal situation and, moreover, that balancing the books based on those numbers is, at the very least, less than an ideal fiscal policy.

Subsequent work, in particular by Eisner, has resulted in a variety of proposed alternatives to the official deficit and debt series published by the U.S. federal government. However, while there does seem to be general consensus that the current series are flawed, there is precious little consensus over what—if anything—should be done about those shortcomings.

The debate over the correct measurement of the government budget deficit is important for two separate reasons: first, and politically most important, it defines the boundaries of the ceaseless debate over what must be done to "balance the nation's books." Second, studies that attempt to correlate the deficit to other macroeconomic phenomena are key elements in attempts to understand the macroeconomics of fiscal policy.

While one can make the case that a single measure of the deficit should be the best based on both criteria, this assertion must be tested. Given the nearly endless variations on how deficits can be measured, it is by no means certain that one measure will emerge as the clearly dominant series, based on both criteria.

Eisner<sup>1</sup> argues [among numerous examples, see 1991, 1993, 1994a, and Eisner and Pieper, 1988, 1992b] that, on the second criterion, the “best” measurement of the deficit (or, at least, a measure superior to others currently in use) is the “price-adjusted high employment deficit” (PAHED<sup>2</sup>), which adjusts the official federal deficit figure for cyclical factors and the so-called inflation tax.<sup>3</sup> Buchanan [1995] used Eisner’s methodology to test seven different specifications of the federal deficit (along with six total-government deficit specifications), but using a different structural deficit series and a different method of computing the inflation tax. Nevertheless, my results confirm that PAHED performs overwhelmingly better than any other federal measure in a variety of econometric tests. (My paper did not challenge Eisner’s arguments about the appropriate measure of the deficit for the first criterion, except to note that the state and local sector—which

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<sup>1</sup> For brevity, I will henceforth refer to all work by Eisner alone and by Eisner and Pieper together as “Eisner,” except in citations. My apologies to Professor Pieper.

<sup>2</sup> Eisner’s papers shift back and forth, seemingly randomly, between defining this variable as a surplus or a deficit, with the only difference being the sign of each observation. For the remainder of this paper, I will consistently refer to the fiscal variable as a deficit, with a negative value indicating a surplus for the relevant year.

<sup>3</sup> On the first criterion—i.e., which measure of the deficit represents “fiscal soundness” at a particular moment—Eisner has argued [1994c] that the separation of the government’s accounts into an operating account and a capital account—with the goal of balance only applied to the operating account—would be strongly preferable to current practice; and it would bring the U.S. federal government into line with most other governments and corporations.

already is separated into operating and capital accounts—should be consolidated with the federal government’s accounts.)

This paper will investigate whether these conclusions about the superiority of the PAHED measure are robust to a variety of alterations to the empirical methods used. The next section will describe the deficit data that are available and the adjustments that Eisner has proposed to improve their meaning. I will then derive a set of hybrid series, using each of the two official deficit series alone and with both methods of computing the inflation tax.

Using those series in Eisner’s specifications and econometric tests from a number of published and unpublished studies, I will test these results against alternative specifications and updated data series. Each of the derived series is then tested using more advanced statistical methods, such as Granger Causality tests, unconstrained vector autoregressions (VAR’s), and Block Exogeneity tests.

In addition to testing the robustness of Eisner’s claim that price-adjustment improves econometric results, this set of tests will also permit comparison of the two structural deficit series published by the federal government, together with a comparison of alternative methods of computing the inflation tax.

The comparison of the two structural deficit series is particularly interesting given that the current trend in the federal government is to discontinue still more series. Whether the now-discontinued series was superior to the remaining one is a key question for macro-econometric analysis. Further, since the results below will show that price adjustment generally does improve the statistical significance of estimates, the method

of price adjustment is potentially important. Isolating those differences is the focus of the remaining sections.

## **II. Deriving the Various Deficit Measures**

There are currently two measures of the fiscal deficit that are most commonly reported in the popular press and referred to in Congressional debates: the on-budget deficit (OBD) and the unified deficit of the federal government (UDF).<sup>4</sup> (When many journalists and politicians refer to the deficit, however, they seem not to be aware that there are differences even between these two measures, with estimates of the two often used interchangeably and seemingly at random.) Both are computed using budget-basis accounting rather than NIPA-basis accounting.<sup>5</sup>

For the purposes of this analysis, however, the comparison will not be between these cash-flow definitions of the deficit, but between different

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<sup>4</sup> A much more complete range of deficit adjustments is explained in detail in Section II of Buchanan [1995]. This section will concentrate only on the structural deficit series and their price-adjusted variants.

<sup>5</sup> NIPA deficits differ from budget-based deficits in several key respects, most notably (in recent years) the exclusion from the NIPA calculations of outlays for deposit insurance. The differences between budget-basis accounting and NIPA-basis accounting are generally much more mundane, however, such as differences in where receipts for certain transfer programs are reported (as negative outlays on the expenditure side for the budget-basis, but as positive values on the receipts side in the NIPA-basis, a difference which nets out of the deficit calculations), as well as some small items that make the accounts slightly different on net, such as the exclusion from the NIPA accounts of Puerto Rico and the U.S. Virgin Islands. See Congressional Budget Office [1994b].

types of cyclically-adjusted, or structural, deficits. Henceforth, therefore, the analysis will exclude OBD and UDF.

### **A. Structural Deficits**

A familiar and basic adjustment to the cash-flow deficit (or, more accurately, to its NIPA-based equivalent) is the separation of structural from cyclical factors. The idea behind the structural deficit is straightforward: it is a hypothetical number, calculated to discover what the deficit would have been had the economy been operating at some specified level of unemployment, often inaccurately referred to as “full” unemployment.

Since, however, there is fierce disagreement over what constitutes full employment (or, indeed, whether such a concept is even meaningful), official government estimates of the structural deficit have side-stepped the issue by substituting some relatively objective unemployment standards for full employment. The Commerce Department’s Bureau of Economic Analysis (BEA) published through mid-1991<sup>6</sup> a series called the “high-

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<sup>6</sup> A continuing source of frustration for analysts of fiscal policy is the cessation of the BEA’s series after the second quarter of 1991. The sweeping revisions announced at that time by the BEA in calculating the NIPA necessitated related revisions in calculating the HED. Unfortunately, the BEA’s budget was cut, preventing them from allocating the resources necessary to make the appropriate revisions. Rather than publish estimates based on outdated methodology, the BEA completely discontinued the series. (With a further, and much more fundamental, set of NIPA revisions recently announced, the BEA’s aging estimates of the structural deficit are now even further out of step with the methodology for estimating other macroeconomic aggregates.) The irony of budget cuts

employment deficit" (HED), based on a constant standard of unemployment (originally 4.9%, but later changed to 6.0%), while the Congressional Budget Office continues to publish a "standardized-employment deficit" (SED), based on a varying unemployment standard.

Neither of these estimates of the structural deficit, however, is calculated with direct reference to the state of the labor market. In the BEA's estimates [see de Leeuw and Holloway, 1983], no claim is made that their standard rate (6.0%) corresponds to anything like "full employment" in the sense of a lack of Keynesian (or involuntary) unemployment. On the other hand, the CBO's standard is the familiar "NAIRU" (non-accelerating inflation rate of unemployment), which might or might not coincide with full employment, depending upon one's theoretical viewpoint.

For the purposes to which the data are used in Eisner's work and here, however, this is potentially not a problem. Since the relationship between unemployment rates and GDP has been thought to be basically linear (by "Okun's Law"<sup>7</sup>), and since the relationship between GDP and deficits is also linear, the result of changing to, say, a four percent unemployment rate as the high-employment standard would be to produce a high-employment deficit that had almost exactly the same variance

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preventing careful analysis of whether budget cuts are even necessary is not lost on the author.

<sup>7</sup> In fact, "the BEA estimates that in the post-1970 period each percentage point of unemployment is associated with 1.9 percent less of cyclically adjusted output." [Eisner and Pieper, 1992a, p. 130] Eisner's calculations for the years prior to 1970 round that up to 2.0%, due to his assumption that productivity was higher during that time.

properties as the BEA's series. The central econometric results, therefore, would be unchanged.

However, work by McNees [1991] indicates that Okun's Law has in fact broken down in recent decades, due mostly to extreme variations in the demographics of the labor force (especially the teenage population). This implies that the debate over which level of unemployment should be called "full," or "natural," or "NAIRU," is potentially important in determining the time-series properties of the structural deficit series; and that debate, therefore, should probably be rejoined. While that is clearly outside of the scope of the current analysis, it is at least possible to include demographic factors in the analyses of unemployment in Section III below.

