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Inventories and Output Volatility

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Abstract: Analyzing disaggregate data on inventories and sales from the U.S. manufacturing and trade sector between 1960 and 1997 yields four main findings. First, I find that IS ratios are somewhat lower after 1984:1 among durable goods manufacturers and durable goods retailers outside the motor vehicle industry. Second, I find that industries which have lowered their IS ratios tend to be those in which the variance of output relative to sales has declined. Third, by decomposing the variance of output into its components, I find that the variance of sales is less important, and the variance of inventory investment is more important, after 1984:1 than in earlier years for the overall manufacturing and trade sector. Finally, the evidence suggests that industries where IS ratios fell are those where inventory investment volatility played a smaller role in output volatility in the later period.

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Introduction

Are business cycles less pronounced now than in earlier years? Several studies offer evidence of decreased aggregate volatility in recent years, and business analysts, too, often claim that future business cycles are likely to feature shorter, less pronounced contractions than earlier cycles displayed. For example, McConnell and Quiros (1997) present informal evidence that post-war GDP volatility declined in the early 1980s, and they specifically find evidence of a one-time decline in the volatility of post-war GDP in 1984:1. Suggested reasons for such changes in output volatility or cyclicality are many and varied, but one item on nearly every "short list" of factors is the widespread embrace of just-in-time inventory management techniques by U.S. firms. For example, the *Economist* (1998) writes:

> What is clear, however, is that the economic cycle has become less bumpy than it used to be...There are several possible explanations for the taming of the business cycle....[including] better inventory control through just-in-time techniques and the use of computers.

Similarly, McConnell and Quiros (1997) point to a decline in the share of inventory investment in GDP fluctuations as a possible source of the output volatility decline.

In this paper, I investigate the relationship between inventory holdings and output volatility at the industry level. I use detailed data from the U.S. manufacturing and trade (M&T) sector from 1960 to 1997, and I relate inventory-sales ratios to several measures of output and inventory volatility. I focus on output volatility because swings in business inventory accumulation have historically accounted for large fractions of GDP volatility. In particular, I take as given the breakpoint identified by McConnell and Quiros (1997) and compare inventory behavior before and after 1983:4. In brief, I find that IS ratios are somewhat lower in the later period among durable goods manufacturers and durable goods retailers outside the motor vehicle

industry. I also find that in the manufacturing and retail sectors, the industries which have lowered their IS ratios tend to be the ones whose output variance (relative to the variance of sales) has declined. Third, by decomposing the variance of output into its components, I find that the variance of sales is less important, and the variance of inventory investment is more important, in the later period than in the earlier period for the overall manufacturing and trade sector. One prominent exception in the manufacturing sector is the motor vehicles industry, where inventory investment variance declined. In retailing, the contribution of inventory investment variance nearly trebled, rising from 20.7% to 59.3% between the earlier and later periods, suggesting an increased role for inventory investment fluctuations in that sector. Overall, the evidence suggests that industries where IS ratios fell are those where inventory investment volatility played a smaller role in output volatility in the later period.

Facts and theories about inventories

Economists care about inventory behavior because, historically, swings in inventory investment have played a prominent role in cyclical fluctuations. In brief, inventory investment is highly volatile and contributes significantly to recessionary declines in GDP, and inventory-sales (IS) ratios are strongly countercyclical, rising during recessions and falling in expansions. In fact, inventory disinvestment is a central part of cyclical contractions. Table 1 reports the average post-war contribution of changes in inventory accumulation ("inventory disinvestment") to the peak-to-trough decline in GDP during contractions. The table shows that the decline in inventory investment accounted for 76 percent of GDP's decline in the average post-war recession. The table reveals three features of the data. First, the manufacturing and retail sectors dominate the wholesale trade sector, accounting for most of the inventory effect, with retailers accounting for

about one- third (.26/.76) of the total contribution.[1] Second, firms in the durable goods sectors account for most of the impact. Third, during the two most recent recessions, the role of durable goods manufacturers was quite muted, as their inventory disinvestment during those episodes accounted for a below-average 11% of the total contraction in GDP. In contrast, the retail sector was of little consequence in the 1981-1982 recession, but key in the 1990-1991 recession. On balance, table 1's evidence suggests that durables goods inventories held by manufacturers and retailers are key to any analysis of the cyclical behavior of inventories.

