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ARE BUSINESS CYCLES ALL ALIKE?

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ABSTRACT

This paper examines two questions. The first is whether economic fluctuations—business cycles—are due to an accumulation of small shocks or instead mostly to infrequent large shocks. The paper concludes that neither of these two extreme views accurately characterize fluctuations. The second question is whether fluctuations are due mostly to one source of shocks, for example monetary, or instead to many sources. The paper concludes that evidence strongly supports the hypothesis of many, about equally important, sources of shocks.

To analyze the empirical evidence and to reach these conclusions, the paper uses two different statistical approaches. The first is estimation of a structural model, using a set of just identifying restrictions. The second is non-structural and may be described as a formalization of the Burns Mitchell techniques. Both approaches are somewhat novel and should be of independent interest.

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Introduction

The propagation-impulse framework, which was introduced in economics by Frisch [1933] and Slutsky [1927], has come to dominate the analysis of economic fluctuations. Fluctuations in economic activity are seen as the result of small, white noise, shocks--impulses--which affect the economy through a complex dynamic propagation system.[1,2] Much, if not most, of empirical macroeconomic investigations have focused on the propagation mechanism. In this paper we focus on the characteristics of the impulses, and the implications of these characteristics for business cycles.

It is convenient, if not completely accurate, to summarize existing research on impulses as centered on two independent but related questions. The first question concerns the number of sources of impulses. It asks whether there is one or many sources of shocks to the economy. Monetarists often single out monetary shocks as the main source of fluctuations;[3] this theme has been echoed recently by Lucas [1977] and examined empirically by the estimation of index or dynamic factor analysis models. The alternative view, that there are many, equally important, sources of shocks seems to dominate most of the day-to-day discussions of economic fluctuations.

The second question concerns the way in which the shocks lead to large fluctuations. It asks whether fluctuations in economic activity are caused by an accumulation of small shocks, where each shock is unimportant if viewed in isolation, or rather whether fluctuations are due to infrequent large shocks. The first view derives theoretical support from Slutsky, who demonstrated that the accumulation of small shocks could generate data which mimicked the behavior of macroeconomic time series. It has been forcefully restated by

Lucas [1977]. The alternative view is less articulated but clearly underlies many descriptions and policy discussions. It is that there are infrequent, large, identifiable shocks which dominate all others. Particular economic fluctuations can be ascribed to particular large shocks followed by periods during which the economy returns to equilibrium. Such a view is implicit in the description of specific periods as the Vietnam War expansion, the oil price recession, or the Volcker disinflation.

The answers to both questions have important implications for economic theory, economic policy, and econometric practice. We cite three examples. The role of monetary policy is quite different if shocks are predominantly monetary or arise partly from policy and partly from the behavior of private agents. The discussion of rules versus discretion is also affected by the nature of shocks. If shocks are small and frequent, policy rules are clearly appropriate. If shocks are instead one of a kind, discretion appears more reasonable.[4] Finally, if infrequent large shocks are present in economic time series, then standard asymptotic approximations to the distribution of estimators may be poor, and robust methods of estimation may be useful.

This paper examines both questions, using two different approaches to analyze the empirical evidence. The first approach is the natural, direct approach, in which we specify and estimate a structural model. This allows us to examine the characteristics of the shocks and to calculate their contributions to economic fluctuations. In Section I we discuss the structural model, the data, and the methodology in detail. In Section II we present the empirical results. We conclude that fluctuations are due, in roughly equal proportions to fiscal, money, demand, and supply shocks. We find substantial evidence against the small shock hypothesis. What emerges however is not an economy characterized by large shocks and a gradual return to equilibrium, but rather an economy with a mixture of large and small shocks.

Our second approach to analyzing the data is an indirect one, which tests one of the implications of the small shock hypothesis. If economic fluctuations arise from an accumulation of small shocks, business cycles must then be, in some precise sense, alike. We therefore look at how "alike" they are. The comparative advantage of the indirect approach is that it does not require specification of the structural model; its comparative disadvantage is that it may have low power against the large shock hypothesis. It is very similar to the study by Burns and Mitchell [1947] of commonality and differences of business cycles. Instead of focusing on graphs, we focus on correlation coefficients between variables and an aggregate activity index. While these correlation coefficients are less revealing than the Burns and Mitchell graphs they do allow us to precisely state hypotheses and carry out statistical tests. Our conclusions are somewhat surprising: Business cycles are not at all alike. This, however, is not inconsistent with the small shock hypothesis, and provides only mild support in favor of the view that large specific events dominate individual cycles. These results cast doubt on the usefulness of using "the business cycle" as a reference frame in the analysis of economic time series. These results are developed in Section III.

Section I. The Direct Approach. Methodology

1. The Structural Model

Let X_t be the vector of variables of interest. We assume that the dynamic behavior of X_t is given by the structural model:[5]

$$X_t = \sum_{i=0}^{n} A_i X_{t-i} + \varepsilon_t \tag{1}$$

$$E(\varepsilon_t \varepsilon_\tau') = \begin{cases} D & \text{if } t=\tau \\ 0 & \text{otherwise} \end{cases}$$

where D is a diagonal matrix.

Our vector X_t includes four variables. Two are the basic macroeconomic variables, the variables of ultimate interest; they are output and the price level. The other two are policy variables. The first is a monetary aggregate, M_1, the second is an index of fiscal policy. We shall describe them more precisely below.

The structural model is composed of four equations. The first two are aggregate demand and aggregate supply. The other two are equations describing policy; they are policy feedback rules. The vector ε_t is the vector of four structural disturbances. It includes aggregate supply and demand disturbances, as well as the disturbances in fiscal and monetary policy. The matrices A_i, $i = 0,\dots n$ represent the propagation mechanism.

We assume that the structural disturbances are contemporaneously uncorrelated, that their covariance matrix, D, is diagonal. However, we do allow the matrix A_0 to differ from zero, so that each structural disturbance is allowed to affect all four variables contemporaneously.

Leaving aside, for the moment, the issue of identification and estimation of (1), we now see how we can formalize the different hypotheses about the nature of the disturbances.

2. Is there a dominant source of disturbances?

There may be no single yes or no answer to this question. A specific source may dominate short-run movements in output but have little effect on medium-run and long-run movements. One source may dominate prices movements, another may dominate output movements.

Variance decompositions are a natural set of statistics to use for shedding light on these questions. These decompositions show the proportion of the K-step ahead forecast error variance of each variable which can be attributed to each of the four shocks. By choosing different values of K, we can look at the effects of each structural disturbance on each variable in the short, medium and long runs.

3. Are there infrequent large shocks?

A first, straightforward, way of answering this question is to look at the distribution of disturbances - or more precisely the distribution of estimated residuals. The statement that there are infrequent large shocks can be interpreted as saying that the probability density function of each shock has thick tails. A convenient measure of the thickness of tails is the kurtosis coefficient of the marginal distribution of each disturbance, $E[(\varepsilon_{jt}/\sigma_j)^4]$. We shall compute these kurtosis coefficients. In addition we shall see whether we can relate the large realizations to specific historical events and fluctuations.

This first approach may, however, be too crude for at least two reasons. The first is that a particular source of shocks may dominate a given time period, not because of a particular large realization but because of a sequence of medium-sized realizations of the same sign. The second reason is similar but more subtle. The system characterized by (1) in a highly aggregated system. Unless it can be derived by exact aggregation - and this is unlikely - it should be thought of as a low dimension representation of the joint behavior of the four variables X_t . In this case the "structural" disturbances ε will be linear combinations of current and lagged values of the underlying disturbances. An underlying "oil shock" may therefore appear as a sequence of negative realizations of the supply disturbance in (1). For both reasons, we go beyond the computation of kurtosis coefficients. For each time period we decompose the difference between each variable and its forecast constructed K periods before, into components due to realizations of each structural disturbance. If we choose K large enough, forecast errors mirror major fluctuations in output as identified by NBER. We can then see whether each of these fluctuations can be attributed to realizations of a specific structural disturbance, for example whether the 73-75 recession is mostly due to adverse supply shocks.

4. Identification and Estimation

Our approach to identification is to avoid as much as is possible overidentifying but controversial restrictions. We impose no restrictions on the lag structure, that is on A_i, $i=1,\ldots,n$. We achieve identification by restrictions on A_0 , the matrix characterizing contemporaneous relations between variables, and by assuming that the covariance matrix of structural disturbances, D , is diagonal. We now describe our approach and the data in more detail.

Choice of variables

We use quarterly data for the period 1947-1 to 1982-4. Output, the price level, monetary and fiscal variables are denoted Y, P, M and G respectively. Output, the price level and the monetary variable are the logarithms of real GNP, of the GNP deflator and of nominal M_1 . The price and money variables are multiplied by four so that all structural disturbances have the interpretations of rates of change, at annual rates. The fiscal variable G is an index which attempts to measure the effect of fiscal policy, that is, of government spending, deficits and debt, on aggregate demand. It is derived from other work (Blanchard [1984]) and is described in detail in Appendix B.

Reducing form estimation

As we impose no restrictions on the lag structure, A_i, $i = 1,\ldots,n$, we can proceed in two steps. The reduced form associated with (1) is given by:

$$X_t = \sum_{i=1}^{n} B_i X_{t-i} + x_t \qquad (2)$$

$$E(x_t x_\tau') = \Omega \qquad \text{if } t=\tau$$

$$= 0 \qquad \text{if } t\neq\tau$$

$$B_i = (I-A_0)^{-1}A_i \; ; \quad \Omega = [(I-A_0)^{-1}]D[(I-A_0)^{-1}]'$$

We first estimate the unconstrained reduced form (2). Under the large shock hypothesis, some of the realizations of the ε_t and thus of x_t may be large; we use therefore a method of estimation which may be more efficient than OLS in this case. We use the bounded influence method developed by Krasker and Welsch [1982], which in effect decreases the weight given to observations with large realizations.[6] We choose a lag length, n , equal to 4.[7]

x_t is the vector of unexpected movements in Y, P, M and G . Let lower case letters denote unexpected movements in these variables, so that this first step in estimation gives us estimated time series for y, p, m and g .