If the high-employment standard is indeed changing significantly over time (due to, for example, demographic changes or sectoral shifts within the economy), the measurement of the structural deficit could change in such a way as to change the time-series econometric results. The Congressional Budget Office's standardized-employment deficit does have a slight variation over time in the employment standard. However, the time path of NAIRU has been very stable. Prior to 1995 [see CBO, 1994a], the CBO's estimate of NAIRU ranged between 5.0% and 6.0%, although it has not been below 5.5% since 1964. In their latest revisions, [CBO, 1995], the NAIRU range is even smaller, between 5.5% and 6.3%, not falling below 5.8% from 1966 onward.<sup>8</sup>

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<sup>8</sup> Since the recent revisions are not symmetrical, the differences between the unrevised and the revised estimates could potentially alter some empirical results.

Buchanan [1995] is based on the unrevised estimates.

For the analysis here, an appropriate concern is whether it is better to use an unchanging unemployment standard or a variable one—and if a varying one, whether NAIRU is the appropriate standard (and, indeed, whose estimate of NAIRU to use). The basic intuition of the structural deficit concept would seem to argue for a varying standard, since there is no guarantee that the full employment unemployment rate is unchanging. On the other hand, as many economists have noted [see, for example, Weiner, 1993], NAIRU might have no reliable relationship at all to “full employment.” If, for institutional reasons, inflation accelerates before or after full employment is reached, NAIRU will not be the appropriate standard, and a standardized-employment deficit based on NAIRU will not measure what we would want a structural deficit to measure.

We are, therefore, choosing between two approaches to measuring the structural deficit that might be inappropriately designed for the task at hand. However, short of constructing an entirely new series to measure the structural deficit (which would clearly entail a separate research project entirely), the best that can be done here is to compare the empirical results reached by using these two structural deficit series.

In fiscal 1990, HED was estimated to be \$176 billion, or 3.2% of GDP. Based on a NAIRU rate of 6.0% (in the revised CBO methodology), SED was estimated in the same fiscal year to equal \$164 billion, or 3.0% of GDP. In fiscal 1994, SED was estimated to equal \$187 billion, or 2.8% of GDP.

## **B. Price Effects**

If properly measured, the deficit would be equivalent to the change in the net real indebtedness of the federal government, or the net increase in the real value of outstanding government bonds. If there is inflation, and

the government's bonds are not indexed, the value of the outstanding obligations will decrease in real terms during the course of a year. The change in the real debt, therefore, will be smaller than the change in the nominal debt. This is what Eisner refers to as a "price effect," the inclusion of which adjusts a deficit downward for this "inflation tax."

Calculating the price effect can be much more complicated than it might seem. In earlier work [e.g., Eisner and Pieper, 1988], Eisner made adjustments for par-to-market valuations of debt as well as careful accounting for the timing of inflation's effects on previously-issued debt (as opposed to the new debt that is issued throughout the year). An alternative, and much simpler, method is simply to multiply the annual inflation rate by the end-of-year par value of outstanding federal debt held by the public. In either case, the price effect is then subtracted from the cyclically-adjusted deficit to compute the Price-Adjusted High Employment Deficit (PAHED)—or, if starting from the CBO's series, the Price-Adjusted Standardized Employment Deficit (PASED).

Since there turned out to be virtually no empirical difference in his studies between the more careful methods of computing price effects and the simpler method<sup>9</sup>, Eisner now recommends using the simpler method of computing price effects [Eisner, 1994b]. Eisner's calculated price effect in 1990 was \$99 billion, or 1.8% of GNP. The simple method of calculation, for 1990, gives a price effect of \$107 billion, or 2.0% of GDP; and in 1994 it was

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<sup>9</sup> This empirical result was confirmed in an earlier draft of Buchanan [1995] as well. The differences between the two methods—in both direct comparisons and comparable regression results—were usually found only at the third or fourth digit after the decimal point.

\$79 billion, or 1.2% of GDP. Subtracting the relevant Price Effects from the relevant deficit, in 1990, PAHED was \$77 billion, or 1.4% of GDP, while PASED was \$57 billion, or 1.0% of GDP. In 1994, PASED was \$108 billion, or 1.6% of GDP.

### **C. Hybrid Series**

HED and PAHED are the two series used in Eisner's various empirical studies, while SED and PASED are the two used in Buchanan [1995]. As noted, both sets of comparisons find strong reasons to believe that the price-adjusted measure is preferable to the unadjusted measure in econometric tests. However, it is possible to construct two further deficit series, cross-matching the methods for calculating each of the adjustments discussed above (cyclical correction and the inflation tax). Creating these hybrids permits further analysis of the properties of the data.

Starting with HED, one can derive a new price-adjusted structural deficit series by subtracting my Price Effects series, rather than Eisner's series. This hybrid series is called PAHED1. Similarly, starting with SED but subtracting Eisner's Price Effects series from it results in a hybrid series called PASED1. In 1990, PAHED1 stood at \$70 billion, or 1.3% of nominal GDP. PASED1, on the other hand, was \$57 billion, or 1.0% of nominal GDP.

### **III. Analysis of Empirical Findings**

The analysis below proceeds along the lines recommended by several recent authors [see, for example, De Long and Lang, 1992] in not merely reporting the "significance" or the lack thereof of particular coefficients. Rather, this examination of Eisner's findings affords an opportunity to

examine closely whether the implications of Eisner's work are "robust to minor changes in specification." [De Long and Lang, p. 1272]

Thus, the results reported here will permit not merely an assessment of whether price-adjustment improves empirical results but, also, whether Eisner's general empirical conclusions regarding the macroeconomic effects of deficits on growth and unemployment are generally supported.

### A. The Basic Approach

In only one paper [Eisner and Pieper, 1988] does Eisner provide direct comparisons of regressions using as explanatory variables the unadjusted high-employment deficit (HED) *versus* the price-adjusted version, showing that, in nearly every case, the explanatory power of the deficit variable was improved through price adjustment.<sup>10</sup> The results reported in Eisner [1991,

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<sup>10</sup> Eisner's results are not *completely* uniform regarding the empirical power of PAHED. In Eisner and Pieper [1988], Table 1.3 presents results from regressing the change in unemployment on a deficit measure, a par-to-market adjustment, and different monetary policy variables. In the two equations which use the monetary base as the monetary policy variable (equations 3.1 and 3.2), the t-statistics for the estimated coefficients of HED and PAHED are, respectively, 3.189 and 3.019, and the adjusted R<sup>2</sup> estimates are 0.746 and 0.736. (The sample period is 1961-84.) Also, Table 1.4 of the same paper shows two instances in which the relevant test statistics do improve slightly with price-adjustment, but the adjusted R<sup>2</sup> goes down.

[Note: the latter result is computationally possible because those results, based on quarterly data, test whether the *sum* of the coefficients on the four deficit variables (i.e., the deficit variable lagged for one, two, three, and four quarters) is significantly different

1993, 1994a] and in Eisner and Pieper [1992b] do not directly report the results of the regressions for HED or any other non-PAHED measures. However, unpublished calculations provided by Eisner (including those on which his published results are based) again show PAHED outperforming HED in every case—in the sense of yielding higher estimated t-statistics on the exogenous deficit variable. (These results are included in the Table 4 at the end of this essay. I contrast those results with my analysis in the next section.)

Eisner generously provided his original series and derivations of both exogenous and endogenous variables<sup>11</sup>, as well as results of his regressions for eight equations: five specifications of a GDP growth equation<sup>12</sup>, and

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from zero. Due to variations among the four coefficients, it is possible for the t-statistic that tests for significance of the sum of the coefficients to go up while the overall fit of the regression, as measured by adjusted  $R^2$ , goes down.]

Although I do not analyze changes in adjusted  $R^2$  as an indicator of the strength of the deficit measure, Eisner does refer to that criterion. The failure of his results to pass that test is, therefore, worthy of note. While these results are hardly the rule in Eisner's results, therefore, the possibility that price-adjustment does not universally improve econometric estimates is demonstrated even in his published results.

<sup>11</sup> The significant exception to this is the price effects calculations, which turn out to be of rather significant interest below. Eisner provided only the derived price effects series, but not the calculations or data necessary to build those series from scratch.

<sup>12</sup> It is worth noting here a problem with the specification of the GDP growth equation: the use of a deficit variable which has GDP in the denominator. Since the deficit variable is lagged, the equation has both current and lagged GDP on the left-hand side and

three of an unemployment equation. (See Table 1 below.) These equations are based on a textbook Keynesian IS/LM model, an example of which I reproduce here for clarity [based on a standard example of this model in Gordon, 1993].