[1]Although not shown in the table, the shares for the three categories of inventories held by manufacturers, namely materials, goods in process, and finished goods, confirm Blinder and Maccini's (1991) finding that finished goods inventories account for little of the total contribution (6% post-war average) despite being the focus of much economic research. In contrast, goods in progress and, to a lesser extent, materials and supplies held by manufacturers are more important.

The two major competing models of inventory behavior, production smoothing models and S,s threshold-type models, offer competing predictions about two key aspects of inventories, namely the variance of output relative to sales and the correlation between sales and inventory investment; see Fitzgerald (1997) or Hornstein (1998) for useful discussions.[2] In production smoothing models, output is predicted to be less (more) variable than sales, when shocks are solely on the demand (cost) side. Such models also typically predict a negative covariance between sales and inventory investment. In contrast, generalized S,s models do not offer predictions on these points (Hornstein (1998)), though with specific assumptions about aggregation and other model features, such models do offer specific predictions. For example, McCarthy and Zakrajsek (1997) develop an S,s model in which output is predicted to be more variable than sales and in which sales and inventory investment should be uncorrelated.

Data

The data used in this paper are quarterly inventories and sales (shipments) data, in chained 1992 billions of dollars, from the U.S. Department of Commerce, for the manufacturing and trade sectors. Manufacturing includes 21 separate industries (essentially 2-digit SIC industries), the merchant wholesale sector includes 19 industries, and the retail trade sector includes 13 sectors.[3] I construct output as the sum of shipments and inventory investment, and the inventory-sales ratio

[2]For retailers and wholesalers, the terms "production" and "output" are taken to mean deliveries of goods from their suppliers. In this paper, I will use these terms interchangeably to denote output in the manufacturing sector and deliveries in the trade sector.

[3]Data on the detailed sectors is available in manufacturing and retail from 1959 onwards; detailed wholesale sectors have data only from 1967 forward. Unless otherwise noted, the paper's calculations will use the 1960-1997 period, thus will include wholesale trade only at the level of durable and nondurable goods.

is denominated in months. Because it is the business cycle aspects of inventory investment which are of most interest, the data are detrended using the Hodrick-Prescott filter.[4]

Have inventory-sales ratios fallen?

[4]See Hodrick and Prescott (1997), and also see Hornstein (1998) for a more general discussion of detrending, extracting the appropriate frequencies from the data, and so on.

Table 2 reports inventory-sales (IS) ratios by sector over several alternative time periods, with period means reported in columns 1 through 3 and cyclical highs reported in columns 4 through 6.[5] Turning first to the means, we find that IS ratios are higher in durable goods industries than in nondurable goods industries and that ratios are highest among durable goods manufacturers. Further, comparing the early period (1960:1-1983:4) to the later period (1984:1-1997:4), we see that IS ratios have not fallen overall; in fact, they have risen. Only among durable goods manufacturers, on average, did IS ratios fall, with the greatest declines occurring in SIC industries 35 (industrial and commercial machinery and computer equipment), 371 (motor vehicles and equipment), and 38 (instruments). In the retail sector, motor vehicle IS ratios rose from 1.55 to 1.85 months, while all other durable goods retailers saw IS ratios fall.

Columns 4 through 6 offer another perspective on whether IS ratios have dropped in recent years. The table shows that the overall M&T IS ratio peaked at about the same point in each of the three recessions reported in the table: 1.48 in the 1973-1975 recession, and 1.53 in the 1981-1982 and 1990-1991 recessions. From that perspective, little has changed. However, durable goods firms saw the cyclical highs fall in the last recession relative to the preceding one, especially in the manufacturing sector. Furthermore, the three broadest sectors exhibit different patterns: in manufacturing, the cyclical maximum fell; in wholesale, it was basically unchanged; and in retail, it rose. Again, one interesting aspect is how motor vehicle-related inventories behaved: in manufacturing (SIC 371), the cyclical high fell from 1.06 to 0.86, comparing the 1981-1982 and 1990-1991 recessions, while in the retail trade sector, motor vehicle inventories reached cyclical highs of 1.92 in 1981-82 and 2.08 in 1990-1991.