Structural estimation

The second step takes us from x to ε . Note that (1) and (2) imply:

$$x = A_0 \, x + \varepsilon \tag{3}$$

Thus, to go from x to ε we need to specify and estimate A_0 , the set of contemporaneous relations between the variables. We specify the following set of relations:

$$y = b_1 p \qquad + \varepsilon^s \qquad \text{(aggregate supply)} \tag{4}$$

$$y = b_2 m - b_3 p + b_4 g \qquad + \varepsilon^d \qquad \text{(aggregate demand)} \tag{5}$$

$$g = c_1 y + c_2 p \qquad + \varepsilon^g \qquad \text{(fiscal role)} \tag{6}$$

$$m = c_3 y + c_4 p \qquad + \varepsilon^m \qquad \text{(money role)} \tag{7}$$

We have chosen standard specifications for aggregate supply and demand. Output supplied is a function of the price level.[8] Output demanded is a function of nominal money, the price level and fiscal policy; this should be viewed as the reduced form of an IS-LM model, so that ε^d is a linear combination of the IS and LM disturbances. The last two equations are policy rules, which allow the fiscal index and money to respond contemporaneously to output and the price level.[9]

Even with the zero restrictions on A_0 implicit in the above equations, the system of equations (4) to (7) is not identified. The model contains 8 coefficients and 4 variances which must be estimated from the 10 unique elements in Ω. To achieve identification we use a priori information on two of the parameters.

Within a quarter, there is little or no discretionary response of fiscal policy to changes in prices and output. Most of the response depends on institutional arrangements, such as the structure of income tax rates, the degree and timing in the indexation of transfer payments and so on. Thus the coefficients c_1 and c_2 can be constructed directly; the details of the computations are given in appendix B. Using these coefficients, we obtain $\hat{\varepsilon}^g$ from (6).

Given the two constructed coefficients c_1 and c_2 we now have six unknown coefficients and four variances to estimate using the ten unique elements in Ω. The model is just identified. Estimation proceeds as follows: $\hat{\varepsilon}^g$ is used as an instrument in (4) to obtain $\hat{\varepsilon}^s$. $\hat{\varepsilon}^g$ and $\hat{\varepsilon}^s$ are used as instruments in (7) to obtain $\hat{\varepsilon}^m$. Finally, $\hat{\varepsilon}^g$, $\hat{\varepsilon}^s$ and $\hat{\varepsilon}^m$ are used as instruments in (5) to obtain $\hat{\varepsilon}_d$.

The validity of these instruments at each stage depends on the plausibility of the assumption that the relevant disturbances are uncorrelated. Although we do not believe that this is exactly the case, we find it plausible that they have low correlation, so that our identification is approximately correct.

It may be useful to compare our method for the identification and estimation of shocks to the more common method used in the vector autoregression literature. A common practice in that literature is to decompose, as we do, the forecast errors into a set of uncorrelated shocks. There the identification problem is solved by assuming that the matrix $(I-A_0)$ is triangular or can be made triangular by rearranging its rows. This yields a recursive structure that is efficiently estimated by OLS. We do not assume a recursive structure but rather impose four zero restrictions in addition to constructing two coefficients c_1 and c_2. Our method produces estimated disturbances much closer to true structural disturbances than would be obtained by imposing a recursive structure on the model.

Section II. The Direct Approach. Results

1. Reduced form evidence

The first step is the estimation of the reduced form given by (2). The estimated $B_i, i=1,\ldots,4$ are of no particular interest. The estimated time series corresponding to unexpected movements of x, that is of y, m, p and g are of more interest. Table 1 gives, for y, m, p and g, the value of residuals larger than 1.5 standard deviations in absolute value, as well as the associated standard deviation and estimated kurtosis.

The kurtosis coefficient of a normally distributed random variable is equal to 3. The 99% significance level of the kurtosis coefficient, for a sample of 120 observations drawn from a normal distribution is 4.34. Thus, ignoring the fact that these are estimated residuals rather than actual realizations, three of the four disturbances have significantly fat tails. As linear combinations of independent random variables have kurtosis smaller than the maximum kurtosis of the variables themselves, this strongly suggests large kurtosis of the structural disturbances.[10] We now turn to structural estimation.

2. The structural coefficients

The second step is estimation of A_0, from equations (4) to (7). We use constructed values for c_1 and c_2 of -.34 and -1.1 respectively. Unexpected increases in output increase taxes more than expenditures and lead to fiscal contraction. Unexpected inflation increases real taxes but decreases real expenditures, leading also to fiscal contraction. We are less confident of c_2, the effect of inflation than we are of c_1. In Appendix A we report

Table 1
Large Reduced Form Disturbances

Date		y	g	m	p
48	4				-2.6
49	1				-2.2
49	4	-2.4			
5Ø	1	3.2	2.6		
5Ø	2		-5.1		1.6
5Ø	3	1.8	-1.6		5.1
51	1				3.7
51	2		4.2		-2.8
51	3		2.2		-1.6
51	4			1.6	
52	2		1.6		
52	3		1.7		
52	4	1.6			
53	1		1.6		
53	4				-1.6
54	1	-1.7			2.1
58	1	-2.2			
59	1		-1.8		
59	3	-2.7			
59	4			-2.9	
6Ø	1	2.2	-2.7		
6Ø	4	-1.9			
62	3			-1.5	
65	4	1.6			
66	3			-2.2	
67	3			1.8	
7Ø	4	-1.8			
71	3	-1.6			
72	2				-1.5
72	4		1.7		
74	4	-1.6			1.7
75	1	-3.1			
75	2		3.6		-1.7
75	3		-3.1		
75	4			-1.6	
78	2	2.2			2.1
79	2			1.7	
8Ø	2	-2.5		-4.2	
8Ø	3	2.4		4.7	
81	3			-3.5	
82	4			3.Ø	
St. Error		.ØØ85	.Ø431	.Ø244	.Ø182
Kurtosis		4.Ø	1Ø.2	8.6	8.2

Ratios of residuals to standard errors are reported alternative structural coefficient estimates based on $c_2=-1.3$ and $c_2=-1.0$.

The results of estimating (4) - (7) are reported in Table 2. All coefficients except one are of the expected sign. Nominal money has a negative contemporaneous effect on output; this is consistent with a positive correlation between unexpected movements in money and output because of the positive effect of output on money supply. Indeed the correlation m and y is .32. (Anticipating results below, we find that the effect of nominal money on output is positive after one quarter.) Aggregate supply is upward sloping; a comparison with the results of Table A1 suggest that the slope of aggregate supply is sensitive to the value of c_2 .

Given our estimates of the reduced form and of A_0 , we can now decompose each variable (Y, P, M, G) as the sum of four distributed lags of each of the structural disturbances $\varepsilon^d, \varepsilon^s, \varepsilon^m$, and ε^g . Technically, we can compute the structural moving average representation of the system characterized by (1).

3. <u>One or many sources of shocks</u>. <u>Variance decomposition</u>.

Does one source of shocks dominate? We have seen that a natural way of answering this question is to characterize the contribution of each disturbance to the unexpected movement in each variable. We define unexpected movement as the difference between the actual value of a variable and the forecast constructed K periods earlier using equation (1). We use 3 values of K. The first case, K = 1 , decomposes the variance of y, p, m, and g into their 4 components, the variances of $\varepsilon^d, \varepsilon^s, \varepsilon^m$ and ε^g . The other 2 values, K = 4 and K = 20 correspond to the medium run and the long run respectively.

The results are reported in Table 3. Demand shocks dominate output in

Table 2. Structural Estimates

Fiscal*	$g = -.34y - 1.1p$	$+ \varepsilon^g$
Money supply	$m = 1.40y + .19p$	$+ \varepsilon^m$
	(1.4) (.7)	
Aggregate supply	$y = .81p$	$+ \varepsilon^s$
	(1.1)	
Aggregate demand	$y = -.10p - .20m + .06g$	$+ \varepsilon^d$
	(-3.1) (-2.2) (2.4)	

* Coefficients constructed, not estimated

t-statistics in parentheses

Standard deviations

ε^g	ε^m	ε^s	ε^d
.041	.024	.017	.011

Table 3. Variance Decompositions

Structural disturbance:	ε^g	ε^s	ε^m	ε^d
Contemporaneously				
$Y - E_{-1}Y$	.03	.19	.04	.74
$G - E_{-1}G$	.78	.14	.00	.08
$M - E_{-1}M$	.01	.01	.74	.25
$P - E_{-1}P$	.01	.74	.01	.24
4 quarters ahead				
$Y - E_{-4}Y$	.15	.16	.16	.54
$G - E_{-4}G$	.70	.13	.00	.16
$M - E_{-4}M$	.13	.03	.67	.17
$P - E_{-4}P$	.01	.65	.01	.33
20 quarters ahead				
$Y - E_{-20}Y$	.27	.20	.17	.37
$G - E_{-20}G$	.66	.12	.05	.17
$M - E_{-20}M$	.28	.04	.64	.05
$P - E_{-20}P$	.15	.22	.36	.26

the short run. supply shocks dominate price in the short run. In the medium and long run, however, <u>all four shocks are important in explaining the behavior of output and prices</u>. There is no evidence in support of the one-dominant-source-of-shocks theory.