**Table 1: Equations Tested and Compared**

Equation Number	Specification	Full time period tested
G-1	$\% \Delta Q_t = a + b_1 \Delta MB_{t-1} + b_2 DEF_{t-1}$	1967-91
G-2	$\% \Delta Q_t = a + b_1 \Delta ERR_{t-2} + b_2 DEF_{t-1}$	1972-91
G-3	$\% \Delta Q_t = a + b_1 \Delta ERR_{t-4} + b_2 DEF_{t-1}$	1974-91
G-4	$\% \Delta Q_t = a + b_1 \Delta ERR_{t-2} + b_2 \Delta MB_{t-1} + b_3 DEF_{t-1}$	1972-91
G-5	$\% \Delta Q_t = a + b_1 \Delta ERR_{t-4} + b_2 \Delta MB_{t-1} + b_3 DEF_{t-1}$	1974-91
U-1	$\Delta U_t = a + b_1 \Delta MB_{t-1} + b_2 \% \Delta WP_t + b_3 \Delta YP_t + b_4 DEF_{t-1}$	1967-91
U-2	$\Delta U_t = a + b_1 \Delta ERR_{t-2} + b_2 \% \Delta WP_t + b_3 \Delta YP_t + b_4 DEF_{t-1}$	1972-91
U-3	$\Delta U_t = a + b_1 \Delta ERR_{t-4} + b_2 \% \Delta WP_t + b_3 \Delta YP_t + b_4 DEF_{t-1}$	1974-91
$\% \Delta Q$ = annual percentage increase in real Gross Domestic Product $MB$ = end-of-period real monetary base, as a percentage of real GDP $U$ = unemployment, as a percentage of the civilian labor force $ERR$ = real trade-weighted exchange rate of the U.S. dollar $DEF$ = fiscal deficit, various derivations $WP$ = working age population (Civilian Noninstitutional Population) $YP$ = population of 16-19 year-olds divided by $WP$		

lagged GDP on the right-hand side, in the denominator. This builds some significant potential bias into the equations, making it likely that the coefficient on the deficit variable will be positive. It is, therefore, likely that these equations could be improved by using instrumental variables methods. Running instrumental variable (IV) regressions for Buchanan [1995], however, I found no change in the sign of the deficit variable from the simple OLS or AR(1) regressions to the IV regressions—while the efficiency of the IV regressions fell significantly due to small-sample problems.

The structural equations are summarized in completely linear form below, with  $C$  denoting aggregate consumption,  $I_p$  planned investment,  $G$  government purchases,  $NX$  net exports,  $T$  net tax revenues,  $L$  the demand for nominal money balances,  $M$  the nominal money stock,  $P$  the price level,  $r$  the real interest rate,  $Y$  real national income,  $e$  the real exchange rate (defined as foreign currency per U.S. dollar), and  $B$  the nominal monetary base. The subscript “o” denotes exogenous levels of a variable:

Goods Market:	Money Market:
(1) $C = C_0 + c(Y-T)$	(7) $\frac{L}{P} = L_0 + \ell_1 Y - \ell_2 r$
(2) $I_p = I_0 + i_1 Y - i_2 r$	(8) $\frac{M}{P} = m \frac{B}{P}$
(3) $G = G_0$	(9) $B = B_0$
(4) $NX = NX_0 - n_1 Y - n_2 e$	
(5) $e = e_0$	
(6) $T = T_0 + tY$	

The two equilibrium equations are:  $Y = C + I + G + NX$ , and  $\frac{L}{P} = \frac{M}{P}$ .

It is a simple matter to derive the general linear results for goods market equilibrium and money market equilibrium, keeping separate the explanatory variables which are of interest:

$$Y = k(A_0 + G_0 - cT_0 - n_2 e_0 - i_2 r), \text{ and } Y = \left(\frac{M}{P} + \ell_2 r\right) / \ell_1,$$

where  $k = \frac{1}{1-c+ct-i_1+n_1}$ , which is the exogenous spending multiplier, and

$A_0 = C_0 + I_0 + NX_0$ , which is the sum of all other exogenous spending.

The presence of the coefficient “c” on  $T_0$  (which is due to the fact that taxes only affect  $Y$  indirectly through consumption) indicates that it is not possible to group a “deficit variable,” such as  $(G_0 - T_0)$  together, unless one creates a companion term, such as the following:  $(G_0 - T_0) + (1 - c)T_0$ ,

which simply equals  $(G_0 - T_0)$ . This would still require separating structural  $G_0$  from structural  $T_0$ , however which Eisner's formulation does not do. Moreover, since taxes can be changed either by changing the exogenous part of the tax code ( $T_0$ ) or by changing the tax rate ( $t$ ), such a composite formulation would still be incomplete, particularly since the relationship between  $t$  and  $Y$  in the equation above is clearly non-linear.

Hence, in this model, to talk about "the deficit" is to discuss the *result* of policy changes on  $G - T$ , not the policy changes themselves ( $G_0$ ,  $T_0$ , or  $t$ ).<sup>13</sup> For the purposes of isolating an exogenous deficit variable in an equation like those run by Eisner, therefore, one needs to select one of those policy variables, the most simple being  $G_0$ , to proxy for the deficit as a whole.<sup>14</sup> Goods market equilibrium is then written as:

$$Y = k(A_1 + G_0 - n_2e_0 - i_2r), \text{ where } A_1 = A_0 - cT_0.$$

Putting that together with the money market equation, solving for  $Y$ , and substituting for  $\frac{M}{P}$ , the result is:

$$Y = a + d_1e_0 + d_2\left(\frac{B_0}{P}\right) + d_3G_0$$

where "a" and the various "d"s are, again, linear combinations of the various parameters and coefficients:

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<sup>13</sup> This is a simple form of the problem referred to by proponents of "dynamic scoring," which is based on the well-known concept that changes in fiscal policy affect output, which affect the actual amount of tax revenue (and thus government borrowing) that will be necessary during any given time period.

<sup>14</sup> While this method is clearly incomplete, it is the only way to derive equations like those tested by Eisner. The purpose here is to test Eisner's empirical relationships rather than to question his underlying model; so this derivation is descriptive rather than prescriptive.

$$a = \frac{-k \ell_2 A_1}{\ell_2 + k i_2 \ell_1}, d_1 = \frac{-k n_2 \ell_2}{\ell_2 + k i_2 \ell_1}, d_2 = \frac{k i_2 m}{\ell_2 + k i_2 \ell_1}, d_3 = \frac{k \ell_2}{\ell_2 + k i_2 \ell_1}.$$

Since each of the parameters was chosen to have a positive value, this implies that  $d_2$  and  $d_3$  are positive, while  $d_1$  is negative, which would indicate that  $Y$  responds positively to expansionary monetary policy (represented by higher  $B_0$ ) and expansionary fiscal policy (represented by higher  $G_0$ ), and negatively to a stronger dollar (represented by an increase in  $e_0$ ).

This, with appropriate lags, motivates the equations for economic growth above, testing for the coefficients  $d_2$  and  $d_3$  together (equation G-1), testing for  $d_1$  and  $d_3$  together (equations G-2 and G-3), and testing for all three coefficients together (equations G-4 and G-5).<sup>15</sup>

If unemployment were linearly correlated with real GDP growth in a stable long-term relationship, it would be possible simply to substitute the change in the unemployment rate as the dependent variable in equations like those just described. However, as noted above, there is reason to believe that Okun's Law has varied substantially in response to demographic variables. McNees [1991, p. 9] explains: "Faster growth in the working-age population, as when the baby boom entered the labor force, implies more unemployment for any given output. In addition, young workers typically

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<sup>15</sup> These relationships are apparently short-run phenomena, since Eisner's formulations use the *growth rate* of GDP as the dependent variable. The long-run growth rate in GDP is almost certainly not affected by any permanent increase in the level of the deficit; so Eisner's choice of this functional form limits the equations' theoretical meaning to the period during which a higher *level* of GDP is reached through faster-than-average GDP growth, i.e., the short-run.

experience relatively high rates of unemployment due to shifts into and out of school and relatively frequent shifts from the first employer or occupation.” For example, since the peak birth-year of the Baby Boom was 1959, there was a disproportionate surge of teenagers into the labor force as the largest wave of the Baby Boom reached young adulthood in the mid-1970’s.

In order to control for those effects, therefore, the unemployment regressions required the inclusion of two new exogenous variables:  $\% \Delta WP$ , the growth rate of the working age population, and  $\Delta YP$ , the change in the proportion of younger workers (ages 16-19) in the overall working age population. Equations U-1, U-2, and U-3 include those two variables along with the lagged monetary or exchange rate variables, to mirror Equations G-1 through G-3.

## **B. Analysis of Basic Statistics**

The basic statistical estimates for each of the six deficit series under discussion are summarized in Tables 2, 3a, and 3b. (Tables 2 through 8 appear at the end of the text.) Table 2 presents the most simple statistics, in both raw dollars and as a percentage of nominal GDP. Note that the HED and SED series are, by construction, larger than their associated price-adjusted series. In addition, note how similar are the HED and SED series to each other. Their means differ by only 0.13% of GDP, while their standard deviations differ by only 0.02% of GDP.

