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EVIDENCE FROM SEVEN COUNTRIES ON WHETHER INVENTORIES SMOOTH AGGREGATE OUTPUT

Kenneth D. West

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ABSTRACT

Casual examination of annual postwar data on inventories and aggregate output for seven developed countries--Canada, France, West Germany, Italy, Japan, United Kingdom, United States--suggests that in these countries the primary function of aggregate inventories is not to smooth aggregate output in the face of aggregate demand shocks. Japan is a possible exception to this generalization.

Kenneth D. West
Woodrow Wilson School
Princeton University
Princeton, NJ 08544

I. Introduction

A number of recent papers have considered whether inventories smooth output fluctuations in the United States (e.g., Blinder (1981)). There does not, however, seem to have been much research on this question, for other countries.[1] This paper is a preliminary attempt to help fill this gap.

It uses annual postwar data from the seven "G7" countries--Canada, France, West Germany, Italy, Japan, the United Kingdom and the United States--to see whether aggregate inventories serve mainly to buffer aggregate output from demand shocks. For all these countries, except possibly Japan, the answer seems to be no, in two senses. First, aggregate output (measured by either GDP or GNP) is more variable than aggregate final sales. Second, positive sales shocks tend to make inventories increase, with output rising more than one to one with such shocks. As is well known for the U.S., then, aggregate inventory behavior does not seem to be consistent with the production smoothing model of Holt et al. (1960).

It should be emphasized that this is a first, preliminary effort in what is likely to be a somewhat larger research project. Since I have yet to obtain quarterly data, I have yet to be able, for example, to replicate for other countries Blinder's (1981) calculations of the contribution of U.S. inventory fluctuations to peak to trough falls in U.S. GNP. I also have yet to obtain a figure for the level (as opposed to change) in inventories; this precludes computation of such elementary statistics as a mean inventory-sales ratio. In addition, my approach is casual, and no standard errors have been calculated.

II. Model and Tests

Let Q_t be real aggregate output, S_t real aggregate final sales, H_t real aggregate inventories. The variables are linked by the identity $Q_t=S_t+\Delta H_t$.

Much recent U.S. research on inventories has assumed a variant of the Holt et al. (1961) production smoothing model. The representative firm minimizes the expected present discounted value of costs over an infinite horizon, with a constant discount rate. In a general version of this model, per period costs are

$$(1)\qquad a_0(\Delta Q_t+u_{1t})^2 + a_1(Q_t+u_{2t})^2 + a_2(H_t-a_3E_tS_{t+1}+u_{3t})^2,$$

where: the a_i are positive parameters; the u_{it} are zero mean iid cost shocks; E_t denotes mathematical expectations conditional on period t information. The three terms in (1) capture costs of changing production, costs of production and costs of having inventories deviate from a target level. See West (1986) for further discussion. Constant and linear terms are allowed in the empirical work but are omitted from (1) for simplicity.

I will consider two implications that follow when the model is specialized, as in Blinder (1982) or Belsley (1969), so that inventories serve mainly to buffer output from demand fluctuations. This requires that a_2a_3 be small relative to a_0 and a_1, and that the costs shocks u_{it} have minor effects (e.g., because the standard deviation of cost shocks is small relative to that of demand shocks). The first of my two tests looks at some sample moments. The specialized model suggests that production Q_t should be smoother than demand S_t: inventories will be adjusted to avoid the costs that result when the level or change of production is varied. Let "var" denote variance, "corr" correlation. The model then suggests

(2a) $\mathrm{var}(Q_t) / \mathrm{var}(S_t) < 1$

(2b) $\mathrm{var}(\Delta Q_t) / \mathrm{var}(\Delta S_t) < 1$

(2c) $\mathrm{corr}(S_t, \Delta H_t) < 0$.

See West (1986) for a formal argument for the first two inequalities. The last inequality follows from the first, since $\mathrm{var}(Q_t) = \mathrm{var}(S_t) + \mathrm{var}(\Delta H_t) + 2\mathrm{cov}(S_t, \Delta H_t)$. I look at (2c) separately because it focuses on the elementary production smoothing notion that inventory investment ΔH_t should be countercylical.

The first inequality does not make sense if variables have unit roots. One can, however, calculate an analogue to $\mathrm{var}(Q_t)-\mathrm{var}(S_t)$ that has a meaningful population counterpart, even in the presence of unit roots. See below.