4. <u>Are there infrequent large shocks?</u> <u>I</u>

Table 4 reports values and dates for all estimated realizations of $\varepsilon^d, \varepsilon^s, \varepsilon^m$ and ε^g larger than 1.5 times their respective standard deviation. We can compare these to traditional, informal, accounts of the history of economic fluctuations since 1948 and see whether specific events which have been emphasized there correspond to large realizations. A useful, concise summary of the events associated with large post-war fluctuations is contained in Table 1 in the paper by Eckstein and Sinai in some volume.

The first major expansion in our sample, from 1949-4 to 1953-2 is usually explained by both fiscal shocks associated with the Korean War and a sharp increase in private spending. We find evidence of both in 1951 as well as in 1952. From 1955 to the early 70's, large shocks are few in number and not easily interpretable. There are, for example, no large shocks to either fiscal policy or private spending corresponding to either the Kennedy tax cut or to the Vietnam War. In the 1970's, major fluctuations are usually explained by the two oil shocks. There is some evidence in favor of this description. We find two large supply shocks in 1974-4 and 1975-1; we also find large fiscal and large demand shocks during the same period. The two recessions of the early 1980's are usually ascribed to monetary policy. We find substantial evidence in favor of this description. There are large shocks to money supply for most of the period 1979-2 to 1982-4, and two very large negative shocks in

Table 4
Large Structural Disturbances

Date		Fiscal	Supply	Money	Demand
48	3	1.9			
48	4		2.5		
49	1	-1.5			-1.9
49	4				-1.8
50	1	3.0	1.8		2.0
50	2	-4.6	-1.6		
50	3		-3.7		3.6
51	1	1.7	-3.6		
51	2	3.1	3.2		
51	3	1.6	1.8		
51	4			1.6	
52	2	1.5			
52	3	2.0			
52	4				1.7
53	4				-1.6
[illegible]	1		-2.8		
[illegible]	3		1.8		
57	4				-1.7
[illegible]	1		-1.5		-1.7
[illegible]	3	1.7			
[illegible]	1		-1.6		
[illegible]	3				-2.3
[illegible]	4			-2.6	
[illegible]	1	-2.6			2.4
[illegible]	3			1.5	
[illegible]	4				-2.0
[illegible]	3			-2.2	
[illegible]	4			1.5	
71	2			2.1	
71	3				-1.8
72	2		1.6		
72	4	1.7			
74	4		-2.4		
75	1		-2.5		-2.4
75	2	3.1	1.9		
75	3	-3.1			
75	4			-1.8	
78	2				2.7
79	2			1.6	
80	2		-2.1	-3.2	-2.7
80	3			3.4	3.4
81	2			1.6	
81	3			-3.8	
82	1			1.6	
82	4			3.7	

1980-2 and 1981-3.

The overall impression is therefore one of infrequent large shocks, but not so large as to dominate all others, and the behavior of aggregate variables for long periods of time. To confirm this impression, we report the kurtosis coefficients of the structural disturbances in Table 5a; in all cases we can reject normality with high confidence. In Table 5b we use another descriptive device. We assume that each structural disturbance is an independent draw from a mixed normal distribution, that is for $x = g$, d, s or m:

$$\varepsilon^x = \varepsilon_1^x \qquad \text{with probability } 1 - P_x$$
$$\varepsilon^x = \varepsilon_2^x \qquad \text{with probability } P_x$$

where

$$\varepsilon_1^x \sim N(0,\sigma_{1x}^2) \quad , \quad \varepsilon_2^x \sim N(0,\sigma_{2x}^2)$$
$$\sigma_{1x}^2 < \sigma_{2x}^2$$

The realization of each disturbance is drawn from either a normal distribution with large variance, with probability P, or from a normal distribution with small variance, with probability $1 - P$. The estimated values of σ_{1x}, σ_{2x}, P_x, estimated by maximum likelihood are reported in Table 5b. The results suggest large, but not very large, ratios of the standard deviation of large to the standard deviation of small shocks; they also suggest infrequent, but not very infrequent large shocks. The estimated probabilities imply that one out of six fiscal or money shocks, and one out of three supply or demand shocks came from the large variance distributions.

Table 5. Characteristics of Structural Disturbances

		ε^g	ε^s	ε^m	ε^d
(a)	Estimated Kurtosis				
	K	7.0	5.4	5.9	4.6
(b)	Disturbances as mixed normals				
	σ_1	.68	.63	.72	.68
		(.08)	(.10)	(.09)	(.13)
	σ_2	2.01	1.62	1.97	1.50
		(.64)	(.41)	(1.03)	(.41)
	Ratio	2.95	2.57	2.73	2.21
	Probability	.15	.27	.14	.30
		(.09)	(.15)	(.15)	(.22)

Standard errors in parentheses

The dating of the large shocks in Table 4 suggests two more characteristics of shocks. First, large shocks tend to be followed by large shocks, suggesting some form of autoregressive conditional heteroskedasticity as discussed in Engle (1982). Second, there seems to be some tendency for large shocks to happen in unison. In 50:1 for example we find large fiscal, supply, and demand shocks, while in 80:3 we find large supply, money, and demand shocks. To confirm these impressions we present in Table 6 the correlations and first autocorrelations between the squares of the structural shocks.[11] The table shows a large positive contemporaneous correlation between the square of the supply shock and the square of the demand shock. A weaker contemporaneous relationship between supply and the fiscal shock is present. The squares of all shocks are positively correlated with their own lagged values; there is also significant correlation between demand, the lagged fiscal and supply shocks, and between the fiscal shock and lagged supply shock. All in all these results suggest an economy characterized by active, volatile periods followed by quiet, calm periods both of varied duration.

5. Are there infrequent large shocks? II

We discussed in Section I the possibility that a specific source of shocks may dominate some episode of economic fluctuations, even if there are no large realizations of the shock. To explore this possibility, we construct an unexpected output series, where the expectations are the forecasts of output based on the estimated model corresponding to (1), 8 quarters before. We chose 8 quarters because the troughs and peaks in this unexpected output series correspond closely to NBER troughs and peaks. We then decompose this forecast error for GNP into components due to each of the four structural dis-

Table 6. Correlations Between Squares of Structural Disturbances

	$(\varepsilon^g)^2$	$(\varepsilon^s)^2$	$(\varepsilon^m)^2$	$(\varepsilon^d)^2$
$(\varepsilon^g)^2$	-	.27	-.05	.08
$(\varepsilon^s)^2$		-	-.01	.36
$(\varepsilon^m)^2$			-	.28
$(\varepsilon^d)^2$				-
$(\varepsilon_{-1}^g)^2$	.33	.43	.00	.33
$(\varepsilon_{-1}^s)^2$	.35	.38	.03	.13
$(\varepsilon_{-1}^m)^2$	.02	-.09	.23	.21
$(\varepsilon_{-1}^d)^2$	.15	.08	.13	.16

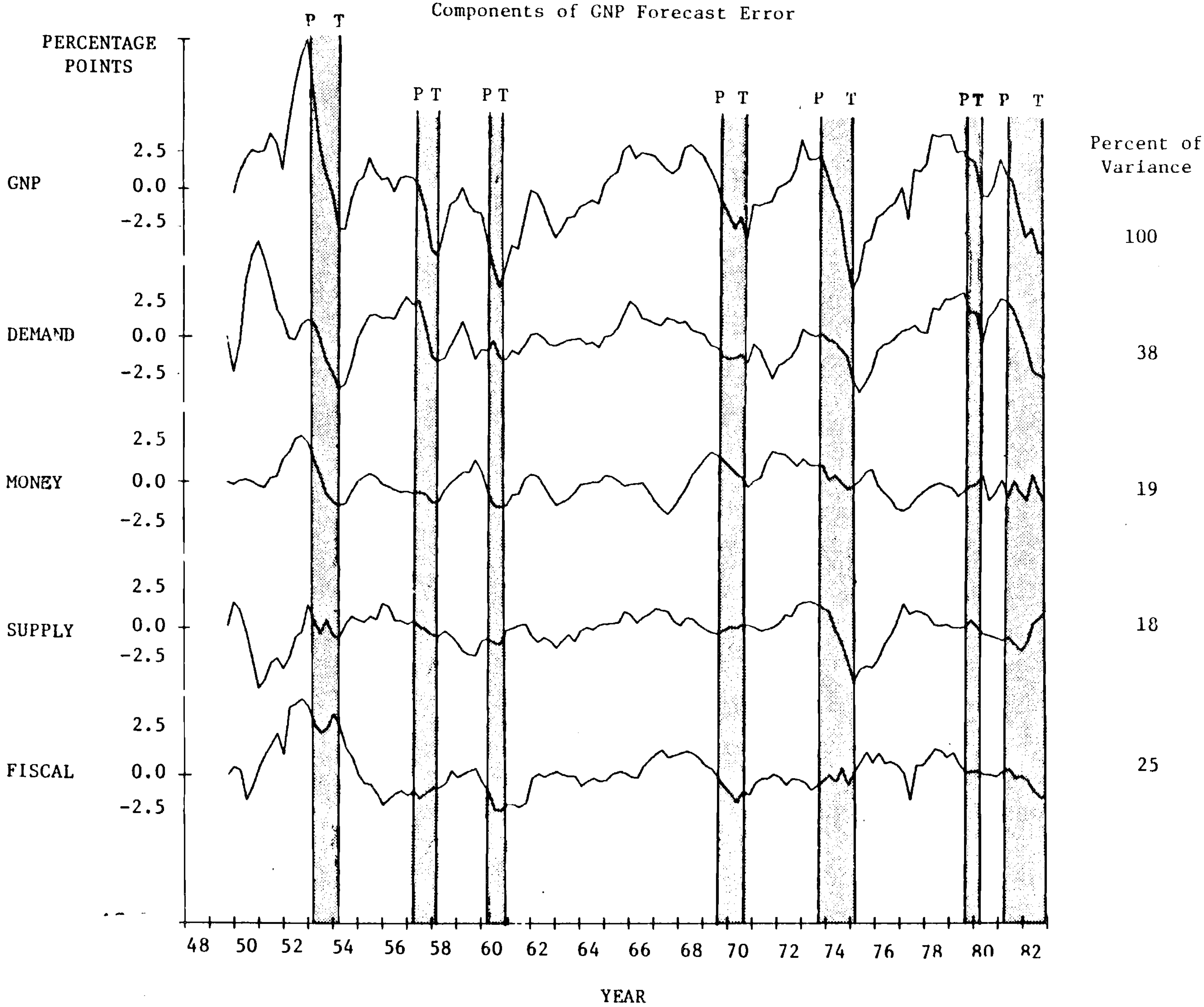
turbances. This decomposition is represented graphically in Figure 1; the corresponding time series are given in Table A2, in Appendix A.