Among the price-adjusted series, it is notable that the standard deviations of all four series are tightly grouped, while the means display a somewhat different pattern. PAHED and PASED1 are very close in mean, and the means of PASED and PAHED1 are close to each other but markedly

lower than the means of the other two series. PAHED and PASED1 are derived from different structural series, but they are both derived from Eisner's Price Effects series; and similarly, PASED and PAHED1 are derived from different structural series but from my simpler Price Effects series. This indicates that the differences (at least in levels) between the two pairs of price-adjusted series are due more to the method of price adjustment than to the method of cyclical adjustment.

Tables 3a and 3b present the correlation matrices for the six deficit measures, both for levels of the series and after simple differencing. Here, a rather different story begins to emerge. HED and SED are not very closely correlated, with estimates of 0.85 for levels and 0.62 for differences. Each of the two non-price-adjusted series is, however, rather tightly correlated with its related price-adjusted series; and each is much less tightly correlated with the other price-adjusted series. For example, HED's correlations (in both levels and after differencing) with PAHED and PAHED1 are greater than 0.9, while HED's correlations with PASED and PASED1 are lower, especially after differencing. A similar, and in fact more extreme, pattern emerges for SED.

On the other hand, the pairs of price-adjusted series that had similar means in Table 2 do not pair up well in these tables. PAHED and PASED1, which share Eisner's Price Effects computation, have correlation estimates of 0.87 and 0.67 in the two tables; and PASED and PAHED1's estimates are nearly identical, at 0.87 and 0.66. The correlations between the two HED-based series, PAHED and PAHED1, are 0.97 and 0.93; while PASED and PASED1's estimates are 0.96 and 0.94.

These hints about the relative importance of price adjustment *versus* cyclical adjustment seem very clear. The two non-price-adjusted series,

HED and SED, have relatively low correlation statistics. Also, for each method of structural adjustment, the method of price-adjustment seems not to affect these correlations. Moreover, price-adjustment seems not to dissipate any of the differences first discovered at the level of HED and SED—i.e., PAHED and PASED are no more correlated (and, in fact, appear to be less so) than are HED and SED; and the same is true for PAHED and PASED1, for PAHED1 and PASED, and for PAHED1 and PASED1.

These hints turn out to be misleading, however, as the regression analysis below will demonstrate. There, to anticipate the punch-line, the PAHED/PASED1 and PASED/PAHED1 pairings show significant similarities, leading to the implication that the method of adjusting for price effects is more important than the method of cyclical adjustment. These results are, however, only partially supported by the other econometric tests that are summarized toward the end of the paper.

### **C. Multiple-Regression Analysis**

Eisner tested the eight specifications summarized in Table 1 above with his two forms of the structural deficit variable (HED and PAHED). He tested each equation using both ordinary least squares (OLS) and OLS with correction for first-order serial correlation (AR1), in each case testing the equation first with HED and then with PAHED as the explanatory deficit variable. Three of these eight equations (equations G-1, G-3, and U-3) were analyzed in Buchanan [1995], and they are also the specifications reported in Eisner [1991] and Eisner and Pieper [1992b].<sup>16</sup>

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<sup>16</sup> An inflation equation was also reported in Eisner and Pieper [1992b] and Buchanan [1995]. However, that equation was omitted in this analysis, because the

Each cell of Table 4 contains three key statistical estimates for the relevant regression: the t-statistic for the estimate of the coefficient on the deficit variable, the Durbin-Watson statistic for the regression, and the significance level of the Ljung-Box Q statistic for the regression.<sup>17</sup> The latter two statistics are provided to demonstrate that OLS estimates are sufficient for each of the regressions and that AR(1) correction is, therefore, unnecessary. In those few instances where the Durbin-Watson statistic is in the “inconclusive” range, the significance levels of the Q statistic (which tests for both first-order and higher orders of serial correlation) was comfortably distant from rejecting the null hypothesis of no serial correlation.<sup>18</sup>

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coefficient on the deficit (with inflation as the dependent variable, in a simple Phillips Curve equation) was consistently estimated to be negative, indicating that the simple structure of that equation most likely failed to capture important long-run inflation dynamics.

<sup>17</sup> The coefficient estimates themselves are not featured here because the focus of this analysis is on the relative statistical explanatory power of the various elements of the deficit series. The coefficient estimates' magnitudes will be of interest once one decides upon the most appropriate deficit series to use in any given set of tests. Thus, Buchanan [1996] looks at the magnitudes of coefficient estimates, based on regressions using PASED as the deficit series.

<sup>18</sup> In a few cases, the Q-statistic indicates that the null hypothesis should be rejected. However, in each of those cases, the Durbin-Watson statistic is in the range that indicates no evidence of first-order serial correlation.

The results of a direct replication of the time periods and data series provided by Eisner, and differing only in the derivation of the deficit variable, are shown in columns SED(1991) and PASED(1991) in Table 4.<sup>19</sup> The results summarized in Buchanan [1995]—which are based, as noted, not only on longer time series but on slightly different estimates of the dependent and non-deficit independent variables—are shown in columns SED(full) and PASED(full) in Table 4.

For each of the eight regressions reported, the PASED(full) series had a higher t-statistic (in absolute value) than the SED(full) series, and the PASED's t-statistic was greater than or equal to 1.9 in two out of five growth regressions (and in one out of five cases for SED). The absolute values of the t-statistics for all of the unemployment regressions were at least 2.31.

The contrasts between those findings and the results in the columns marked SED(1991) and PASED(1991) is pronounced. First, the level of significance is higher for the SED(full) regressions than for either the SED(1991) or the PASED(1991) regressions in six of the eight equations (including all five growth equations). Second, the levels of the t-statistics is distinctly lower, with the estimates being above 1.9 only in the unemployment equations (for either SED(1991) or PASED(1991)). Third, the absolute values of the t-statistics were dramatically lower than Eisner's in every case—so much so that there is no longer a specification of the growth

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<sup>19</sup> The other (non-deficit) data series provided by Eisner differed from those in Buchanan [1995] in ways that were seemingly non-controversial: end-of-year values versus annual averages, slightly different monetary base derivations (even among the various published articles by Eisner), etc. Using the exact series provided by Eisner helps put to rest doubts about whether any of these differences matter for the analysis at hand.

equation that indicates a statistically-significant estimate of the coefficient on any deficit variable.

In short, carrying on the analysis entirely with Eisner's data and specifications—but with SED and PASED as the deficit variables—makes the statistical results significantly less compelling (in the sense of the significance level of the computed t-statistics) than the results in my independent replication. This is true both of the comparative power of using price-adjusted *versus* unadjusted cyclical deficits and, perhaps more significantly, of the power of any deficit variable in explaining GDP growth.

The foregoing analysis (which compared the SED(full) and PASED(full) columns with the SED(1991) and PASED(1991) columns) tested whether the differences in the regressions which were not related to the deficit were important. The logically opposite test—comparing the columns labeled HED and PAHED with the SED(1991) and PASED(1991) columns—permits the deficit series themselves to be compared. That is, I compare the results of regressions which used my SED and PASED series but which were limited to Eisner's exact time periods (rather than my typical 1967-93 period) and which used his series for all other exogenous and endogenous variables.

The t-statistics for PAHED again are greater in absolute value than the t-statistics for HED in every case. In fact, the results for HED and PAHED mirror those of SED(full) and PASED(full) very closely, although the absolute values of the HED/PAHED t-statistics are somewhat lower in a few cases of the growth equations and somewhat higher in all of the unemployment equations. Once again, the contrast with the "replicated" results is just as marked as were the differences in the comparison above—and in very similar ways.

Where does this leave the analysis? My original results and Eisner's results bear a striking resemblance; but both differ in very obvious—and virtually identical—ways from the results using Eisner's time periods and non-deficit variables with my deficit series. Based on this, unfortunately, it is not possible to infer whether deficit or non-deficit differences are the source of the contrast. Further analysis is necessary.

#### **D. Analyzing the Macroeconomic Implications**

Before turning to that, however, it is appropriate to consider the implications of this analysis on the larger questions of the macroeconomic relationships being tested. For the growth equations, it is actually somewhat difficult (based on these tests, at least) to support the idea that growth in GDP is directly related to deficit spending. While the *t*-statistics for PASED(full) and PAHED in equation G-2 (which is the equation with a two-year-lagged real exchange rate series as a right-hand variable, in addition to the deficit) allow rejection of the null at the 95% level, PASED(1991) does not reject the null in G-2; and none of the other four versions of the growth equation allow the null to be rejected, no matter which definition of the deficit one chooses.