A second test of the model looks at how inventories respond to sales shocks. If the cost of having inventories deviate from a target level is small ($a_2 a_3$ is small relative to a_0 and a_1), inventories should be drawn down when there is a positive sales shock. (This does not hold under all circumstances. See Blinder (1986).) One admittedly crude way to check this is to suppose that only lagged sales are used to forecast future sales. Suppose that the sales process follows an autoregression,

(3) $$S_t = f_1 S_{t-1} + f_2 S_{t-2} + \ldots + f_q S_{t-q} + v_t.$$

The f_i are parameters, v_t is the zero mean iid sales shock. Constant and trend terms, included in the empirical work, are omitted for simplicity. The lag polynomial $(1-f_1L-\dots-f_qL^q)$ has roots on or outside the unit circle, with a root on the unit circle implying that differencing is required to induce stationarity.

By algebra such as in Blanchard (1983), the decision rule for inventories is

$$(4) \qquad H_t = r_1H_{t-1} + r_2H_{t-2} + d_1S_t + \dots + d_qS_{t-q+1} + u_t,$$

where constant and trend terms have again been suppressed. The r_i and d_i are functions of the cost parameters a_i, the sales parameters f_i and the rate for discounting future costs. The disturbance u_t is a linear combination of the u_{it}.

Suppose, finally, that cost and demand shocks (u_t and v_t) are uncorrelated. If S_t and H_t are stationary (the lag polynomial in (3) does not have a root on the unit circle) one can estimate (3) and (4) by OLS. If S_t and H_t have unit roots, it is more efficient to impose the unit root in (3). In either case, one can then use the estimates to trace out the impact of a sales shock on inventories: $\partial H_t/\partial v_t = d_1$, etc.

III. Results

A. Data

Annual data on nominal and real GNP or GDP and on nominal change in inventories was taken from the International Financial Statistics tape of the International Monetary Fund. Annual rather than quarterly data were used in part because they seem likely to be more reliable: figures on inventory investment in Germany, for example, are benchmarked against data on inventory levels only annually, with preliminary quarterly figures simply computed as a residual (OECD, 1981, p13). The definition of inventory investment, incidentally, does not appear to be identical in all countries, since there seems to be some variation in the treatment of certain stocks held by the government (OECD (1967, 1972, 1981)).

Data were available 1957-1986 for six of the countries, 1961-1986 for Canada. Aggregate output Q was measured by GNP when this was available (Germany, Japan, United Kingdom, United States), GDP otherwise (Canada, France, Italy). For all countries, the base year for the real data is 1980 and all data are expressed in billions of units of home currency.

A deflator was calculated by dividing nominal by real output. Real inventory investment ΔH_t was calculated by dividing the nominal IFS figure by the deflator. Real final sales S_t was then computed as $S_t = Q_t - \Delta H_t$. A real inventory series H_t was created by accumulating the changes in real inventories: $H_1 = \Delta H_1$, $H_2 = H_1 + \Delta H_2$, etc. (The IFS tape does not seem to supply a figure for the level of inventories.) All such manufactured values of H_t are of course too low by a constant value of H_0, the presample value of the inventory stock. Note that the series being off by a constant will affect only the constant term in regressions, and will leave estimates of, for example, variances and correlations unchanged.

My procedure for computing a real series for H_t and ΔH_t is nonetheless unsatisfactory in that it uses the output deflator to convert the inventory data. In the U.S., at least, a more subtle and complicated procedure is employed by the Department of Commerce in constructing constant dollar inventory series (Hinrichs and Eckman (1983)). To get an idea of how substantial are the biases induced by my deflation procedure, I compared the deflated IFS data for the United States to the constant dollar Department of Commerce data, with the latter obtained from Citibase. The results are in Table I, with notes at the foot of the table describing the procedure used. Since the Department of Commerce is the source for the IFS data, the correlation between the two real GNP series is virtually perfect (Table I, panel A). (See below for the qualifier "virtually.") The differing deflation procedures led to only slight discrepancies between the two sets of inventory and sales figures, with correlations of about .99, in levels or differences (panel A). In addition, the correlation of moments within each data set are very close. Compare panels B and C. (Note that the figures for Q and ΔQ are not identical, for the two data sets. I believe that the minor discrepancies resulted because of errors introduced when I converted the Department of Commerce data from its 1982 base year to the 1980 base year that IFS uses.)

It seems from Table I, then, that the use of an output deflator to deflate nominal data on inventory investment introduces only very slight errors. I will therefore proceed on the tentative assumption that the use of data deflated in this way is unlikely to introduce serious biases.