No single recession can be attributed to only one source of shock. Post war recessions appear to be due to the combination of two or three shocks. The 1960-4 trough for example, where the GNP forecast error is -6.7% is attributed to a fiscal shock component (-2.4%), a supply shock component (-1.1%), a money shock component (-1.7%) and a demand shock component (-1.4%). The 1975-1 trough, where the GNP forecast error is also -6.7% seems to have a large supply shock component (-3.6%) and a demand shock component (-2.9%). The 1982-4 trough, where the GNP forecast error if -4.5% is decomposed as -1.4% (fiscal), 1.1% (supply), -1.4% (money) and -2.8% (demand).

To summarize the results of this section, we find substantial evidence against the single source of shock hypothesis. We find some evidence of large infrequent shocks; however they do not seem to dominate economic fluctuations.

CHART 1

Components of GNP Forecast Error



Section III. The indirect approach.

If economic fluctuations are due to an accumulation of small shocks, then in some sense, business cycles should be all alike. In this section, we make precise the sense in which cycles should be alike and examine the empirical evidence.

The most influential contributions to the position that cycles are alike is the empirical work carried out by Burns and Mitchell on pre-World War II data. Their work was not only focused on the characteristic cyclical behavior of many economic variables but also on how, in specific cycles, the behavior of these variables differed from their characteristic cyclical behavior. When looking at their graphs, one is impressed at how similar the behavior of most variables is across different cycles; this is true of quantities, for which it may not be too surprising but also, for example, of interest rates.

We considered extending the Burns-Mitchell (B-M) graph method to the eight post War cycles but decided against it. Many steps of the method, and in particular their time deformation, are judgemental rather than mechanical. As a result, it is impossible to derive the statistical properties of their results. When comparing for example the graphs of short rates across two cycles, we have no statistical yardstick to decide whether they are similar or significantly different. As a result also, we do not know which details, in the wealth of details provided in these graphs, should be thought of as significant.

Therefore, we use an approach which is in the spirit of Burns and Mitchell but allows us to derive the statistical properties of the estimators we use. The trade off is that the statistics we give are much less revealing than the B-M graphs. Our approach is to compute the cross correlations at different leads and lags between various variables and a reference variable such as GNP, across different cycles.

<u>The construction of correlation coefficients</u>

The first step is to divide the sample into subsamples. We adopt the standard division into cycles, with trough points determined by the NBER chronology. This division may not be, under the large shock hypothesis, the most appropriate as a large shock may well dominate parts of two cycles. It is, however, the most uncontroversial. Defining the trough-to-trough period as a cycle, there are seven complete cycles for which we have data; their dates are given in Table 7. This gives us seven subsamples.

For each subsample, we compute cross-correlations at various leads and lags between the reference variable and the variable considered. Deterministic seasonality is removed from all variables before the calculation of the correlations. A more difficult issue is that of the time trend: the series may be generated either by a deterministic time trend or a stochastic time trend or by both. In the previous two sections, this issue was unimportant in the sense that inclusion or exclusion of a deterministic trend together with unconstrained lag structures in the reduced form made little difference to estimated realizations of the disturbances. Here, the issue is much more important. Computing deviations from a single deterministic trend for the whole sample may be very misleading if the trend is stochastic. On the other hand taking first or second differences of the time series probably removes non-stationarities associated with a stochastic trend but correlations between first or second differences of the time series are difficult to interpret.

In their work, Burns and Mitchell adopt an agnostic and flexible solution to that problem. They compute deviations of the variables from subsample means. Thus they proxy the time trend by a step function: although this does not capture the time trend within each subsample, it does imply that across subsamples, the estimated time trend will track the underlying one. We initially followed B-M in their formalization but found this procedure to be misleading for variables with strong time trends. During each subsample, both the reference and the other variable are below their means at the beginning and above their means at the end; this generates spuriously high correlation between the variables. We modify the B-M procedure as follows: for each subsample, we allow both for a level and a time trend; the time trend is given by the slope of the line going from trough to trough. This should be thought of as a flexible (perhaps too flexible) parameterisation of the time trend, allowing for six level and slope changes over the complete sample.

The cross-correlations are then computed for deviations of each of the two series from its trend. We compute correlations of the reference variable and of the other variable, up to two leads and lags.

<u>The construction of confidence levels</u>

For each variable we calculate cross-correlations with our reference variable, GNP, for each of the seven cycles. We then want to answer the following questions: should we be surprised by the differences in estimated correlation across cycles? More precisely, under the null hypothesis that fluctuations are due to the accumulation of small shocks, how large are these differences in the correlation coefficients likely to be? Thus, we must derive the distribution of the differences between the largest and smallest correlation coefficients, at each lag or lead for each variable. This distribution is far too difficult to derive analytically; instead we rely on Monte Carlo simulations.

The first step is to estimate, for each variable, the bivariate process generating the reference variable and the variable under consideration. We allow for four lags of each variable and a linear time trend, for the period 1947:1 to 1982:4. The method of estimation is, for the same reasons as in Section I, Krasker-Welsch.

The second step is to simulate the bivariate process, using disturbances drawn from a normal distribution for disturbances. (Thus we implicitly characterize the "small shock" hypothesis as a hypothesis that this joint distribution is normal.) We generate 1000 samples of 147 observations each. We then divide each sample into cycles by identifying troughs in the GNP series. Let x_t denote the log of real GNP at time t. Time t is a trough if two conditions are satisfied. The first is that

$$x_{t-1} > x_t < x_{t+1} < x_{t+2} < x_{t+3}$$

and the second that x_t be at least 1/2 % below the previous peak value of x. The first insures that expansions are longer than 3 periods and the second eliminates minor downturns. (When applied to the actual sample, this rule correctly identifies NBER troughs, except for two which differ from the NBER trough by one quarter.) Given this division into cycles, we compute, as in the actual sample, cycle specific correlations, and obtain, for each of the 1000 samples, the difference between the largest and the smallest correlation. Finally, by looking at the 1000 samples, we get an empirical distribution for the differences.

What we report in Table 7 for each variable and for correlations at each lead and lag are probabilities that in the corresponding empirical distributions, the difference between the largest and smallest correlation exceeds the value of this difference in the actual sample. This probability is denoted P. _A very small value of P indicates that the difference observed in the actual sample is surprisingly large under the small shock hypothesis_. It would therefore be evidence against the small shock hypothesis.

The choice of variables

Most quantity variables, such as consumption or investment appear highly correlated with real GNP. Most of the models we have imply that it should be so, nearly irrespective of the source of shocks. Most models imply that correlations of prices and interest rates with GNP will be of different signs depending on the source of shocks. We report results for various prices, interest rates, policy variables, and quantities.

We look at _three real wages_. In all three cases, the numerator is the same, the index of average hourly earnings of production and non-supervisory workers, adjusted for overtime and interindustry shifts, in manufacturing. In Table 7a, the wage is deflated by the GNP deflator. In Table 7b, it is deflated by the CPI and is therefore a consumption real wage. In Table 7c, it is deflated by the producer price index for manufacturers and is therefore a product wage. In all three cases, we take the logarithm of the real wage so constructed.

We then look at _two relative prices_. Both are relative prices of materials in terms of finished goods. Because of the two oil shocks, we consider two different prices. The first is the ratio of the price of crude fuels to the producer price index for finished goods and is studied in Table 7d. Table 7e gives the behavior of the price of non-food, non-fuel materials in terms of finished goods.

We then look at the behavior of interest rates. Table 7f characterizes the behavior of the nominal three month treasury bill rate. Table 7g gives the behavior of Moody's AAA corporate bond yield.

We consider the two policy variables: the fiscal index defined in the first section, and nominal M_1. The results are given in Tables 7h and 7i.

Finally, we consider three quantity variables. Table 7j shows the behavior of real consumption expenditures. Tables 7k and 7l show the behavior of non-residential and residential investment.

General results.

In looking at Table 7, there are two types of questions we want to answer. The first is not directly the subject of the paper but is clearly of interest. It is about the typical behavior of each variable in the cycle. The answer is given, for each variable by the sequence of average correlation coefficients at the different lags and leads. How do these sequences relate to B-M graphs? The relation is roughly the following: If the sequence is flat and close to zero, the variable has little cyclical behavior. If the sequence is flat and positive, the variable is procyclical, peaking at the cycle peak; if flat and negative, it is countercyclical, reaching its trough at the cycle peak.