Using the De Long and Lang [1992] criteria noted above, therefore, it is difficult to conclude, based on this variety of specifications, time periods, and data definitions, that the growth/deficit relationship is robust. If one were interested in highlighting the “best” result, however, one could support that relationship based on either of the two noted results. This is a strong indication of the value of a broader analysis.

On the other hand, the unemployment/deficit relationship appears to be much stronger. Particularly for equations U-2 and U-3, but even under

U-1, the relationship holds up very well. This is even true for the tests using only SED and HED, indicating that price-adjustment is not even necessary to detect a significant relationship between a deficit variable and the unemployment rate.

### **E. Shorter Time Periods**

Another way to test the robustness of Eisner's results is to look at the results of regressions in smaller subsets of the overall time periods of his equations (listed in Table 1 above). To that end, each equation was tested using all of Eisner's data and specifications, but in a progression of fifteen-year sample periods.<sup>20</sup> For example, for those equations with a sample period of 1967-91, eleven separate sub-period regressions could be tested: 1967-81, 1968-82, and so on through 1977-91.

For each of the eight equations, Table 5 reports the t-statistics for the estimated coefficients on HED and PAHED in each fifteen year sub-period. Whereas PAHED's t-statistics had been higher than HED's in the full time period for all eight equations, there were significant variations in the results for the shorter sample periods.

In Equation G-1, for example, HED outperforms PAHED in three of the first five sub-periods, whereas PAHED dominates in all six subsequent samples. However, a potentially more important pattern emerged during

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<sup>20</sup> Fifteen years was chosen, somewhat arbitrarily, as a round number that would provide a minimally-acceptable number of degrees of freedom for each regression at the same time that it would provide a useful number of separate regressions to compare. The unemployment regressions, having two additional explanatory variables, are particularly sensitive to this small number of total observations.

the later time periods, in that the significance of the t-statistics for both deficit measures plunges dramatically, becoming not merely “insignificant” at even the 90% level of confidence, but actually becoming essentially zero in the last two time periods (with HED’s t-statistic—and thus its estimated coefficient—actually becoming negative in the last sub-period).

Across all eight equations, this latter result is repeated, with the latest sub-periods having very low levels of significance and the “wrong” sign in several instances. (However, equations U-2 and U-3, despite having smaller t-statistics in the later sub-periods, continue to show high statistical significance.) This is in notable contrast to the sub-periods through 1986 or 1987, which have remarkably robust estimates (and, in those robust periods, results for HED which are generally stronger than for PAHED for the unemployment equations). Equation U-1, for example, has peak estimated t-statistics of  $-7.35$  and  $-5.01$  for the 1970-84 time period, which fall to  $-1.06$  and  $-1.88$  for the 1977-91 time period.

To summarize, the analysis of shorter sample periods reveals that the dominance of PAHED over HED is far from universal, even though it had appeared to be so in the full sample periods. Moreover, the robustness of the macroeconomic findings are seriously questioned for the growth regressions for the more recent time periods, with the ability to reject the null hypothesis that “the deficit variable has no effect on growth” seriously compromised. The unemployment relationship, on the other hand, holds up much more strongly, at least for equations U-2 and U-3.

#### **IV. Comparing Methods of Cyclical Adjustment and Price Adjustment**

As noted above, there are two further possible explanations for the differences in the empirical results: that the key difference is the cyclically-adjusted deficit series (HED *versus* SED), or that it is the different Price Effects calculations which create the contrasts. I therefore tested each equation with PASED1, which was defined as Eisner's Price Effects series subtracted from SED, and with PAHED1, which was constructed using my simpler Price Effects series subtracted from HED.

It is appropriate in these comparisons to use the results for SED(1991) and PASED(1991), since those results are based on tests which used the same time periods and non-deficit variables as the results for HED, PAHED, PAHED1, and PASED1. Obviously, this eliminates other potential sources of bias in the results.

An initial noteworthy result is that the t-statistics for PASED1 exceed those for SED(1991) in every equation on Table 4, confirming again Eisner's claim that price-adjustment strengthens the results. On the other hand, PAHED1 has lower t-statistics than HED in three cases, showing that the simpler price adjustment method degrades the results so much that even the non-price-adjusted series is potentially more powerful than PAHED1.

##### **A. Isolating Cyclical Adjustment**

A direct way to isolate differences due to cyclical and price adjustments involves comparing two price-adjusted series at a time. In order to discover whether the method of cyclical adjustment (the BEA's or the CBO's) is a source of differences, one can compare PAHED with PASED1 and PASED with PAHED1. Any differences within each of those

pairings must be due to the cyclical adjustment, since each pair shares the same Price Effects series. The other issue involves whether the method of price adjustment is a source of statistical differences; and the appropriate pairings here are PAHED with PAHED1 and PASED with PASED1, since each pair shares the same structural deficit series.

### **PAHED and PASED1**

The t-statistics for PAHED and PASED1 in the eight equations tested are remarkably similar, with PAHED's estimate higher in each case; but the differences range only from 0.02 to 0.63. In addition, PASED1 has significant coefficients in nearly all of the equations in which PAHED had significant coefficients, including all three specifications of the unemployment equation—and the one instance in which it does not, equation G-2, still has a t-statistic for PASED1 of 1.91.

The results for PASED1 thus indicate that it is possible to come close to Eisner's results even using a different method of computing the cyclically-adjusted deficit. Based on this comparison, therefore, SED and HED would not seem to produce the differences seen in the previous comparisons of results.

### **PASED and PAHED1**

Looking at the two measures that are constructed using the simple method of price adjustment, the story is very much the same as above. While PAHED1 has higher t-statistics in all eight cases, the numerical results are, again, typically extremely similar. In two of the unemployment specifications, PASED provides a statistically significant t-

statistic (and U-1's estimate of 1.99 is only slightly below the cutoff for 95% significance), mirroring the significance of the estimates for PAHED1.

It is also notable that equation G-2 does not have statistically significant values of the t-statistic for PASED and PAHED1, whereas the estimates for PAHED and PASED1 for G-2 were above (or were very close to) the cut-off point for statistical significance at the 95% level.

Once again, therefore, the same method of price adjustment with a different method of cyclical adjustment produced nearly-identical results. The evidence appears to support the conclusion that there is little difference in using HED or SED, but that simple versus complex price adjustment changes things significantly.

### **B. Isolating Price Adjustment**

To investigate the tentative conclusion reached in the previous section, the remaining method of comparison pairs up deficit measures by their method of cyclical adjustment. If the results of these comparisons show significant differences in results among the relevant pairs, the confidence one could have in the conclusions above would be strengthened. If the results show that each pair has similar results, however, the mystery would be deepened.

#### **PAHED and PAHED1**

The comparison of PAHED and PAHED1 shows some clear differences in regression results. The t-statistics for PAHED1 are lower than those for PAHED in every case, generally by a large margin (ranging from 0.33 to 0.93 in difference). For equation G-2, again, the PAHED result

shows a rather comfortable level of statistical significance; while the result for PAHED1 is lower than that necessary for significance.

The decline in the values of the t-statistics (by changing the deficit variable from PAHED to PAHED1) can be put into sharper focus by noting the following: While PAHED's t-statistics were larger in absolute value than were HED's in all eight instances, there were three cases where the estimated t-statistic for PAHED1 was smaller than that for HED.

Therefore, the decline does not merely demonstrate that one method of price adjustment seems to create much more significant results than the other method, but that the simple form of price adjustment (at least in three of the cases tested) is actually, when combined with HED rather than SED, worse than no price adjustment at all.

### **PASED and PASED1**

Finally, the PASED and PASED1 columns show that the results diverge once again. PASED1, which uses Eisner's more complex method of price adjustment, has higher t-statistics than does PASED in each of the eight equations, by margins ranging from 0.37 to 1.22. Virtually the same story regarding equations G-2 and U-1 is repeated once again here: using the simple method of price adjustment makes the results statistically insignificant in G-2 and decreases the t-statistic in U-1 to slightly below the cutoff. Also, the results for PASED are once again worse than for SED alone in two of the equations tested, and they are less than 0.1 higher in two others.

Thus, while the method of price-adjustment initially might have appeared to be far less important than the method of cyclical adjustment,

quite the opposite is true in the empirical results shown. Eisner's results are much less compelling when the "simple" method of price adjustment is substituted for his method, even though the logic behind the simple adjustment appears to be sound.