B. Empirical Results

Columns (2) to (4) of Table II report inequalities (2a) to (2c). Column (5) reports essentially a measure of var(Q)-var(S) that is legitimate in the presence of unit roots; inequality (2a) indicates that this difference should be positive. Column (5) was calculated as described in West (1987), using five lags of ΔS_t. Column (6) is presented to scale the column (5) figure. With the possible exception of Japan, the well known U.S. experience is typical--aggregate output is about 15 to 100 per cent more variable than final sales (columns (1) and (2)). In Japan, however, output is not even 10 percent more variable. Column (5) indicates that the column (2) result is not a spurious result of inappropriate treatment of unit roots--output is more variable than sales even when unit roots are explicitly allowed. In all countries but Japan, inventory investment is procyclical (column (3)).

Table III contains the impulse response functions of inventories to a positive sales shock, of magnitude one 1980 unit of home currency (e.g., one 1980 French franc, for France). Panel A presents the results when (3) and (4) were estimated in levels, panel B when a unit root was imposed in (3). The lag length q was set to 2; the Q statistic in all of the regrssions suggested that this sufficed to whiten the residuals. Deterministic terms were included as described in note 2 to Table I. Detailed regression results are in an appendix available from the author on request.

To read the table, consider the entry for Canada in panel A. If sales unexpectedly rise by one Canadian dollar, inventories initially rise by 42 Canadian cents. The next year they rise by an additional 9 cents (9=52-41), before beginning to fall back toward their trend line. Although for panel B equation (3) was estimated in differences, the figures in panel B apply to the level and not the difference of inventories.

A positive sales shock initially causes inventories to rise: with the exception of Japan, in differences, all entries in year 0 are positive. In differenced specifications, the year 5 figure suggests that a positive sales shock also causes a rise in the steady state level of inventories, again with the exception of Japan.

III. Conclusion

Casual examination of annual postwar data suggests that in the "G7" group of countries aggregate inventories do not serve mainly to smooth output fluctuations in the face of aggregate demand shocks. Japan provides a possible exception, although even in Japan production smoothing behavior, if present, is not particularly marked. That inventory behavior is qualitatively similar in these countries is consistent with Moore (1978), which gives the level and change in inventories the same position in the NBER reference cycle in each of the seven countries.

A simple extension of this work is to consider quarterly data as well, at least in those countries where the quarterly data are reasonably reliable. The work of Wilkinson (1986) suggests that quarterly results are likely to be broadly similar, although it also suggests that at quarterly frequencies Japanese inventory behavior is not qualitatively different from that of the other countries. More generally, desireable areas for future research include considering the role of inventories in business cycles in light of international differences in tax systems, in the degree to which various economies are open, and in the sources of business cycle shocks.

Footnotes

1. In a paper that I became aware of only after drafting the present paper, Wilkinson (1986) touches on whether inventories smooth production, for exactly the countries considered in this paper. Wilkinson's main focus, however, is estimation of a general model of inventory demand for a subset of these countries.

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Appendix

This appendix presents the regressions that underlie the impulse responses in Table III. The variable "CONA" is a dummy that is one before 1973, zero afterwards; "TREND" is a trend term, set to one in 1957, two in 1958, etc. (except for Canada, where TREND was set to one in 1961, etc.); TRENDA is defined as CONA*TREND; "DS" is the first difference of S_t.

CANADA

EQUATION 1
DEPENDENT VARIABLE 58 H
FROM 1963: 1 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 16
R**2 .98903902 RBAR**2 .98424359
SSR 47.764767 SEE 1.7278015
DURBIN-WATSON 2.00779076
Q(12)= 11.0438 SIGNIFICANCE LEVEL .525170

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	-16.73981	10.96055	-1.527279	.1462173
2	CONA	60	0	-16.02322	5.476943	-2.925577	.9900848E-02
3	TREND	59	0	-3.287598	1.368445	-2.402434	.2877952E-01
4	TRENDA	61	0	.7901299	.3162813	2.498188	.2376070E-01
5	H	58	1	.3737908	.2368947	1.577877	.1341580
6	H	58	2	-.7226021E-02	.1736176	-.4162033E-01	.9673163
7	S	55	0	.4241014	.1212540	3.497630	.2978422E-02
8	S	55	1	-.2531486E-01	.1794164	-.1410956	.8895556

DEPENDENT VARIABLE 55 S
FROM 1963: 1 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 18
R**2 .99806112 RBAR**2 .99752254
SSR 218.05390 SEE 3.4805323
DURBIN-WATSON 2.11355449
Q(12)= 9.30378 SIGNIFICANCE LEVEL .676788

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	38.23217	14.51185	2.634549	.1682913E-01
2	CONA	60	0	-7.454069	7.945065	-.9382011	.3605605
3	TREND	59	0	3.912491	1.764215	2.217695	.3968226E-01
4	TRENDA	61	0	.2472674	.4522575	.5467403	.5912712
5	S	55	1	.8902210	.2374818	3.748587	.1470567E-02
6	S	55	2	-.3172498	.2188498	-1.449624	.1643638