If the sequence is not flat, the variable has cyclical behavior but reaches its peak, or its trough if countercyclical, before or after the cyclical peak. If for example, ρ_{-1} is large and negative, this suggests that the variable is countercyclical, reaching its trough one quarter before the cyclical peak. As expected the quantity variables are pro-cyclical; there seems to be a tendency for non-residential investment to lag GNP by one quarter and residential investment to lead GNP by one quarter. We find little average cyclical behavior of real wages. Relative fuel prices and long-term interest rates are countercyclical and lead GNP by at least two quarters. Relative non-food/non-fuel materials and short-term rates appear to be pro-cyclical. We now turn to the second question, which is one of the subjects of this paper. How different are the correlations and are these differences surprising?

The first part of the answer is that <u>correlations are very different across cycles</u>. This is true both for variables with little cyclical behavior such as the real wage, or for variables which vary cyclically, such as nominal rates. These differences suggest that business cycles are indeed not all alike. The second part of the answer may however also be surprising: it is that <u>under the small shock hypothesis, such differences are not unusual</u>. For most correlations and most variables, the P values are not particularly small. Thus, the tentative conclusion of this section is that, although business cycles are not very much alike, their differences are not inconsistent with the hypothesis of the accumulation of small shocks through an invariant propagation mechanism.

Table 7. Correlations

Cycles :	trough to trough			
1	49-4	to	54-2	(peak : 53-2
2	54-2	to	58-2	: 57-3
3	58-2	to	61-1	: 60-2
4	61-1	to	70-4	: 69-4
5	70-4	to	75-1	: 73-4
6	75-1	to	80-2	: 79-4
7	80-2	to	82-4	: 81-2)

ρ_i: correlation between the reference variable, logarithm of real GNP at time t and the other variable at time t+i.

Real Wages

(a) Real wage in terms of the GNP deflator (in log)

	ρ_{-2}	ρ_{-1}	ρ_0	ρ_{+1}	ρ_{+2}
Cycle 1	-.81	-.70	-.36	-.25	.09
2	-.06	-.41	-.48	-.18	.44
3	-.17	.02	.03	-.35	-.59
4	-.11	-.13	-.01	-.04	-.00
5	.85	.90	.90	.65	.37
6	.75	.84	.84	.75	.63
7	.62	.61	.06	-.29	-.38
Average	-.15	-.16	.14	.04	.08
Difference	1.67	1.61	1.38	1.10	1.22
P	.04	.07	.27	.65	.52

(b) Real wage in terms of the CPI (in log)

	ρ_{-2}	ρ_{-1}	ρ_{0}	ρ_{+1}	ρ_{+2}
Cycle 1	-.53	-.58	-.57	-.64	-.57
2	.09	.44	.79	.85	.76
3	-.15	.29	.75	.47	-.07
4	.56	.57	.63	.56	.49
5	.84	.67	.47	.02	-.31
6	.78	.89	.88	.78	.65
7	.57	.32	-.31	-.53	-.24
Average	.30	.37	.37	.21	.10
Difference	1.37	1.47	1.45	1.49	1.34
P	.48	.31	.32	.22	.49

(c) Real wage in terms of the PPI (in log)

	ρ_{-2}	ρ_{-1}	ρ_{0}	ρ_{+1}	ρ_{+2}
Cycle 1	-.68	-.71	-.63	-.55	-.28
2	.17	.60	.91	.88	.63
3	-.29	.45	.87	.62	.27
4	-.46	-.56	-.62	-.72	-.76
5	.88	.74	.52	.08	-.27
6	.78	.86	.82	.71	.59
7	-.42	-.70	-.72	-.60	.01
Average	-.02	.09	.16	.06	.02
Difference	1.57	1.57	1.62	1.61	1.40
P	.17	.18	.13	.11	.44

<u>Relative Prices</u>

(d) Relative price of crude fuels in terms of finished goods (in log)

	ρ_{-2}	ρ_{-1}	ρ_0	ρ_{+1}	ρ_{+2}
Cycle 1	-.65	-.61	-.45	-.43	-.19
2	-.25	-.04	.09	.31	.41
3	-.07	.45	.42	.46	.17
4	-.61	-.75	-.86	-.91	-.91
5	-.66	-.86	-.91	-.81	-.63
6	.47	.46	.35	.34	.44
7	-.56	-.39	-.23	-.16	-.01
Average	-.33	-.24	-.22	-.17	-.10
Difference	1.13	1.33	1.33	1.37	1.35
P	.56	.39	.39	.30	.38

(e) Relative price of non-food/non-fuel materials in terms of finished goods (in log)

	ρ_{-2}	ρ_{-1}	ρ_0	ρ_{+1}	ρ_{+2}
Cycle 1	.62	.66	.56	.30	-.12
2	.17	.69	.92	.78	.51
3	.32	.75	.89	.64	.24
4	.09	.06	.02	-.16	-.35
5	-.06	.28	.62	.82	.89
6	-.75	-.77	-.58	-.40	-.23
7	-.02	.59	.92	.82	.32
Average	.05	.32	.47	.40	.18
Difference	1.38	1.53	1.51	1.22	1.24
P	.32	.16	.15	.37	.56

Quantity Variables

(j) Logarithm of real consumption expenditures

	ρ_{-2}	ρ_{-1}	ρ_0	ρ_{+1}	ρ_{+2}
Cycle 1	.22	.35	.32	-.02	-.46
2	.47	.78	.97	.72	.23
3	-.03	.61	.90	.84	.33
4	.69	.78	.88	.91	.90
5	.87	.96	.88	.59	.26
6	.69	.83	.96	.76	.60
7	.39	.86	.91	.40	-.03
Average	.47	.74	.83	.60	.26
Difference	.90	.61	.65	.93	1.36
P	.73	.69	.42	.54	.35

(k) Logarithm real residential investment expenditures

	ρ_{-2}	ρ_{-1}	ρ_0	ρ_{+1}	ρ_{+2}
Cycle 1	.34	.18	-.09	-.49	-.82
2	.77	.71	.55	-.00	-.50
3	.31	.78	.92	.65	.08
4	.02	-.01	-.11	-.29	-.47
5	.91	.88	.78	.43	-.01
6	.73	.86	.94	.73	.52
7	.72	.93	.68	.16	-.37
Average	.54	.62	.52	.17	-.22
Difference	.91	.94	1.05	1.21	1.34
P	.58	.38	.28	.22	.17

(1) Logarithm real non-residential investment expenditures

	ρ_{-2}	ρ_{-1}	ρ_0	ρ_1	ρ_2
Cycle 1	.30	.50	.63	.39	-.19
2	.02	.45	.86	.90	.75
3	-.65	-.23	.28	.81	.84
4	.75	.83	.89	.91	.87
5	.38	.68	.92	.97	.89
6	.39	.53	.77	.88	.89
7	-.58	.08	.64	.88	.84
Average	.09	.41	.71	.82	.70
Difference	1.40	1.06	.64	.58	1.08
P	.15	.41	.52	.53	.39

Section IV. Conclusions

In Sections I and II we specified and estimated a structural model which allowed us to directly investigate the properties of shocks and their role in economic fluctuations. From this analysis we conclude that fluctuations are due, in roughly equal proportions to fiscal, money, demand, and supply shocks. We find substantial evidence against the small shock hypothesis. What emerges, however, is not an economy characterized by large shocks and a gradual return to equilibrium, but rather an economy with a mixture of large and small shocks.

In Section III we investigated the influence of shocks on economic fluctuations in an indirect way by examining stability of correlations between different economic variables across all of the post-war business cycles. Here we found that correlations were very unstable--that business cycles were not at all alike. This, however, is not inconsistent with the small shock hypothesis, and provides only mild support in favor of the view that large specific events dominate the characteristics of individual cycles. These results cast doubt on the usefulness of using "the business cycle" as a reference frame in the analysis of economic time series.

Footnotes

1. This framework is only one of many which can generate fluctuations. Another one, which clearly underlies much of the early NBER work on cycles is based on floor-ceiling dynamics, with a much smaller role for impulses. There are probably two reasons why the white noise impulse-linear propagation framework is now widely used. It is convenient to use both analytically and empirically, because of its close relation to linear time series analysis. Statistical evidence which would allow to choose between the different frameworks has been hard to come by.

2. In the standard dynamic simultaneous equation model impulses arise from the exogenous variables and the noise in the system. In the model we employ we do not distinguish between endogenous and exogenous variables. The entire system is driven by the innovations (the one step ahead forecast errors) in the variables. A portion of what we call "innovations" would be explained by current movements of exogenous variables in large macroeconomic models. For example, we find large negative "supply" innovations in late 1974. In a large model these would be explained by oil import prices.

3. A supplement to the Journal of Monetary Economics was devoted to the analysis of the sources of impulses in different countries, using the Brunner-Meltzer approach. Conclusions vary somewhat across countries but "measures expressing an unanticipated or accelerating monetary impulse figure foremost" [Brunner and Meltzer, p. 14, 1978].

4. A good example of the importance of the nature of the shocks for the rules versus discretion debate is given by the answers of Lucas and Solow to the question, "What should policy have been in 1973-1975?" in Fischer [1980].

5. We assume that the propagation mechanism is linear and time invariant. Violation of either of these assumptions would likely lead to estimated shocks whose distributions have tails thicker than the distribution of the true shocks.

6. LAD or other robust M estimators, could also have been used. In some circumstances OLS may be more efficient than the robust estimators because of the presence of lagged values.

7. Each equation in the vector autoregression included a constant and a linear time trend. When the vector autoregression was estimated without a time trend the estimated residuals, x, were essentially unchanged.

8. A more detailed specification of aggregate supply, recognizing the effects of the price of materials would be:

$$y = d_1p - d_2(p_m - p) \qquad + \varepsilon^{ys}$$
$$p_m = d_3p + d_4y \qquad + \varepsilon^{pm}$$

where supply depend on the price of materials, p_m, and the price level, and where in turn the nominal price of materials depends on the price level and the level of output. The two equations have, however, the same specification, and it is therefore impossible to identify separately the shocks to the price of materials and to supply, ε^{pm} and ε^{ys}. Equation

(4) is therefore the solved-out version of this two-equations system, and ε^s is a linear combination of these two shocks.