## **V. More Advanced Econometric Methods**

The forgoing brings to light questions about the cause-and-effect relationships between deficits and other macroeconomic variables. More advanced econometric methods can and should, therefore, be brought to bear on the relationships under investigation. The results of tests of bivariate Granger Causality, unrestricted vector auto-regressions (VAR's), and Block Exogeneity tests using restricted VAR's are summarized in Tables 6, 7, and 8, respectively.<sup>21</sup>

### **A. Granger Causality**

One of the enduring questions in statistics is the issue of causality, i.e., which of two (or more) statistically correlated variables causes the other(s)? Since there is still no generally-accepted way to directly prove the direction of causation, it has become common to test for the more limited concept of "precedence," also known as Granger Causality [see Granger 1969, and Sims 1972]. This type of test detects whether changes in one

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<sup>21</sup> Unfortunately, since the data sets used here are based on annual data, it is not feasible to look at smaller time periods for these more complicated tests (which use up a large number of degrees of freedom), along the lines shown in section III.D. In fact, I extended the data set back to 1963 in order to provide a few more observations for the overall tests; but this still did not allow for meaningful sub-period testing.

variable precede changes in another in real time; but, being a bivariate test, the question of alternate causality is not addressed.

Table 6 shows the results of two-sided tests of Granger Causality for fiscal deficits in separate bivariate tests *versus* GDP growth and the change in unemployment. Each pair of tests was carried out for one lag of each variable, for two lags, and for three lags.<sup>22</sup> Entries in the table indicate the significance level of the F-statistic for the test that the coefficients on the lagged versions of the “causing variable” are zero.<sup>23</sup>

Looking at the tests of the hypothesis that the deficit variable Granger-causes GDP growth (i.e.,  $\% \Delta \text{GDP}$ ), the values for HED are significantly lower (which is to say that they indicate Granger Causality more strongly) than for SED for all three lag lengths. For two and three lags, the results for HED are significant at the 95% level, while the tests for reverse causality show no reason to believe that GDP growth Granger-causes the deficit.

No matter which form of price adjustment is used, all four price-adjusted versions of HED and SED have more significant results than the results of HED and SED without adjustment. The next interesting question,

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<sup>22</sup> There are several methods available to test for the appropriate length of the lags. Tests using the Akaike Information Criterion (AIC) [Akaike, 1973], however, were not helpful in providing guidance as to lag length. In each case, the AIC's results argued for an implausibly high number of lags (e.g., 16 annual lags). Such a high number of lags is also, of course, implausible from a theoretical perspective, i.e., that one variable lagged by sixteen years could Granger-cause another seems unlikely. Therefore, I chose to display the results for the most plausible lag lengths: one, two, and three years.

<sup>23</sup> For a single-lag test, the F-statistic is equivalent to the t-statistic.

therefore, is whether the different types of price adjustment provide different levels of improvement.

Looking at PAHED and PAHED1, there is extremely little difference between the results for the two measures of the deficit, especially for two and three lags—which also show extremely high levels of statistical significance for the F-statistics. For PASED and PASED1, however, PASED has a generally worse result; and neither has a significance level that allows for rejection of the null hypothesis (that the deficit variable Granger-causes GDP growth).

In fact, for one and three lags, all of the SED variables have more significant statistics for the reverse causality test, i.e., that GDP growth Granger-causes the fiscal deficit. That reverse test is highly statistically significant, moreover, for all three versions of the SED-based deficit measures for a three-year lag—in contrast to the three HED-based measures, all of which have causality running much more significantly from deficits to growth. This is potent evidence that SED-based deficits are much weaker in these tests; that is, they not only show weaker evidence of deficits causing growth, but stronger evidence of the counter-intuitive result that growth causes deficits.

These results tend to support the conclusion that HED is a much better basis for the fiscal deficit variable than is SED. Looking at the PAHED/PASED1 and the PASED/PAHED1 pairings verifies this, in that the pairings do not have similar significance levels. There is little if any reason, based on these results, to conclude that the method of price adjustment changes the results significantly.

For the Granger-causality tests which use the change in the unemployment rate and the various deficit measures, the results are much

more significant in indicating deficit-to-unemployment Granger-causality; and there is no indication of reverse causality even for the SED-based measures. For the other analytical questions, however, the results lead to the same result as the GDP/deficit causality results: all versions of HED provide more significant results than all versions of SED, leading to the conclusion that cyclical adjustment differences matter, while price adjustment methods do not. This is precisely the opposite conclusion to that drawn in the analysis of multiple regression results.

For the macroeconomic implications, the results here provide stronger evidence (than did the multiple regression results) to support the theory that GDP growth is affected positively by deficits. The unemployment relationship is even more potent, confirming the results summarized previously.

## **B. Unrestricted Vector Auto-Regressions**

Table 7 presents the results of unrestricted vector autoregressions for the six deficit measures with the following variables (each with two annual lags): the deficit (generically referred to as DEF, with a different autoregression for each of the six measures under scrutiny), the change in the real monetary base ( $\Delta MB$ ), the percentage change in GDP ( $\% \Delta GDP$ ), inflation (INF, as measured by the annual percentage change in the implicit GDP deflator), and short-term interest rates (RS, the discount rate on three-month U.S. Treasury Bills). Following the method used in tests reported in Eisner and Pieper [1992b]<sup>24</sup>, these VAR's involve testing the

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<sup>24</sup> I chose to replicate Eisner in using two lags, both because this made sense macroeconomically and because VAR's use so many degrees of freedom. One lag was not

following five equations, where “a” is a constant and b<sub>i</sub> through f<sub>i</sub> are coefficients:

$$\begin{aligned}
 \text{DEF}_t &= a + \sum_{i=1}^2 b_i \Delta \text{MB}_{t-i} + \sum_{i=1}^2 c_i \% \Delta \text{GDP}_{t-i} + \sum_{i=1}^2 d_i \text{INF}_{t-i} + \sum_{i=1}^2 e_i \text{RS}_{t-i} + \sum_{i=1}^2 f_i \text{DEF}_{t-i} \\
 \Delta \text{MB}_t &= a + \sum_{i=1}^2 b_i \Delta \text{MB}_{t-i} + \sum_{i=1}^2 c_i \% \Delta \text{GDP}_{t-i} + \sum_{i=1}^2 d_i \text{INF}_{t-i} + \sum_{i=1}^2 e_i \text{RS}_{t-i} + \sum_{i=1}^2 f_i \text{DEF}_{t-i} \\
 \% \Delta \text{GDP}_t &= a + \sum_{i=1}^2 b_i \Delta \text{MB}_{t-i} + \sum_{i=1}^2 c_i \% \Delta \text{GDP}_{t-i} + \sum_{i=1}^2 d_i \text{INF}_{t-i} + \sum_{i=1}^2 e_i \text{RS}_{t-i} + \sum_{i=1}^2 f_i \text{DEF}_{t-i} \\
 \text{INF}_t &= a + \sum_{i=1}^2 b_i \Delta \text{MB}_{t-i} + \sum_{i=1}^2 c_i \% \Delta \text{GDP}_{t-i} + \sum_{i=1}^2 d_i \text{INF}_{t-i} + \sum_{i=1}^2 e_i \text{RS}_{t-i} + \sum_{i=1}^2 f_i \text{DEF}_{t-i} \\
 \text{RS}_t &= a + \sum_{i=1}^2 b_i \Delta \text{MB}_{t-i} + \sum_{i=1}^2 c_i \% \Delta \text{GDP}_{t-i} + \sum_{i=1}^2 d_i \text{INF}_{t-i} + \sum_{i=1}^2 e_i \text{RS}_{t-i} + \sum_{i=1}^2 f_i \text{DEF}_{t-i}
 \end{aligned}$$

For each of the deficit measures, I report the significance level of the F-statistic for the deficit variable (testing whether the coefficients on both lags of the deficit are zero, i.e., that  $f_1 = f_2 = 0$ ) in the second and third equations (i.e., those with GDP growth and inflation as dependent variables).<sup>25</sup> [Reminder: Lower significance levels imply stronger results.]

Unfortunately, there is very little useful information to draw from these results. None of the tests provides better than an 82% level of confidence to reject the null. The differences between non-price-adjusted deficit measures (HED and SED) and price-adjusted measures shows no pattern whatsoever; nor do any of the four pairings of price-adjusted measures.

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sufficient to provide interesting results, while three or more lags decreased the efficiency of the results beyond the point of being useful.

<sup>25</sup> I do not report the results for the other three equations, although they are part of the full VAR specification. These are the sets of five equations from which impulse response functions are computed in Buchanan [1995].

The conclusions that can be drawn from these tests are few indeed. Perhaps the only strong conclusion that one could draw is that *no* deficit variable contributes significantly to this specification of a VAR. Luckily, however, the VAR concept can be used in further tests of block exogeneity, described in the next section.

### C. Block Exogeneity

The multivariate generalization of the Granger-causality procedure is the test for Block Exogeneity. In this case, the block exogeneity test allows one to test whether the addition of two lags of the deficit variable improves the statistical power of a VAR for the block of four non-deficit variables from the VAR tested in the previous section—change in real monetary base, GDP growth, inflation, and short-term interest rates.