DEPENDENT VARIABLE 58 H
FROM 1964: 1 UNTIL 1986: 1
OBSERVATIONS 23 DEGREES OF FREEDOM 17
R**2 .98154034 RBAR**2 .97611102
SSR 69.200104 SEE 2.0175714
DURBIN-WATSON 2.21693126
Q(11)= 5.80212 SIGNIFICANCE LEVEL .886236

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	4.147434	4.800125	.8640263	.3996008
2	CONA	60	0	-4.177098	2.011217	-2.076901	.5328529E-01
3	H	58	1	.8168205	.1939805	4.210839	.5877191E-03

4	H	58	2	-.5047350E-01	.1989408	-.2537111	.8027617
5	S	55	0	.3949734	.1256435	3.143603	.5923799E-02
6	S	55	1	-.3867587	.1369065	-2.824985	.1167454E-01

FROM 1964: 1 UNTIL 1986: 1
OBSERVATIONS 23 DEGREES OF FREEDOM 20
R**2 .03915775 RBAR**2 -.05692648
SSR 294.81107 SEE 3.8393428
DURBIN-WATSON 1.90959615
Q(11)= 5.72299 SIGNIFICANCE LEVEL .891193

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	7.656204	2.423738	3.158841	.4938464E-02
2	CONA	60	0	.3889986	1.629621	.2387049	.8137633
3	DS	62	1	.1956368	.2186314	.8948246	.3815239

FRANCE

DEPENDENT VARIABLE 58 H
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 20
R**2 .99872681 RBAR**2 .99828119
SSR 2008.6296 SEE 10.021551
DURBIN-WATSON 1.81707604
Q(14)= 14.3769 SIGNIFICANCE LEVEL .422025

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	-248.9981	95.11964	-2.617736	.1648167E-01
2	CONA	60	0	-181.9639	38.53727	-4.721765	.1306577E-03
3	TREND	59	0	-25.28214	5.578954	-4.531698	.2032021E-03
4	TRENDA	61	0	10.13997	1.854756	5.467011	.2372280E-04
5	H	58	1	.2539118	.1951642	1.301016	.2080432
6	H	58	2	-.1110112	.1734240	-.6401141	.5293641
7	S	55	0	.1594285	.1292163	1.233811	.2315764
8	S	55	1	.3751399	.1462067	2.565819	.1843826E-01

DEPENDENT VARIABLE 55 S
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 22
R**2 .99944846 RBAR**2 .99932311
SSR 6781.9751 SEE 17.557665
DURBIN-WATSON 1.65455314
Q(14)= 17.8585 SIGNIFICANCE LEVEL .213302

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	145.2466	105.5546	1.376034	.1826584
2	CONA	60	0	-107.9207	48.98106	-2.203315	.3834177E-01
3	TREND	59	0	-6.343469	8.145230	-.7787956	.4443968
4	TRENDA	61	0	7.624856	2.417916	3.153483	.4609784E-02
5	S	55	1	.8946098	.1957673	4.569762	.1500172E-03
6	S	55	2	.1362254	.2123302	.6415733	.5277788

DEPENDENT VARIABLE 58 H
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 21
R**2 .99590426 RBAR**2 .99492909
SSR 5760.0538 SEE 16.561651
DURBIN-WATSON 2.47858477
Q(13)= 14.5138 SIGNIFICANCE LEVEL .338679

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	1.689767	70.71018	.2389709E-01	.9811603
2	CONA	60	0	7.290768	18.51509	.3937744	.6977173
3	H	58	1	1.156837	.2133847	5.421368	.2232189E-04
4	H	58	2	-.1716669	.2795113	-.6141679	.5457012
5	S	55	0	.2565095	.2043924	1.254985	.2232713
6	S	55	1	-.2554063	.1809619	-1.411382	.1727770

DEPENDENT VARIABLE 62 DS
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 24
R**2 .35190867 RBAR**2 .29790106
SSR 9474.9874 SEE 19.869352
DURBIN-WATSON 2.04351877
Q(13)= 7.08740 SIGNIFICANCE LEVEL .897592

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	***********
1	CONSTANT	0	0	33.88328	13.50192	2.509516	.1924191E-01
2	CONA	60	0	12.76319	8.046953	1.586089	.1258083
3	DS	62	1	.4578821	.1765245	2.593873	.1592333E-01