9. If money supply responds to interest rates directly rather than to output and prices, ε^m and ε^d will both depend partly on money demand shocks and thus will be correlated. Our estimation method will then attribute as much of the variance as possible to ε^m and incorporate the residual in ε^d.

10. A more precise statement is the following: Let X_1 and X_2 be independent variables with kurtosis K_1 and K_2, one of which is greater than or equal to 3. Then if Z is a linear combination of X_1 and X_2, $K_Z \leq \max(K_1,K_2)$. We do not, however, assume independence but only zero correlation of the structural disturbances.

11. While the contemporaneous correlation between the levels of the shock is zero by construction, the same is not true of the squares of the shocks.

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APPENDIX A

Table A1. Alternative Structural Estimates

$c_2 = 1.3$

Fiscal	$g = -.34y - 1.3p$	$+ \varepsilon^g$
Money supply	$m = 1.20y + .22p$	$+ \varepsilon^m$
Aggregate supply	$y = .45y$	$+ \varepsilon^s$
Aggregate demand	$y = .09g - .10m - .40p$	$+ \varepsilon^d$

	ε^g	ε^m	ε^s	ε^d
Standard deviations	.041	.024	.011	.014

$c_1 = 1.0$

Fiscal	$g = -.34y - 1.0p$	$+ \varepsilon^g$
Money supply	$m = 1.52y + .14p$	$+ \varepsilon^m$
Aggregate supply	$y = 1.40p$	$+ \varepsilon^s$
Aggregate demand	$y = .05g - .10m - .09p$	$+ \varepsilon^d$

	ε^g	ε^m	ε^s	ε^d
Standard deviations	.040	.029	.027	.010

Table A2
Decomposition of Eigth Quarter
Forecast Errors for GNP

Date		GNP	Eg	Es	Em	Ed
50	1	-0.31	0.53	1.72	-0.17	-2.40
50	2	1.09	0.29	1.12	0.11	-0.43
50	3	1.99	-1.68	-0.30	0.16	3.81
50	4	2.56	-0.76	-2.15	0.01	5.46
51	1	2.44	0.41	-4.10	-0.27	6.41
51	2	2.52	1.31	-3.59	-0.39	5.19
51	3	3.65	2.07	-2.37	0.29	3.66
51	4	3.05	2.83	-2.06	0.40	1.88
52	1	1.33	1.39	-2.74	1.55	1.13
52	2	4.47	4.55	-1.99	2.02	-0.12
52	3	7.00	4.82	-0.62	2.97	-0.17
52	4	8.85	5.16	-0.27	3.14	0.81
53	1	9.98	4.65	1.51	2.70	1.12
53	2	6.31	3.47	0.44	1.46	0.94
53	3	2.81	2.85	-0.39	0.47	-0.12
53	4	1.10	3.09	0.50	-0.85	-1.64
54	1	-0.39	4.14	-0.56	-1.41	-2.56
54	2	-2.66	3.27	-0.66	-1.64	-3.62
54	3	-2.76	1.79	0.25	-1.53	-3.26
54	4	-0.75	1.17	0.75	-0.70	-1.96
55	1	0.44	0.03	0.54	0.00	-0.14
55	2	0.83	-0.55	0.37	0.31	0.70
55	3	2.08	-0.64	0.75	0.55	1.42
55	4	1.12	-1.24	0.57	0.32	1.48
56	1	0.64	-2.01	1.62	-0.21	1.24
56	2	0.76	-1.60	1.44	-0.34	1.27
56	3	-0.21	-1.26	0.47	-0.59	1.18
56	4	0.78	-1.04	0.47	-0.70	2.04
57	1	0.85	-1.37	0.24	-0.69	2.67
57	2	0.74	-1.04	0.45	-0.80	2.13
57	3	0.25	-1.55	0.04	-0.70	2.45
57	4	-1.44	-1.13	-0.13	-0.86	0.69
58	1	-4.20	-0.86	-0.54	-1.44	-1.35
58	2	-4.48	-0.86	-0.55	-1.38	-1.69
58	3	-2.85	-0.57	-0.25	-0.57	-1.46
58	4	-1.07	0.30	-0.58	-0.11	-0.68
59	1	-0.78	-0.14	-1.07	0.30	0.13
59	2	0.09	0.08	-1.68	0.69	1.00
59	3	-1.04	0.29	-1.85	0.66	-0.13
59	4	-1.58	0.42	-1.92	1.46	-1.54
60	1	-1.60	-0.51	-0.92	0.71	-0.89
60	2	-3.47	-1.06	-0.78	-0.67	-0.96
60	3	-5.34	-2.28	-1.06	-1.69	-0.30
60	4	-6.69	-2.39	-1.14	-1.72	-1.44
61	1	-5.33	-1.93	-0.20	-1.65	-1.55
61	2	-3.04	-1.95	-0.05	-0.92	-0.93
61	3	-4.10	-2.13	0.12	-0.88	-1.21
61	4	-1.95	-1.84	0.22	0.23	-0.56
62	1	-0.09	-0.17	-0.59	0.54	0.13
62	2	-0.33	0.10	-0.99	0.38	0.17
62	3	-1.15	-0.11	-0.66	-0.29	-0.10
62	4	-2.39	0.08	-0.90	-1.02	-0.56
63	1	-3.32	0.26	-1.36	-1.60	-0.62
63	2	-2.71	0.06	-0.91	-1.42	-0.43
63	3	-1.95	-0.03	-0.46	-1.20	-0.26
63	4	-1.92	-0.03	-0.97	-0.76	-0.17

Table A2
Continued

Date		GNP	Eg	Es	Em	Ed
64	1	-1.25	-Ø.7Ø	-Ø.21	-Ø.18	-Ø.15
64	2	-Ø.99	-Ø.38	Ø.Ø1	-Ø.12	-Ø.5Ø
64	3	-Ø.76	-Ø.17	-Ø.15	-Ø.Ø7	-Ø.37
64	4	-1.Ø1	-Ø.4Ø	Ø.2Ø	-Ø.Ø5	-Ø.76
65	1	Ø.34	-Ø.31	Ø.25	Ø.41	-Ø.Ø1
65	2	Ø.83	Ø.11	Ø.27	Ø.4Ø	Ø.Ø4
65	3	1.16	Ø.22	Ø.34	Ø.Ø5	Ø.55
65	4	2.55	Ø.21	1.11	-Ø.28	1.51
66	1	2.97	-Ø.Ø9	Ø.85	-Ø.17	2.38
66	2	2.Ø6	-Ø.14	Ø.34	-Ø.16	2.Ø2
66	3	2.43	Ø.61	Ø.71	-Ø.Ø8	1.19
66	4	2.33	1.Ø4	Ø.92	-Ø.71	1.Ø8
67	1	2.22	1.44	1.28	-1.36	Ø.85
67	2	1.79	1.72	1.21	-1.88	Ø.74
67	3	1.32	1.21	1.Ø9	-2.22	1.24
67	4	1.Ø7	1.31	Ø.42	-1.77	1.1Ø
68	1	1.43	1.47	Ø.15	-1.Ø9	Ø.9Ø
68	2	2.75	1.6Ø	Ø.67	-Ø.5Ø	Ø.98
68	3	3.ØØ	1.48	Ø.6Ø	Ø.5Ø	Ø.42
68	4	2.57	1.13	Ø.2Ø	Ø.97	Ø.27
69	1	2.22	Ø.66	-Ø.1Ø	1.51	Ø.14
69	2	1.39	Ø.36	-Ø.35	1.98	-Ø.6Ø
69	3	Ø.44	-Ø.19	-Ø.44	1.82	-Ø.76
69	4	-Ø.9Ø	-Ø.79	-Ø.17	1.42	-1.35
7Ø	1	-1.76	-1.28	Ø.Ø6	Ø.99	-1.52
7Ø	2	-2.69	-1.83	-Ø.Ø5	Ø.63	-1.44
7Ø	3	-1.89	-1.Ø9	Ø.19	Ø.28	-1.26
7Ø	4	-3.37	-1.32	Ø.14	-Ø.39	-1.79
71	1	-1.Ø4	-Ø.55	-Ø.Ø1	Ø.Ø4	-Ø.52
71	2	-1.16	-Ø.22	-Ø.24	Ø.26	-Ø.95
71	3	-Ø.94	-Ø.24	-Ø.15	1.38	-1.93
71	4	-Ø.84	Ø.Ø3	-Ø.Ø2	2.Ø7	-2.92
72	1	Ø.Ø8	-Ø.14	Ø.29	1.91	-1.98
72	2	Ø.28	-Ø.65	Ø.86	1.84	-1.78
72	3	Ø.57	-Ø.26	Ø.74	1.5Ø	-1.4Ø
72	4	1.45	-Ø.3Ø	1.53	1.Ø5	-Ø.83
73	1	3.28	-Ø.47	1.71	1.57	Ø.48
73	2	1.98	-1.ØØ	1.75	1.Ø9	Ø.14
73	3	2.ØØ	-Ø.66	1.55	1.11	Ø.ØØ
73	4	2.19	-Ø.38	1.35	1.Ø8	Ø.14
74	1	Ø.96	Ø.ØØ	1.Ø3	Ø.16	-Ø.23
74	2	-Ø.46	-Ø.41	-Ø.18	Ø.44	-Ø.31
74	3	-1.53	Ø.41	-1.Ø5	-Ø.Ø9	-Ø.81
74	4	-4.78	-Ø.63	-2.35	-Ø.51	-1.3Ø
75	1	-6.75	Ø.13	-3.65	-Ø.3Ø	-2.93
75	2	-5.9Ø	Ø.84	-2.88	Ø.ØØ	-3.87
75	3	-3.68	1.52	-2.63	Ø.6Ø	-3.17
75	4	-3.41	Ø.84	-2.71	Ø.88	-2.43
76	1	-1.96	1.49	-2.14	-Ø.28	-1.Ø2
76	2	-1.68	Ø.8Ø	-1.14	-Ø.78	-Ø.56
76	3	-1.23	Ø.91	-Ø.51	-1.19	-Ø.44
76	4	-Ø.92	Ø.65	Ø.33	-1.87	-Ø.Ø4
77	1	Ø.1Ø	Ø.14	1.61	-2.Ø1	Ø.36
77	2	-2.Ø3	-1.64	Ø.9Ø	-1.75	Ø.46
77	3	1.31	Ø.66	1.12	-1.21	Ø.74
77	4	1.2Ø	Ø.68	1.Ø7	-Ø.81	Ø.27