[5]The ratios are constructed from the data prior to detrending.

On balance, then, the evidence points to declining IS ratios among durable goods manufacturers and durable goods retailers excluding motor vehicles. Outside of these groups, IS ratios were at best flat, at worst up somewhat. This compares to earlier work by Ben Salem and Jacques (1996) and Hirsch (1996), who find that inventory-sales (IS) ratios have declined in the manufacturing sector, but that ratios have risen in the wholesale and retail trade sectors.

The variance of output relative to sales

In this section of the paper, I examine the variance of output relative to the variance of sales, and I relate this relative output variance to IS ratios. In brief, I find some evidence that industries with high IS ratios are those whose output variance is relatively high. I also find that in the manufacturing and retail sectors, the industries which have lowered their IS ratios tend to be the ones whose relative output variance has declined; the opposite seems to be true in the wholesale sector. This establishes, in an unstructured way, a connection between lower IS ratios and decreased output volatility, at least in the manufacturing and retail sectors.

Table 3 reports the ratio of the variance of output to the variance of sales for the broad sectors studied here. The ratio exceeds 1 in all cases, as output is more volatile than sales. This is especially true in the durable goods sectors. Comparing the early and later periods, I find that output volatility relative to sales has risen in all cases.[6] However, the disaggregate data indicate that eight of the 21 manufacturing industries experienced declines, most notably several durable goods industries, including SICs 32 (stone, clay and glass), 35 (industrial machinery and computer equipment), 36 (electronic equipment), 371 (motor vehicles), and 37-excluding 371 (all other

[6]As we shall see in table 5 below, the variance of output has declined in absolute terms; table 3's relative variance measure has risen because the variance of sales has declined even

transportation equipment). In the retail sector, although only one disaggregate industry (other durable goods retailers) showed a decline in relative output variability, the overall retail sector excluding motor vehicles experienced a decline from 3.12 to 2.05. This highlights the importance of retail motor vehicles, in which output variability rose from 2.74 to 4.16. Note the overlap between the sectors where IS ratios have declined and sectors where output volatility has declined: for example, SIC 35 (industrial machinery) had its mean IS ratios fall from 3.32 to 2.14, while SIC 371 (motor vehicles) had its IS ratio fall from 0.98 to 0.63; both industries experienced declines in output volatility. In the retail sector, motor vehicle IS ratios rose from 1.55 to 1.85 as output volatility rose considerably. For motor vehicles, it appears that IS ratios and output volatility relative to sales volatility have fallen in the manufacturing sector but risen in the retail trade sector.

Table 4 relates the relative variance of output to IS ratios in a more formal way. For each detailed sector, I compute the relative variance of output, first over the full sample period and then separately for the early and later periods. I also compute the mean and maximum IS ratio for those time periods. Table 4's top panel reports the cross-sectional correlation coefficients between the IS ratio and the relative variance measure, for all industries together as well as separately for the three broad sectors. In manufacturing and retail, the correlation is large and positive, suggesting that high IS ratios are associated with high output volatility; the correlation is weaker in the wholesale sector. The bottom panel addresses the issue of whether those sectors that lowered their IS ratios are those whose output volatility declined. For each industry, I calculate the ratio of the early to later period output volatility, the ratio of the early to later mean

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further.

IS ratios, and the ratio of the 1981-1982 cyclical high to the 1990-1991 cyclical high IS ratio. The table's bottom panel reports the cross-sectional correlation between the early to later output volatility ratio and the early to later period IS ratio. Again, manufacturing and retail show positive correlations, suggesting that industries whose IS ratios fell are indeed those industries whose output volatility (relative to sales) declined. The wholesale sector is somewhat different, showing a negative correlation.

Covariance of sales and inventory investment

Table 5 contains the covariances between sales (S) and inventory investment (CBI) for the broad sectors studied here, again for the full period as well as for the early and later periods. In all cases, the covariance is positive over the full sample period, and the covariance declines between the early and later periods. In retail, the covariance actually becomes slightly negative in the later period, implying that inventory investment declines when sales are rising.