GERMANY

DEPENDENT VARIABLE 58 H
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 20
R**2 .99509608 RBAR**2 .99337971
SSR 1078.6679 SEE 7.3439360
DURBIN-WATSON 1.81966902
Q(14)= 21.8082 SIGNIFICANCE LEVEL .826416E-01

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	20.79672	65.37711	.3181039	.7537038
2	CONA	60	0	-63.01075	27.50094	-2.291222	.3294090E-01
3	TREND	59	0	-1.276331	2.671419	-.4777728	.6379922
4	TRENDA	61	0	3.268744	1.451761	2.251572	.3574851E-01
5	H	58	1	.7799695	.2148897	3.629628	.1669361E-02
6	H	58	2	-.1000176	.1862073	-.5371303	.5971034
7	S	55	0	.3117748	.9417525E-01	3.310582	.3490552E-02
8	S	55	1	-.2454603	.9884446E-01	-2.483298	.2200355E-01

DEPENDENT VARIABLE 55 S
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 22
R**2 .99770075 RBAR**2 .99717820
SSR 5553.4449 SEE 15.888024
DURBIN-WATSON 2.24384840
Q(14)= 7.85937 SIGNIFICANCE LEVEL .896523

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	481.8509	122.2265	3.942278	.6942135E-03
2	CONA	60	0	-142.3405	54.28748	-2.621976	.1556777E-01
3	TREND	59	0	19.79654	4.821937	4.105517	.4662716E-03
4	TRENDA	61	0	8.289593	2.784646	2.976892	.6957002E-02
5	S	55	1	.8375364	.1732463	4.834368	.7874076E-04
6	S	55	2	-.5053499	.1753594	-2.881795	.8659444E-02

DEPENDENT VARIABLE 58 H
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 21
R**2 .99221373 RBAR**2 .99035986
SSR 1472.1456 SEE 8.3727039
DURBIN-WATSON 1.85910356
Q(13)= 17.0833 SIGNIFICANCE LEVEL .195524

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	22.00284	30.76446	.7152032	.4823600
2	CONA	60	0	-.6501302	6.576950	-.9884981E-01	.9221950
3	H	58	1	1.093086	.1769914	6.175925	.3979447E-05
4	H	58	2	-.3032321E-01	.1974664	-.1535613	.8794217
5	S	55	0	.2880999	.8569303E-01	3.361999	.2949553E-02
6	S	55	1	-.3188529	.1025602	-3.108935	.5312504E-02

DEPENDENT VARIABLE 62 DS

FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 24
R**2 .20122406 RBAR**2 .13465940
SSR 9842.9953 SEE 20.251538
DURBIN-WATSON 1.51407333
Q(13)= 9.48542 SIGNIFICANCE LEVEL .735374

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	23.54861	7.987181	2.948300	.7014495E-02
2	CONA	60	0	15.51615	8.529404	1.819137	.8139013E-01
3	DS	62	1	.1549073	.1993956	.7768841	.4448173

ITALY

DEPENDENT VARIABLE 58 H
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 20
R**2 .99672825 RBAR**2 .99558314
SSR .14896430E+09 SEE 2729.1418
DURBIN-WATSON 1.74121320
Q(14)= 16.4462 SIGNIFICANCE LEVEL .286892

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	-43431.51	29469.83	-1.473762	.1561120
2	CONA	60	0	21478.60	20469.36	1.049305	.3065530
3	TREND	59	0	1168.524	2011.704	.5808629	.5678214
4	TRENDA	61	0	-2060.729	1276.105	-1.614858	.1220080
5	H	58	1	.1221922	.2569715	.4755086	.6395768
6	H	58	2	.3410030	.2310486	1.475893	.1555440
7	S	55	0	.2800146	.1526802	1.833994	.8157898E-01
8	S	55	1	-.9030871E-01	.1522481	-.5931682	.5597173

DEPENDENT VARIABLE 55 S
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 22
R**2 .99898056 RBAR**2 .99874887
SSR .20158786E+09 SEE 3027.0587
DURBIN-WATSON 2.21366997
Q(14)= 13.4966 SIGNIFICANCE LEVEL .487849

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	98028.72	[illegible]734.73	4.727755	.1020588E-03
2	CONA	60	0	-24506.65	8661.579	-2.829352	.9761645E-02
3	TREND	59	0	6401.474	1301.752	4.917584	.6433328E-04
4	TRENDA	61	0	1572.760	470.4408	3.343161	.2944205E-02
5	S	55	1	.9737594	.1560850	6.238647	.2802800E-05
6	S	55	2	-.6566621	.1514223	-4.336626	.2651255E-03