That is, a set of four regressions is computed twice, once in a restricted form (excluding the lagged deficit variables as exogenous variables) and the other in an unrestricted form (including one and two annual lags on the deficit):

#### Restricted set of regressions:

$$\begin{aligned}\Delta MB_t &= a + \sum_{i=1}^2 b_i \Delta MB_{t-i} + \sum_{i=1}^2 c_i \% \Delta GDP_{t-i} + \sum_{i=1}^2 d_i INF_{t-i} + \sum_{i=1}^2 e_i RS_{t-i} \\ \% \Delta GDP_t &= a + \sum_{i=1}^2 b_i \Delta MB_{t-i} + \sum_{i=1}^2 c_i \% \Delta GDP_{t-i} + \sum_{i=1}^2 d_i INF_{t-i} + \sum_{i=1}^2 e_i RS_{t-i} \\ INF_t &= a + \sum_{i=1}^2 b_i \Delta MB_{t-i} + \sum_{i=1}^2 c_i \% \Delta GDP_{t-i} + \sum_{i=1}^2 d_i INF_{t-i} + \sum_{i=1}^2 e_i RS_{t-i} \\ RS_t &= a + \sum_{i=1}^2 b_i \Delta MB_{t-i} + \sum_{i=1}^2 c_i \% \Delta GDP_{t-i} + \sum_{i=1}^2 d_i INF_{t-i} + \sum_{i=1}^2 e_i RS_{t-i}\end{aligned}$$

#### Unrestricted set of regressions:

$$\Delta MB_t = a + \sum_{i=1}^2 b_i \Delta MB_{t-i} + \sum_{i=1}^2 c_i \% \Delta GDP_{t-i} + \sum_{i=1}^2 d_i INF_{t-i} + \sum_{i=1}^2 e_i RS_{t-i} + \sum_{i=1}^2 f_i DEF_{t-i}$$

$$\begin{aligned} \% \Delta \text{GDP}_t &= a + \sum_{i=1}^2 b_i \Delta \text{MB}_{t-i} + \sum_{i=1}^2 c_i \% \Delta \text{GDP}_{t-i} + \sum_{i=1}^2 d_i \text{INF}_{t-i} + \sum_{i=1}^2 e_i \text{RS}_{t-i} + \sum_{i=1}^2 f_i \text{DEF}_{t-i} \\ \text{INF}_t &= a + \sum_{i=1}^2 b_i \Delta \text{MB}_{t-i} + \sum_{i=1}^2 c_i \% \Delta \text{GDP}_{t-i} + \sum_{i=1}^2 d_i \text{INF}_{t-i} + \sum_{i=1}^2 e_i \text{RS}_{t-i} + \sum_{i=1}^2 f_i \text{DEF}_{t-i} \\ \text{RS}_t &= a + \sum_{i=1}^2 b_i \Delta \text{MB}_{t-i} + \sum_{i=1}^2 c_i \% \Delta \text{GDP}_{t-i} + \sum_{i=1}^2 d_i \text{INF}_{t-i} + \sum_{i=1}^2 e_i \text{RS}_{t-i} + \sum_{i=1}^2 f_i \text{DEF}_{t-i} \end{aligned}$$

These systems are estimated using ordinary least squares for each of the equations. Using the resulting sample residuals, variance-covariance matrices for each of the two blocks of equations can be computed.<sup>26</sup> Taking the logarithm of the determinant of each matrix, subtracting the results (restricted minus unrestricted), and multiplying the difference by the number of observations minus nine<sup>27</sup> provides a test statistic which has a  $\chi^2$  distribution with 8 degrees of freedom<sup>28</sup>. The  $\chi^2$  test indicates whether one can reject the null hypothesis that the addition of a fiscal deficit variable was not helpful in forecasting the other four variables.

Table 8 presents the results of block exogeneity tests for this null hypothesis. These results are quite different from the bivariate Granger-causality tests above, supporting instead the conclusions drawn from the previous multiple regression analysis. Specifically, the use of Eisner's

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<sup>26</sup> The discussion here is drawn from Hamilton [1994, pp. 309-12].

<sup>27</sup> For asymptotically large samples, the difference in the log determinants should be multiplied simply by T, the total number of observations. However, Sims [1980, p. 17] suggests a small sample correction, multiplying the difference in the log determinants by "T - k, where k is the total number of regression coefficients estimated divided by the number of equations." In this case,  $k = 72/8 = 9$ .

<sup>28</sup> This is determined by the total number of restrictions = two lags \* four restricted variables \* one unrestricted variable.

price adjustment method (PAHED and PASED1) provides more significant estimates than either HED/SED or PAHED1/PASED. In fact, the simple method of price adjustment once again provides less significant results than no price adjustment at all.

On the other hand, based on these results, one would conclude that HED is a better basis for the deficit than is SED. For SED vs. HED, for PAHED vs. PASED1, and for PAHED1 vs. PASED, the HED-based measure always has the more significant statistic. The conclusion from this would be that *both* cyclical and price adjustment methods can affect the results.

For the macroeconomic conclusions, the results indicate very strongly that virtually any deficit measure is significant, allowing one to reject the null hypothesis that the restricted block of variables is unaffected by the exogenous lags of the fiscal deficit .

## **VI. Conclusions**

Four interesting results are implied by the empirical analysis summarized above. First, price-adjustment does seem to improve empirical results over non-price-adjustment. Second, the use of the CBO's measure of a structural deficit does not appear to alter the results of multiple regressions that rely on the discontinued BEA measure, although they do worsen the results in Granger-causality and block exogeneity tests.

Third, the method of computing Price Effects in creating a price-adjusted cyclically-adjusted deficit appears to affect the regression results rather significantly, both pertaining to the comparison among deficit measures and regarding the macroeconomic significance of changes in the deficit (however it is measured). This conclusion is supported by the

evidence from multiple regression analysis and block exogeneity tests, but not by Granger-causality tests.

Finally, there appear to be important differences in the significance of the results, depending on the chosen time period, with regressions covering the 1970's through the mid-1980's being the most robust and those running into the late 1980's being the least so. In the later periods, moreover, even the sign of the effect of deficits is questionable. These tests were carried out for multiple regression equations, but not for the other advanced econometric results.

Overall, the empirical results for these analyses indicate that price-adjustment is usually but not always statistically improving, that important measurement issues remain in assessing the various adjustments to deficits, and that the evolving macroeconomy potentially makes long time-series studies inappropriate.

**Table 2: Comparison of Deficit Measures**

Measure	Raw Numbers				As pct. of nominal GDP			
	Max	Min	Mean	St.Dev.	Max	Min	Mean	St.Dev.
HED	185.40	1.17	62.96	63.92	4.33	0.19	2.08	1.11
PAHED	147.41	-19.96	30.91	48.05	3.45	-1.35	0.85	1.21
PAHED1	139.67	-43.60	22.93	45.78	3.27	-1.42	0.59	1.22
SED	186.00	2.00	65.00	62.31	4.53	0.34	2.21	1.13
PASED	140.27	-26.80	24.96	42.94	3.35	-1.02	0.67	1.18
PASED1	148.01	-16.36	32.94	46.20	3.58	-1.17	0.94	1.19

Raw numbers are expressed in billions of dollars. Sample period: 1963-1991

HED— High-Employment Deficit, Bureau of Economic Analysis  
PAHED— HED minus Price Effects, as calculated by Eisner  
PAHED1— HED minus Price Effects, calculated as annual inflation rate times Federal Net Financial Assets  
SED— Standardized-Employment Deficit, Congressional Budget Office  
PASED— SED minus Price Effects, calculated as annual inflation rate times Federal Net Financial Assets  
PASED1— SED minus Price Effects, as calculated by Eisner

Sources: *Economic Report of the President*, 1994; *Survey of Current Business*, August 1994; *Economic Indicators*, September 1994; CitiBase, 1978; data provided by Robert Eisner

**Table 3a: Correlation Matrix for Six Deficit Measures**

	HED	PAHED	PAHED1	SED	PASED	PASED1
HED	1					
PAHED	0.95	1				
PAHED1	0.91	0.97	1			
SED	0.85	0.77	0.71	1		
PASED	0.82	0.85	0.87	0.90	1	
PASED1	0.85	0.87	0.82	0.95	0.96	1

Sample period: 1963-91. Source: Author's estimates.

**Table 3b: Correlation Matrix for Changes in Six Deficit Measures**

	HED	PAHED	PAHED1	SED	PASED	PASED1
HED	1					
PAHED	0.94	1				
PAHED1	0.93	0.93	1			
SED	0.62	0.54	0.56	1		
PASED	0.59	0.56	0.66	0.94	1	
PASED1	0.64	0.67	0.64	0.95	0.94	1

Sample period: 1964-91. Source: Author's estimates.