Table A2
Continued

Date		GNP	Eg	Es	Em	Ed
78	1	1.72	1.16	0.81	-0.49	0.23
78	2	3.65	1.77	0.20	-0.23	1.90
78	3	3.54	1.66	0.16	-0.11	1.83
78	4	3.68	1.19	0.25	-0.29	2.53
79	1	3.65	1.53	-0.01	-0.41	2.54
79	2	2.47	0.73	0.00	-1.02	2.75
79	3	2.55	0.17	0.04	-0.61	2.95
79	4	2.10	0.26	0.52	-0.28	1.60
80	1	1.83	0.29	0.10	-0.19	1.62
80	2	-0.42	0.05	-0.45	0.42	-0.44
80	3	-0.53	0.04	-0.53	-1.30	1.26
80	4	0.25	-0.09	-0.66	-0.77	1.78
81	1	2.05	0.27	-0.88	0.08	2.59
81	2	1.00	0.36	-0.64	-1.05	2.32
81	3	0.47	-0.21	-1.10	0.07	1.71
81	4	-1.68	-0.03	-1.51	-0.76	0.61
82	1	-3.30	-0.37	-1.04	-1.29	-0.58
82	2	-2.69	-1.11	0.27	0.46	-2.30
82	3	-4.26	-1.50	0.61	-0.69	-2.68
82	4	-4.47	-1.41	1.14	-1.40	-2.80

Appendix B. Construction of the fiscal index G.

The index is derived and discussed in Blanchard [1984]. Its empirical counterpart is derived and discussed in Blanchard [1983]. This is a short summary.

1. The theoretical index

The index measures the effect of fiscal policy on aggregate demand at given interest rates. It is given by:

$$\tilde{G}_t \equiv \lambda(B_t - \int_t^{\infty} T_{t,s}\, e^{-(r+p)(s-t)} ds) + Z_t$$

where

Z_t, B_t, T_t are government spending, debt and taxes. $x_{t,s}$ denotes the anticipation, as of t, of a variable x at time s.

The first term measures the effect of fiscal policy on consumption. λ is the propensity to consume out of wealth. B_t is part of wealth and increases consumption. The present value of taxes, however, decreases human wealth and consumption; taxes are discounted at a rate $(r + p)$, higher than the interest rate r. The second term captures the direct effect of government spending.

The index can be rewritten as:

$$\tilde{G}_t = (Z_t - \lambda \int_t^{\infty} Z_{t,s} e^{-(r+p)(t-s)} ds)$$
$$+ \lambda(B_t - \int_t^{\infty} (T_{t,s} - Z_{t,s}) e^{-(r+p)(t-s)} ds)$$

Table B1

Fiscal Index and its Components

Date		G	$(Z-Z^*)/\overline{Z}$	$B/\overline{Z}$	$D/\overline{Z}$	$D^*/\overline{Z}$
47	1	0.238	-0.003	7.788	-0.560	-0.533
47	2	0.225	-0.003	7.521	-0.515	-0.527
47	3	0.280	-0.003	7.216	-0.396	-0.450
47	4	0.141	-0.003	6.877	-0.523	-0.550
48	1	0.165	-0.003	6.654	-0.466	-0.506
48	2	0.253	-0.003	6.472	-0.373	-0.397
48	3	0.354	-0.003	6.257	-0.248	-0.275
48	4	0.408	-0.002	6.219	-0.186	-0.219
49	1	0.447	0.002	6.212	-0.119	-0.191
49	2	0.501	0.012	6.201	-0.030	-0.153
49	3	0.513	0.020	6.144	-0.005	-0.145
49	4	0.486	0.024	6.099	-0.007	-0.177
50	1	0.582	0.017	6.071	0.007	-0.050
50	2	0.347	0.009	5.976	-0.285	-0.252
50	3	0.218	0.002	5.762	-0.474	-0.332
50	4	0.171	0.000	5.596	-0.477	-0.367
51	1	0.156	-0.002	5.353	-0.478	-0.352
51	2	0.318	-0.006	5.258	-0.265	-0.187
51	3	0.459	-0.006	5.187	-0.111	-0.041
51	4	0.466	-0.004	5.095	-0.056	-0.036
52	1	0.424	-0.006	5.057	-0.093	-0.073
52	2	0.490	-0.006	5.020	-0.014	-0.006
52	3	0.551	-0.006	4.951	0.058	0.062
52	4	0.505	-0.008	4.872	-0.015	0.034
53	1	0.535	-0.009	4.834	0.000	0.074
53	2	0.555	-0.009	4.808	0.033	0.094
53	3	0.513	-0.009	4.768	0.022	0.049
53	4	0.539	-0.002	4.757	0.129	0.048
54	1	0.504	0.009	4.674	0.105	0.011
54	2	0.431	0.012	4.626	0.035	-0.060
54	3	0.409	0.014	4.605	0.009	-0.080
54	4	0.361	0.010	4.539	-0.045	-0.114
55	1	0.325	0.008	4.462	-0.104	-0.134
55	2	0.276	0.003	4.394	-0.151	-0.170
55	3	0.285	0.002	4.328	-0.148	-0.150
55	4	0.250	0.002	4.246	-0.177	-0.175
56	1	0.225	0.000	4.156	-0.175	-0.195
56	2	0.225	0.002	4.067	-0.162	-0.188
56	3	0.216	0.001	3.969	-0.151	-0.190
56	4	0.194	0.001	3.884	-0.170	-0.202
57	1	0.215	0.000	3.793	-0.139	-0.170
57	2	0.224	0.000	3.730	-0.114	-0.158
57	3	0.214	0.001	3.647	-0.114	-0.162
57	4	0.236	0.008	3.621	-0.059	-0.152
58	1	0.288	0.022	3.586	0.030	-0.119
58	2	0.298	0.035	3.556	0.090	-0.130
58	3	0.361	0.032	3.515	0.088	-0.042
58	4	0.349	0.023	3.481	0.058	-0.037
59	1	0.258	0.016	3.434	-0.033	-0.115
59	2	0.208	0.010	3.391	-0.092	-0.150
59	3	0.220	0.011	3.360	-0.056	-0.142
59	4	0.211	0.013	3.317	-0.061	-0.148

$$\theta_2 = \sum_{i=1}^{4} \frac{T_i}{T} \eta_{T_i Y_i} \eta_{Y_i P}$$

$\frac{T_i}{T}$ is available in dL80, Table 6.

$\eta_{T_i Y_i}$ are given in Table 8 in dL82. (They are lower than the $\eta_{T_i Y_i}$ reported above for the computations of θ_1.)

$\eta_{Y_i P}$ are given in Table 7 in dL82.

We calculated θ_2 using elasticities and tax proportions for 1959, 1969, 1979. The results were very close. A plausible range for θ_2 (depending on which $\eta_{T_i Y_i}$ are used) is .1 to .3. We choose .2 for computations in the text.

Our fiscal policy rule is therefore:

$$g = -.34y - 1.1p + \varepsilon^g$$

Table B1
Continued

Date		G	$(Z-Z^*)/\overline{Z}$	$B/\overline{Z}$	$D/\overline{Z}$	$D^*/\overline{Z}$
73	1	0.180	0.005	1.886	-0.032	-0.008
73	2	0.159	0.004	1.871	-0.042	-0.028
73	3	0.127	0.002	1.817	-0.065	-0.054
73	4	0.128	0.001	1.772	-0.060	-0.048
74	1	0.109	0.000	1.751	-0.056	-0.070
74	2	0.118	0.001	1.707	-0.034	-0.059
74	3	0.086	0.002	1.647	-0.044	-0.089
74	4	0.106	0.006	1.605	0.003	-0.075
75	1	0.146	0.019	1.584	0.076	-0.054
75	2	0.327	0.037	1.599	0.242	0.112
75	3	0.226	0.038	1.625	0.132	0.007
75	4	0.218	0.037	1.638	0.122	0.000
76	1	0.200	0.036	1.673	0.088	-0.017
76	2	0.176	0.033	1.706	0.062	-0.042
76	3	0.182	0.030	1.722	0.068	-0.035
76	4	0.191	0.027	1.714	0.077	-0.022
77	1	0.153	0.026	1.722	0.026	-0.056
77	2	0.170	0.022	1.716	0.034	-0.032
77	3	0.200	0.019	1.685	0.058	0.005
77	4	0.188	0.018	1.699	0.051	-0.008
78	1	0.175	0.014	1.699	0.037	-0.016
78	2	0.139	0.010	1.687	-0.016	-0.043
78	3	0.124	0.010	1.658	-0.028	-0.055
78	4	0.118	0.008	1.644	-0.039	-0.057
79	1	0.089	0.007	1.624	-0.062	-0.084
79	2	0.068	0.005	1.593	-0.070	-0.101
79	3	0.091	0.005	1.559	-0.048	-0.074
79	4	0.103	0.006	1.550	-0.030	-0.063
80	1	0.106	0.006	1.540	-0.022	-0.060
80	2	0.117	0.013	1.518	0.019	-0.062
80	3	0.125	0.019	1.491	0.035	-0.058
80	4	0.110	0.018	1.487	0.020	-0.071
81	1	0.062	0.021	1.468	-0.039	-0.117
81	2	0.063	0.027	1.480	-0.035	-0.124
81	3	0.078	0.025	1.442	-0.019	-0.102
81	4	0.099	0.020	1.434	0.024	-0.081
82	1	0.099	0.028	1.446	0.041	-0.094
82	2	0.099	0.035	1.458	0.043	-0.104
82	3	0.146	0.046	1.449	0.094	-0.068
82	4	0.204	0.051	1.502	0.157	-0.022