DEPENDENT VARIABLE 58 H
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 21
R**2 .99603069 RBAR**2 .99508562
SSR .16964985E+09 SEE 2842.2815
DURBIN-WATSON 1.79019095
Q(13)= 15.6878 SIGNIFICANCE LEVEL .266399

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	3972.961	5754.478	.6904120	.4974956
2	CONA	60	0	-11019.97	2907.001	-3.790837	.1070081E-02
3	H	58	1	.3751585	.2158175	1.738313	.9679825E-01
4	H	58	2	.4526874	.1963401	2.305629	.3142943E-01
5	S	55	0	.2769286	.1333828	2.076195	.5034467E-01
6	S	55	1	-.2268460	.1324410	-1.712808	.1014754

DEPENDENT VARIABLE 62 DS
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 24
R**2 .18495619 RBAR**2 .11703587
SSR .42143739E+09 SEE 4190.4524
DURBIN-WATSON 1.61708644
Q(13)= 17.3557 SIGNIFICANCE LEVEL .183551

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	6260.603	2101.444	2.979190	.6519928E-02
2	CONA	60	0	1882.850	1683.614	1.118338	.2744921
3	DS	62	1	.3173094	.1928455	1.645408	.1129212

JAPAN

DEPENDENT VARIABLE 58 H
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 20
R**2 .99903395 RBAR**2 .99869584
SSR 10846406. SEE 736.42400
DURBIN-WATSON 1.88003932
Q(14)= 21.8643 SIGNIFICANCE LEVEL .814461E-01

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	17631.48	3271.678	5.389123	.2828695E-04
2	CONA	60	0	-22190.99	4387.806	-5.057422	.6024011E-04
3	TREND	59	0	-773.1774	376.9583	-2.051095	.5358863E-01
4	TRENDA	61	0	1130.617	196.2432	5.761305	.1227312E-04
5	H	58	1	.5390738	.1781743	3.025542	.6680168E-02
6	H	58	2	-.1987330	.1402048	-1.417448	.1717434
7	S	55	0	.8388975E-01	.7590362E-01	1.105214	.2821856
8	S	55	1	.8338998E-01	.5025344E-01	1.659389	.1126376

DEPENDENT VARIABLE 55 S
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 22
R**2 .99925724 RBAR**2 .99908844
SSR .12834935E+09 SEE 2415.3802
DURBIN-WATSON 1.50186423
Q(14)= 14.5678 SIGNIFICANCE LEVEL .408319

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	-3121.000	4352.632	-.7170376	.4808951
2	CONA	60	0	5413.821	4648.558	1.164624	.2566453
3	TREND	59	0	3480.368	795.6725	4.374121	.2419129E-03
4	TRENDA	61	0	280.3498	235.5809	1.190036	.2467163
5	S	55	1	.5069374	.1639136	3.092712	.5314874E-02
6	S	55	2	.1868985	.1520010	1.229587	.2318403

DEPENDENT VARIABLE 58 H
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 21
R**2 .99723433 RBAR**2 .99657584
SSR 27625522. SEE 1146.9529
DURBIN-WATSON 2.02684389
Q(13)= 5.35934 SIGNIFICANCE LEVEL .966408

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	102.6271	1391.445	.7375578E-01	.9419027
2	CONA	60	0	2198.793	1329.586	1.653743	.1130519
3	H	58	1	1.260734	.1902364	6.627198	.1466669E-05
4	H	58	2	-.2655727	.2183681	-1.216170	.2374144
5	S	55	0	-.8869468E-01	.7747954E-01	-1.144750	.2651929
6	S	55	1	.9763668E-01	.7706960E-01	1.266864	.2190749

```
DEPENDENT VARIABLE   62      DS
FROM  1960:  1  UNTIL  1986:  1
OBSERVATIONS              27      DEGREES OF FREEDOM     24
R**2             .06610051      RBAR**2          -.01172445
SSR          .34766718E+09      SEE          3806.0652
DURBIN-WATSON  1.98739839
Q(  13)=    7.76157         SIGNIFICANCE LEVEL  .858779
```

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	7029.356	2020.294	3.479374	.1938741E-02
2	CONA	60	0	1159.631	1466.154	.7909343	.4367292
3	DS	62	1	.1925365	.1882151	1.022960	.3165279

UNITED KINGDOM

DEPENDENT VARIABLE 58 H
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 20
R**2 .98389997 RBAR**2 .97826496
SSR 42.656206 SEE 1.4604144
DURBIN-WATSON 1.77050370
Q(14)= 19.8631 SIGNIFICANCE LEVEL .134518