Because we are ultimately interested in output volatility, decomposing the variance of output into its components is useful. Since output is the sum of sales and inventory investment, the variance of output equals the sum of the variance of sales, the variance of inventory investment, and twice the covariance between sales and inventory investment. Table 6 reports, in levels and in percent terms, the components for the overall manufacturing and trade sector for the different time periods studied.

Several patterns emerge from the table. First, the variance of output has declined; this is true for the disaggregate industries in the manufacturing and wholesale trade sectors, as well as for the retail sector excluding motor vehicles. Much of the decline is due to a decline in the variance of sales, which occurred in all but eight of the 34 manufacturing and retail industries. In

percentage terms, the variance of sales is less important in the later period, accounting for 50.9% of total output variance, compared to 66.2% of the total during the earlier period. Second, the variance of inventory investment has risen for the M&T sector overall, as well as for the manufacturing, wholesale trade, and retail trade sectors independently. However, nine of 21 manufacturing industries show a decline in the variance of inventory investment, though as a share of total output variance, inventory investment variance has risen in nearly all industries. The one prominent exception is, again, SIC 371, the motor vehicles industry, where the share of total output variance accounted for by inventory investment variance fell from 7.8% to 3.5% between the earlier and later periods. In retailing, the variance of inventory investment rose in all industries but one (lumber stores), and as a percentage of total output variance, the contribution of inventory investment variance rose from 20.7% to a whopping 59.3% between the earlier and later periods. In that sense, we can say that inventory investment volatility has become a more pronounced factor in the retail sector. Furthermore, this increase is not solely due to motor vehicles; it is prominent throughout the sector.

In fact, computing correlations between IS ratios and the shares of inventory investment variance in total output variance, similar to the exercise in table 4, shows that in the manufacturing and retail sectors, the industries where IS ratios fell the most are those in which inventory investment variance accounted for smaller shares of total output variance; the correlation is especially strong in the retail sector. In the wholesale trade sector, the correlation is negative.

Discussion and conclusions

In this paper, I use detailed manufacturing and trade sector data to examine several

measures of inventory behavior before and after 1984:1, a point identified by previous researchers as the time of a one-time decline in GDP volatility. Because movements in wholesale trade inventory investment are, on average, less important in business cycle fluctuations than are movements in manufacturing and retail inventory accumulation, I emphasize the key results from the latter two sectors.

First, I find some evidence that IS ratios were lower after 1984:1 than in the earlier period among durable goods manufacturers and durable goods retailers excluding motor vehicles; outside of these groups, IS ratios were at best flat, at worst up somewhat. Second, output is more variable than sales in all industries over each time period examined, by and large consistent with previous research. Comparing the early and later periods, I find that output volatility relative to sales has risen overall, but that several durable goods manufacturing industries show declines, noticeably several whose IS ratios have declined over time. In fact, simple correlations show that in the manufacturing and retail sectors, the industries which have lowered their IS ratios tend to be the ones whose relative output variance has declined; the opposite seems to be true in the wholesale sector.

Third, I decompose the variance of output into its components and find that much of the decline in output variability after 1984:1 is due to declines in sales variability, which, in percentage terms, is less important in the later period. The share of total output variance accounted for by inventory investment variance has risen for the M&T sector overall. One prominent exception in the manufacturing sector is the motor vehicles industry, where inventory investment variance became less important in the later period. In retailing, the contribution of inventory investment variance nearly trebled, rising from 20.7% to 59.3% between the earlier and later periods,

suggesting an increased role for inventory investment fluctuations in that sector. More formally, correlations between IS ratios and the shares accounted for by inventory investment variance are positive in the manufacturing and retail sector, suggesting that industries where IS ratios fell are those where inventory investment volatility played a smaller role in output volatility in the later period.

Finally, the motor vehicle industry stands out as sector worth further study. In the manufacturing sector, motor vehicle IS ratios fell, output volatility fell, and inventory investment volatility became less important a factor in overall output volatility. In the retail motor vehicle sector, the opposite was true on all counts. If inventories and volatility have just been pushed "downstream", then it is hard to argue that, for the economy as a whole, changes in inventory management in one sector of the economy imply smoother aggregate output paths in the years ahead.