**Table 4: Diagnostic Results for Regressions of Eight Specifications of the Deficit Variable in Equations from Table 1. Ordinary Least Squares**

Equation	SED (full)	PASED (full)	HED	PAHED	PAHED1	SED (1991)	PASED (1991)	PASED1
G-1	1.02	1.47	0.90	1.66	1.06	0.21	0.32	1.03
	1.66	1.66	1.37	1.34	1.39	1.52	1.53	1.52
	0.31	0.24	0.18	0.21	0.18	0.13	0.11	0.08
G-2	1.91	2.43	1.57	2.12	1.79	1.27	1.54	1.91
	1.61	1.64	1.34	1.33	1.35	1.49	1.51	1.51
	0.17	0.21	0.27	0.35	0.29	0.21	0.23	0.29
G-3	1.54	1.90	1.54	1.87	1.38	1.43	1.23	1.80
	1.83	1.81	1.48	1.47	1.46	1.62	1.57	1.63
	0.86	0.11	0.29	0.44	0.21	0.17	0.13	0.30
G-4	0.99	1.45	0.53	1.17	0.63	0.15	0.21	0.90
	1.66	1.65	1.36	1.31	1.37	1.46	1.46	1.47
	0.31	0.23	0.35	0.38	0.33	0.33	0.32	0.33
G-5	0.97	1.34	0.97	1.37	0.73	0.82	0.48	1.29
	1.84	1.81	1.47	1.48	1.46	1.60	1.56	1.64
	0.11	0.11	0.29	0.44	0.21	0.17	0.14	0.30
U-1	-2.31	-2.72	-2.68	-3.49	-2.56	-1.92	-1.99	-2.87
	1.88	1.92	1.70	1.76	1.72	2.01	2.03	2.09
	0.38	0.47	0.64	0.59	0.75	0.18	0.29	0.19
U-2	-3.32	-4.65	-4.10	-5.21	-4.48	-3.23	-3.98	-4.62
	1.82	2.07	1.66	1.87	1.73	1.96	2.20	2.29
	0.03	0.17	0.23	0.31	0.71	0.02	0.10	0.04
U-3	-2.89	-3.78	-3.87	-4.64	-4.01	-2.90	-3.40	-4.62
	1.89	1.93	1.84	1.83	1.79	2.00	2.05	2.29
	0.01	0.19	0.17	0.27	0.60	0.02	0.15	0.04

Each cell in the table presents, from top to bottom: the estimated t-statistic for the coefficient on the deficit variable in the relevant equation, the Durbin-Watson statistic, and the significance level of the Ljung-Box Q-statistic for the regression.

HED— High-Employment Deficit, BEA  
 SED (full)— Standardized-Employment Deficit, CBO, 1967-93  
 SED (1991)— Standardized-Employment Deficit, CBO, time periods specified in Table 1.  
 PAHED— HED minus Price Effects, as calculated by Eisner  
 PASED (full)— SED minus Price Effects, calculated as annual inflation rate times Federal Net Financial Assets, 1967-93  
 PASED (1991)— SED minus Price Effects, calculated as annual inflation rate times Federal Net Financial Assets, time periods as specified in Table 1.  
 PAHED1— HED minus Price Effects, calculated as annual inflation rate times Federal Net Financial Assets, time periods as specified in Table 1.  
 PASED1— SED minus Price Effects, as calculated by Eisner

Source: Author's calculations; sample periods as shown in Table 1

**Table 5: t-statistics for HED and PAHED in Regressions  
Over Fifteen-Year Sub-Periods**

Sample Period	Equation Tested <sup>1</sup>								
	G-1	G-2	G-3	G-4	G-5	U-1	U-2	U-3	
HED 1967-81	3.86		4.25			-4.21		-4.56	
PAHED 1967-81	4.12		4.73			-4.14		-5.02	
HED 1968-82	3.70		4.40			-4.21		-4.61	
PAHED 1968-82	3.56		4.41			-3.85		-4.52	
HED 1969-83	4.87		5.20			-6.09		-5.63	
PAHED 1969-83	5.09		5.82			-5.09		-5.52	
HED 1970-84	6.25		6.94			-7.35		-7.31	
PAHED 1970-84	5.91		7.19			-5.01		-6.18	
HED 1971-85	2.78		4.10			-4.02		-5.08	
PAHED 1971-85	2.76		4.39			-3.48		-4.83	
HED 1972-86	1.35	1.92	2.78	1.11		-2.49	-2.93	-3.43	
PAHED 1972-86	1.52	2.23	3.20	1.30		-2.59	-3.40	-3.97	
HED 1973-87	0.91	1.55	2.09	0.57		-4.22	-4.27	-4.68	
PAHED 1973-87	1.14	1.79	2.47	0.76		-5.20	-5.85	-6.68	
HED 1974-88	1.25	2.41	2.26	1.17	1.48	-3.38	-5.24	-4.23	
PAHED 1974-88	1.39	2.52	2.44	1.28	1.64	-3.38	-5.95	-4.48	
HED 1975-89	0.78	2.21	1.93	0.75	0.99	-3.35	-5.36	-4.28	
PAHED 1975-89	0.98	2.34	2.21	0.88	1.25	-3.18	-6.22	-4.35	
HED 1976-90	0.09	1.48	1.08	0.09	0.08	-2.40	-3.40	-3.14	
PAHED 1976-90	0.25	1.61	1.21	0.17	0.20	-2.22	-4.23	-3.18	
HED 1977-91	-0.66	1.09	0.71	-0.63	-0.62	-1.06	-2.75	-2.47	
PAHED 1977-91	0.04	1.50	1.01	0.03	-0.10	-1.88	-4.41	-2.94	

<sup>1</sup> Refers to equation numbers in Table 1, in text.

HED— High-Employment Deficit, BEA

PAHED— HED minus Price Effects, as calculated by Eisner

Source: Author's calculations using Ordinary Least Squares

**Table 6: Significance Levels of Two-Way Granger-Causality Tests**

Dependent Variable (Y)	Deficit Variable (X)	1 lag		2 lags		3 lags	
		X causes Y	Y causes X	X causes Y	Y causes X	X causes Y	Y causes X
%ΔGDP	HED	0.48	0.64	0.01	0.85	0.03	0.42
%ΔGDP	PAHED	0.10	0.33	0.003	0.80	0.02	0.77
%ΔGDP	PAHED1	0.15	0.73	0.002	0.99	0.02	0.53
%ΔGDP	SED	0.88	0.11	0.23	0.25	0.37	0.05
%ΔGDP	PASED	0.50	0.14	0.14	0.32	0.25	0.05
%ΔGDP	PASED1	0.38	0.02	0.12	0.66	0.20	0.03
ΔUN	HED	0.04	0.81	0.001	0.88	0.005	0.85
ΔUN	PAHED	0.003	0.63	0.001	0.94	0.004	0.93
ΔUN	PAHED1	0.01	0.88	0.000	0.82	0.002	0.73
ΔUN	SED	0.10	0.38	0.04	0.55	0.06	0.25
ΔUN	PASED	0.01	0.22	0.008	0.58	0.02	0.21
ΔUN	PASED1	0.01	0.07	0.009	0.24	0.01	0.19

Sample period: 1963-91; Source: Author's calculations

**Table 7: Significance Levels of F-statistics on Lags of Deficit Variables in Unconstrained Vector Auto-regressions**

Deficit Variable	Significance Level of F-statistic for Deficit Variable in Individual Regressions with Dependent Variable:	
	GROWTH	INF
HED	0.24	0.51
PAHED	0.27	0.23
PAHED1	0.24	0.52
SED	0.18	0.46
PASED	0.29	0.87
PASED1	0.31	0.46

Unconstrained VAR's with two lags of each variable and a constant term.  
 Variables: DEFICIT, DBASE, GROWTH, INF, RSHORT  
 DEFICIT— various measures of fiscal deficit  
 DBASE— change in real monetary base  
 GROWTH— percentage change in real GDP  
 INF— percentage change in implicit GDP deflator  
 RSHORT— interest rate on 3-month Treasury Bills

Sample period: 1963-91; Source: Author's calculations

**Table 8: Significance Levels of Block Exogeneity Tests**

Deficit Variable	Significance Level
HED	0.006
PAHED	0.002
PAHED1	0.014
SED	0.015
PASED	0.034
PASED1	0.014
Significance levels of $\chi^2$ tests of the null hypothesis that the inclusion of two lags of the deficit variable does not improve the results of a VAR with DBASE, GROWTH, INF, and RSHORT as a block. Variables as defined in previous tables.	
Sample period: 1963-91 Source: Author's calculations	

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