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	-14.32222	20.09536	-.7127125	.4842567
2	CONA	60	0	-10.72116	6.147868	-1.743882	.9653160E-01
3	TREND	59	0	-.7147482	.4927134	-1.450637	.1623848
4	TRENDA	61	0	.5272937	.3105368	1.698007	.1050125
5	H	58	1	.6077541	.2238044	2.715559	.1331639E-01
6	H	58	2	-.1347649	.1988503	-.6777207	.5057142
7	S	55	0	.2013167	.1231522	1.634698	.1177550
8	S	55	1	.6202803E-02	.1457582	.4255542E-01	.9664779

DEPENDENT VARIABLE 55 S
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 22
R**2 .99547359 RBAR**2 .99444486
SSR 160.05730 SEE 2.6972823
DURBIN-WATSON 2.04128488
Q(14)= 15.4394 SIGNIFICANCE LEVEL .348792

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	90.35688	40.86804	2.210942	.3773871E-01
2	CONA	60	0	-13.66754	10.75335	-1.271002	.2170032
3	TREND	59	0	2.368763	.8867338	2.671335	.1394594E-01
4	TRENDA	61	0	.8685092	.5173458	1.678779	.1073445
5	S	55	1	.6383311	.2192640	2.911245	.8093660E-02
6	S	55	2	-.2733692	.2147138	-1.273179	.2162440

DEPENDENT VARIABLE 58 H
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 21
R**2 .97175023 RBAR**2 .96502410
SSR 63.778240 SEE 1.7427160
DURBIN-WATSON 1.95164622
Q(13)= 15.8782 SIGNIFICANCE LEVEL .255771

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	-2.516434	7.137546	-.3525629	.7279301
2	CONA	60	0	-.3360566E-01	1.503731	-.2234818E-01	.9823812
3	H	58	1	1.045694	.2053216	5.092955	.4814433E-04
4	H	58	2	-.2173789	.2110891	-1.029797	.3148210
5	S	55	0	.1676925	.1259543	1.331376	.1973385
6	S	55	1	-.1351587	.1521424	-.8883693	.3844049

```
DEPENDENT VARIABLE   62      DS
FROM  1960:  1  UNTIL  1986:  1
OBSERVATIONS           27      DEGREES OF FREEDOM     24
R**2              .08041199    RBAR**2           .00377966
SSR          229.31625         SEE           3.0910910
DURBIN-WATSON  1.91093884
Q(  13)=    14.8957        SIGNIFICANCE LEVEL  .313908
```

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	3.715077	1.175901	3.159345	.4237194E-02
2	CONA	60	0	1.737877	1.201643	1.446251	.1610411
3	DS	62	1	-.2235854E-01	.1980421	-.1128979	.9110505

UNITED STATES

DEPENDENT VARIABLE 58 H
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 20
R**2 .99707872 RBAR**2 .99605627
SSR 1572.4870 SEE 8.8670372
DURBIN-WATSON 2.22502963
Q(14)= 21.7682 SIGNIFICANCE LEVEL .835050E-01

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	-177.2676	65.13066	-2.721723	.1313761E-01
2	CONA	60	0	-125.2317	27.37688	-4.574361	.1839955E-03
3	TREND	59	0	-7.445814	3.306050	-2.252178	.3570400E-01
4	TRENDA	61	0	5.599822	1.242630	4.506427	.2155203E-03
5	H	58	1	.1535297	.2146041	.7154090	.4826255
6	H	58	2	.1466708	.1332512	1.100710	.2840950
7	S	55	0	.2475900	.5249414E-01	4.716527	.1322542E-03
8	S	55	1	-.1756203E-01	.7292529E-01	-.2408221	.8121445

DEPENDENT VARIABLE 55 S
FROM 1959: 1 UNTIL 1986: 1
OBSERVATIONS 28 DEGREES OF FREEDOM 22
R**2 .99780490 RBAR**2 .99730601
SSR 16515.570 SEE 27.399046
DURBIN-WATSON 1.93089223
Q(14)= 9.71518 SIGNIFICANCE LEVEL .782697

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	695.5421	162.3440	4.284371	.3012370E-03
2	CONA	60	0	49.13625	53.68118	.9153347	.3699404
3	TREND	59	0	44.02860	8.333793	5.283140	.2661438E-04
4	TRENDA	61	0	-.4478542	2.689492	-.1665200	.8692687
5	S	55	1	1.020495	.1454526	7.015999	.4852811E-06
6	S	55	2	-.6768683	.1420352	-4.765498	.9309898E-04

DEPENDENT VARIABLE 58 H
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 21
R**2 .99295245 RBAR**2 .99127447
SSR 3413.6324 SEE 12.749664
DURBIN-WATSON 2.19641360
Q(13)= 19.6268 SIGNIFICANCE LEVEL .104914