Table B1
Continued

Date		G	$(Z-Z^*)/\overline{Z}$	$B/\overline{Z}$	$D/\overline{Z}$	$D^*/\overline{Z}$
60	1	0.106	0.009	3.261	-0.171	-0.241
60	2	0.132	0.010	3.222	-0.126	-0.216
60	3	0.150	0.012	3.176	-0.091	-0.198
60	4	0.160	0.019	3.142	-0.059	-0.197
61	1	0.195	0.023	3.116	-0.021	-0.163
61	2	0.212	0.025	3.072	-0.012	-0.141
61	3	0.201	0.021	3.029	-0.025	-0.142
61	4	0.204	0.016	3.013	-0.042	-0.127
62	1	0.241	0.012	2.976	-0.007	-0.081
62	2	0.224	0.011	2.954	-0.025	-0.094
62	3	0.210	0.011	2.936	-0.037	-0.107
62	4	0.205	0.011	2.902	-0.030	-0.110
63	1	0.181	0.012	2.874	-0.050	-0.132
63	2	0.150	0.011	2.857	-0.087	-0.159
63	3	0.162	0.009	2.834	-0.081	-0.141
63	4	0.172	0.009	2.794	-0.068	-0.126
64	1	0.206	0.008	2.767	-0.045	-0.085
64	2	0.240	0.007	2.740	-0.011	-0.047
64	3	0.196	0.005	2.705	-0.049	-0.086
64	4	0.175	0.004	2.680	-0.063	-0.104
65	1	0.142	0.003	2.639	-0.107	-0.128
65	2	0.149	0.002	2.608	-0.103	-0.115
65	3	0.212	0.000	2.575	-0.044	-0.046
65	4	0.227	-0.001	2.537	-0.044	-0.022
66	1	0.202	-0.002	2.488	-0.074	-0.037
66	2	0.184	-0.002	2.436	-0.080	-0.052
66	3	0.213	-0.003	2.399	-0.046	-0.019
66	4	0.227	-0.004	2.361	-0.028	-0.001
67	1	0.263	-0.003	2.332	0.022	0.035
67	2	0.263	-0.004	2.310	0.027	0.037
67	3	0.264	-0.004	2.274	0.028	0.042
67	4	0.259	-0.003	2.279	0.019	0.037
68	1	0.235	-0.003	2.278	-0.005	0.013
68	2	0.257	-0.005	2.277	0.005	0.040
68	3	0.195	-0.005	2.220	-0.057	-0.015
68	4	0.166	-0.006	2.210	-0.077	-0.044
69	1	0.100	-0.006	2.181	-0.144	-0.106
69	2	0.091	-0.005	2.143	-0.143	-0.113
69	3	0.104	-0.005	2.050	-0.112	-0.093
69	4	0.095	-0.005	2.041	-0.101	-0.106
70	1	0.110	-0.005	2.031	-0.070	-0.094
70	2	0.164	-0.003	2.002	-0.004	-0.041
70	3	0.169	0.002	1.958	0.003	-0.036
70	4	0.179	0.006	1.950	0.032	-0.035
71	1	0.188	0.011	1.953	0.021	-0.025
71	2	0.210	0.013	1.917	0.050	-0.003
71	3	0.206	0.013	1.910	0.048	-0.007
71	4	0.201	0.014	1.938	0.040	-0.015
72	1	0.166	0.013	1.944	-0.006	-0.047
72	2	0.207	0.012	1.923	0.025	0.000
72	3	0.164	0.009	1.885	-0.017	-0.035
72	4	0.230	0.007	1.869	0.040	0.038

This shows that fiscal policy affects aggregate demand through the deviation of spending from "normal" spending (first line), through the level of debt and the sequence of anticipated deficits, net of interest payments, $D_{t,s} \equiv (Z_{t,s} - T_{t,s})$.

2. The empirical counterpart

We assume that at any time t , D and Z are anticipated to return at rate ξ to their full employment values D^*, Z^* respectively. More precisely:

$$dZ_{t,s}/ds = \xi(Z_t^* - Z_{t,s})$$
$$dD_{t,s}/ds = \xi(D_t^* - D_{t,s})$$

the index becomes:

$$\tilde{G}_t = Z_t - \lambda\left(\frac{1}{r+p} Z_t^* + \frac{1}{r+p+\xi}(Z_t - Z_t^*)\right)$$
$$+ \lambda\left(B_t + \frac{1}{r+p} D_t^* + \frac{1}{r+p+\xi}(D_t - D_t^*)\right).$$

From the study of aggregate consumption by Hayashi [1982], we choose λ = .08, p = .05, r = .03. We choose ξ = .30 (all at annual rates). This gives:

$$\tilde{G}_t = .79(Z_t - Z_t^*) + .08B_t + .21D_t + .79D_t^*$$

Let $\bar{Z}_t$ be the exponentially fitted trend for government spending. The index used in the paper is $G_t = \tilde{G}_t / \bar{Z}_t$. Time series for G_t and its components $(Z_t-Z_t^*)/\overline{Z}_t, B_t/\overline{Z}_t, D_t/\overline{Z}_t, D_t^*/\overline{Z}_t$ are given in Table B1.

3. <u>Construction of the fiscal feedback rule</u>

Let g, z, z*, d, d*, t, t* be the unexpected components of G, $(Z/\overline{Z})$, $(Z^*/\overline{Z})$, $(D/\overline{Z})$, $(D^*/\overline{Z})$, $(T/\overline{Z})$ and $(T^*/\overline{Z})$. They satisfy therefore:

$$g = .79(z-z^*) + .08b + .21d + .79d^*.$$

Using $d = z - t$, $d^* = z^* - t^*$ gives:

$$g=z-(.21t+.79t^*)+.08b$$

Let y and p be, as in the text, the unexpected components of the logarithms of GNP and of the price level. Then

$$\frac{dg}{dy} = \frac{dz}{dy} - .21\frac{dt}{dy},$$

as by definition $\frac{dt^*}{dy} = 0$ and by construction, B being beginning of quarter debt, $\frac{db}{dy} = 0$.

$$\frac{dg}{dp} = \frac{dz}{dp} - .21\frac{dt}{dp} - .79\frac{dt^*}{dp} \simeq \frac{dz}{dp} - \frac{dt}{dp}$$

as the effect of unexpected price movements on actual and full employment taxes is approximately the same.

Let σ_1, σ_2 be the elasticities of movements in government spending with respect to unexpected movements in the level of output and in the price level respectively. Let θ_1, θ_2 be similar elasticities for taxes. Then:

$$dg = (\sigma_1 - .21\theta_1)dy$$

$$dg = (\sigma_2 - \theta_2)dp$$

We assume that, within a quarter, there is no discretionary response of g to either y or p. The response depends only on institutional arrangements. We therefore use the results of deLeeuw et al. [1980] and deLeeuw and Holloway [1982] (hereafter dL80 and dL82) to construct σ_1, σ_2, θ_1, and θ_2.

σ_1 :

From Table 19 of dL80 a one percentage point increase in the unemployment rate increases spending in the first quarter by .6% at an annual rate. From Okun's Law it is reasonable to assume that a 1% innovation in output reduces unemployment by roughly .1 percentage point in the first quarter. Putting these together we have $\sigma_1 = -.06$.

σ_2 :

G is composed of (1) purchases of goods and services, (2) wage payments to government employees, and (3) transfer payments. There is little or no effect of unexpected inflation on nominal purchases within a quarter. Although parts of (2) and (3) are indexed, indexation is not contemporaneous. Nominal payments for some transfer programs (Medicare, Medicaid) increase with inflation. A plausible range for σ_2 is -.8 to -1.0. We choose -.9 for the computations in the text.

θ_1 :

We considered four categories of taxes and income tax bases:

(1) Personal Income Tax

(2) Corporate Income Tax

(3) Indirect Business Taxes

(4) Social Security and Other Taxes

we have

$$\theta_1 = \sum_{i=1}^{4} \frac{T_i}{T} \eta_{T_i Y_i} \eta_{Y_i Y}$$

$\frac{T_i}{T}$ is available in dL80, Table 6, for selected years.

$\eta_{Y_i Y}$ is available in dL80, Table 8.

$\eta_{T_1 Y_1}$ is available in dL80, Table 10.

$\eta_{T_2 Y_2}$ is available in dL80, p. 38, column 1.

$\eta_{T_3 Y_3}$ is available in dL80, Table 15, and

$\eta_{T_4 Y_4}$ is available in dL80, Table 18.

We calculated θ_1 using elasticities and tax proportions for 1959 and 1979. The results were very close and yielded $\theta_1 = 1.4$.

θ_2 :

We considered the same four categories of taxes. In the same way as before, we have