In conclusion, this paper has established a cross-sectional correlation between IS ratios, output volatility, and inventory volatility. This is a useful first step in addressing the extent to which recent changes in inventory management techniques may have "tamed" the business cycle. Of course, as Hornstein (1998) notes, attributing overall inventory investment volatility to individual sectors is difficult because of the covariance across sectors, and I cannot conclude that changes in inventory management techniques, as revealed through lower IS ratios, are responsible for declines in output volatility. However, the cross-sectional evidence does point to a connection between lower inventory holdings and decreased output volatility. Future research must address the covariance issue to make more progress in understanding the implications of new inventory management techniques for the business cycle.

References

Ben Salem, Melika, and Jean-Francois Jacques, "About the stability of the inventory-sales ratio: an empirical study with U.S. sectoral data." *Applied Economics Letters* 3 (1996): 467-469.

Blinder, Alan S., and Louis J. Maccini, "Taking Stock: A Critical Assessment of Recent Research on Inventories." *Journal of Economic Perspectives* 5, 1 (Winter 1991): 73-96.

The Economist. "The business cycle: puncture ahead." December 5, 1998, p. 90.

Fitzgerald, Terry J., "Inventories and the Business Cycle: An Overview." *Economic Review*, Federal Reserve Bank of Cleveland, 33, 3 (1997): 11-22.

Hirsch, Albert A., "Has inventory management in the U.S. become more efficient and flexible" A macroeconomic perspective." *International Journal of Production Economics* 45 (1996): 37-46.

Hodrick, Robert J., and Edward C. Prescott. "Postwar U.S. Business Cycles: An Empirical Investigation." *Journal of Money, Credit, and Banking* 29, 1 (February 1997): 1-16.

Hornstein, Andreas. "Inventory investment and the business cycle." Federal Reserve Bank of Richmond *Economic Quarterly* 84, 2 (Spring 1998): 49-71.

McCarthy, Jonathan, and Egon Zakrajsek, "Microeconomic Inventory Adjustment and Aggregate Dynamics." Working paper, Federal Reserve Bank of New York, November 1998.

McCarthy, Jonathan, and Egon Zakrajsek, "Trade Inventories." Working paper, Federal Reserve Bank of New York, December 1997.

McConnell, Margaret M., and Gabriel Perez Quiros, "Output Fluctuations in the United States: What Has Changed Since the Early 1980s?" Working paper 9735, Federal Reserve Bank of New York, November 1997.

Table 1

Inventory investment's share of recessionary declines in GDP
Percent

	mean	1981:1-1982:4	1990:3-1991:1
Total change in business inventories	76	31	49
manufacturing	35	12	6
durable goods	28	12	10
nondurable goods	7	-0	-3
merchant wholesale	5	3	6
durable goods	5	2	1
nondurable goods	0	1	4
retail	26	-1	28
durable goods	23	-7	28
nondurable goods	4	7	0

Notes: raw data are in billions of chained 1992 dollars. Shares are computed by sector for each postwar recession; the mean over all recessions is reported in column 1, and shares for the most recent two recessions are reported in columns 2 and 3.

Table 2 Inventories-Sales Ratios
Number of months

	Mean ratio			Maximum ratio			
	1960:1-1997:4	1960:1-1983:4	1984:1-1997:4	1973:4-1975:1	1981:3-1982:4	1990:3-1991:1	
manufacturing and trade		1.36	1.33	1.42	1.48	1.53	1.53
manufacturing	1.51	1.52	1.50	1.78	1.78	1.66	
manufacturing-durable gds	1.93	1.96	1.86	2.39	2.47	2.15	
manufacturing-nondurable gds	1.13	1.13	1.13	1.22	1.20	1.18	
wholesale trade	1.15	1.07	1.30	1.14	1.36	1.38	
wholesale trade-durable gds	1.56	1.50	1.67	1.77	2.09	1.80	
wholesale trade-nondurable gds		0.79	0.71	0.94	0.70	0.82	0.98
retail trade		1.24	1.14	1.41	1.31	1.31	1.47
retail trade-durable gds		1.94	1.91	2.00	2.32	2.22	2.20
retail trade-nondurable gds	0.91	0.82	1.08	0.90	0.93	1.07	

Columns 1-3 report the mean inventories-sales (IS) ratio, in monhts, for the time periods listed in the column headings. Columns 4-6 report the maximum IS ratio reached in the three contractions listed in the column headings.