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	-30.11396	63.49155	-.4742987	.6401816
2	CONA	60	0	-2.910922	10.81572	-.2691381	.7904500
3	H	58	1	.8626624	.2272601	3.795926	.1057195E-02
4	H	58	2	-.4170011E-02	.1690812	-.2466277E-01	.9805568
5	S	55	0	.2147840	.6337914E-01	3.388876	.2769428E-02
6	S	55	1	-.1844669	.9241532E-01	-1.996064	.5905749E-01

DEPENDENT VARIABLE 62 DS
FROM 1960: 1 UNTIL 1986: 1
OBSERVATIONS 27 DEGREES OF FREEDOM 24
R**2 .18856556 RBAR**2 .12094602
SSR 37846.711 SEE 39.710783
DURBIN-WATSON 1.55255237
Q(13)= 17.6703 SIGNIFICANCE LEVEL .170444

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC	SIGNIF LEVEL
***	*******	***	***	************	************	************	************
1	CONSTANT	0	0	36.78968	16.44500	2.237135	.3482873E-01
2	CONA	60	0	2.062821	15.29792	.1348432	.8938603
3	DS	62	1	.4413385	.1870160	2.359897	.2675084E-01

Table I

A. Correlations Between Deflated IFS and Department of Commerce Data

Q	S	H	ΔQ	ΔS	ΔH
1.0000	.9993	.9878	1.0000	.9985	.9931

B. Correlations Within Deflated IFS Data

	Q	S	H		ΔQ	ΔS	ΔH
Q	2758.5	.96838	.81880	ΔQ	2942.1	.93789	.77325
S	2340.1	2116.9	.82621	ΔS	2134.1	1759.8	.65576
H	649.68	574.29	228.23	ΔH	619.64	406.41	218.26

C. Correlations Within Deflated Department of Commerce Data

	Q	S	H		ΔQ	ΔS	ΔH
Q	2759.2	.97086	.78475	ΔQ	2943.0	.94018	.74336
S	2345.1	2114.7	.79109	ΔS	2156.4	1787.6	.61899
H	710.49	627.02	297.08	ΔH	581.63	377.46	208.02

Notes:
1. Annual data, 1957-1986.
2. Moments for Q, S and H calculated around a constant and time trend, for ΔQ, ΔS and ΔH around a constant. For each, a shift in these deterministic terms was allowed in 1974.
3. In panels B and C, variances and covariances are on and below the diagonal, correlations are above the diagonal.

Table II

Relative Variability of Output and Final Sales

(1) Country	(2) var(Q)/var(S)	(3) var(ΔQ)/var(ΔS)	(4) corr(S,ΔH)	(5) $E(Q^2-S^2)$	(6) var(ΔQ)
Canada	1.55	2.20	.18	-24.2	29.4
France	1.15	1.48	.07	-1751.7	870.2
W. Germany	1.39	1.76	.22	-151.8	664.0
Italy	1.64	2.53	.15	-13.3×10^6	4.5×10^6
Japan	1.02	1.07	-.01	-12.2×10^6	16.7×10^6
U.K.	1.75	1.94	.37	-6.9	17.0
U.S.	1.30	1.67	.33	-713.6	3047.0

Notes:

1. See notes to Table I.
2. For columns (5) and (6), units are billions of real (1980) units of home currency, squared.
3. As explained in the text, column (5) essentially calculates var(Q)-var(S) in a fashion that is robust to the presence of unit roots. Column (6) is presented solely for comparison to column (5).

Table III

Inventory Response to One Unit Sales Shock

A. Regression Estimates in Levels

Country	Year 0	1	2	3	4	5
Canada	.42	.51	.37	.18	.05	-.01
France	.16	.56	.61	.60	.60	.62
W. Germany	.31	.26	.03	-.13	-.14	-.06
Italy	.28	.22	.12	-.04	-.08	-.06
Japan	.08	.17	.16	.11	.08	.06
U.K.	.20	.26	.16	.05	-.01	-.02
U.S.	.25	.27	.15	-.02	-.12	-.10

B. Regression Estimates in Differences

Country	Year 0	1	2	3	4	5
Canada	.39	.41	.34	.27	.21	.17
France	.26	.42	.49	.52	.54	.54
W. Germany	.29	.33	.32	.31	.29	.27
Italy	.28	.24	.31	.31	.33	.34
Japan	-.09	-.12	-.12	-.11	-.10	-.08
U.K.	.17	.20	.21	.21	.20	.20
U.S.	.21	.31	.35	.37	.38	.38

Notes:
1. See notes to Table I.