Table 3 Ratio of Variance of Output to Variance of Sales

	1960:1-1997:4	1960:1-1983:4	1984:1-1997:4	
manufacturing and trade		1.59	1.51	1.96
manufacturing	1.63	1.55	2.13	
manufacturing-durable gds	1.88	1.79	2.24	
manufacturing-nondurable gds	1.34	1.24	2.07	
wholesale trade	1.48	1.38	1.95	
wholesale trade-durable gds	1.65	1.50	2.23	
wholesale trade-nondurable gds		1.50	1.36	1.79
retail trade		1.94	1.81	2.24
retail trade-durable gds		2.48	2.20	3.02
retail trade-nondurable gds	1.76	1.75	1.78	

Table 4 Correlation between inventories-sales ratio and relative variance of output

Correlation between Var(Q)/Var(S) and:					
	full sample	manufacturing	wholesale*	retail	
Mean IS ratio		.585	.682	.274	.688
Maximum IS ratio	.556	.742	.246	.693	

Correlation between $(Var(Q)/Var(S))_{early}/(Var(Q)/Var(S))_{later}$ and:					
	full sample	manufacturing	wholesale*	retail	
Mean IS $ratio_{early}$/ Mean IS $ratio_{later}$		.306	.253	-.178	.436
Max IS $ratio_{1981:3\text{-}1982:4}$/ Max IS $ratio_{1990:3\text{-}1991:1}$	.175	.288	-.200	.178	

*The IS ratios and and relative variance measures are computed over the 1967:1-1997:1 period for the wholesale trade sector; all others use data from 1959:1-1997:4.

Notes: Var(Q)/Var(S) and IS ratios are computed separately by industry. The top panel reports the cross-sectional correlation between the mean (maximum) IS ratio and the relative output variance (Var(Q)/Var(S)). For the bottom panel, the ratio of the early period (1960:1-1983:4) relative variance to the later period (1984:1-1997:4) relative variance is computed; similarly, the ratio of the early to later period IS ratio is computed. The table reports the correlation between these two ratios (line 3), as well as the correlation between the relative variance ratio and the ratio of the cyclical maxima (1981-1982 vs. 1990-1991).

Table 5 Covariance of sales and inventory investment

	1960:1-1997:4	1960:1-1983:4	1984:1-1997:4	
manufacturing and trade		27.75	32.48	18.27
manufacturing	9.30	11.35	5.41	
manufacturing-durable gds	5.82	7.14	3.30	
manufacturing-nondurable gds	0.28	0.33	0.18	
wholesale trade	1.26	1.55	0.66	
wholesale trade-durable gds	0.80	1.01	0.38	
wholesale trade-nondurable gds		0.11	0.06	0.19
retail trade		1.14	1.91	-0.32
retail trade-durable gds		0.37	0.79	-0.41
retail trade-nondurable gds	0.13	0.27	-0.14	

Note: the covariance of sales and inventory investment is computed separately for each sector over the time periods indicated.

Table 6 Decomposition of variance of output, manufacturing and trade sector

levels	var(Q)	var(S)	var(CBI)	2cov(S,CBI)
1960:1-1997:4	209.0	131.1	21.0	55.5
1960:1-1983:4	250.7	166.0	17.0	65.0
1984:1-1997:4	133.0	67.7	28.0	36.6
difference	117.7	98.3	-11.0	14.0
percent				
	var(Q)	var(S)	var(CBI)	2cov(S,CBI)
1960:1-1997:4	100.0	62.7	10.0	26.6
1960:1-1983:4	100.0	66.2	6.8	25.9
1984:1-1997:4	100.0	50.9	21.1	27.5
difference	NA	15.3	-14.3	-1.57

Note: the variances of output (Q), sales (S), and inventory investment (CBI) and the cov(S,CBi) are computed for the aggregate manufacturing and trade sector over the early (1960:1-1983:4) and later (1984:1-1997:4) time periods.