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THE SEASONAL CYCLE IN U.S. MANUFACTURING

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ABSTRACT

This paper examines the seasonal cycle in the manufacturing sector of the U.S. economy. We present estimates of the seasonal patterns in monthly data for 2-digit industries, and we demonstrate the similarity of the seasonal cycle and the business cycle in manufacturing with respect to several key stylized facts about business cycles. The results are an important addition to those in Barsky and Miron (1989) because the monthly data for manufacturing display interesting seasonal fluctuations that are hidden in the quarterly data examined by Barsky and Miron. The most significant is a sharp slowdown in July followed by a significant rebound in August. We argue that this event is not easily explained by technology or preference shifts but instead results from synergies across economic agents.

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1. Introduction

In a recent paper, Barsky and Miron (1989) examine the seasonal cycle in the U.S. economy. Using quarterly data on standard aggregate variables, they show that quantity series such as output, employment and the money stock are strongly seasonal while price series such as wages, interest rates, and the price level are essentially aseasonal. The overall pattern of seasonal variation is dominated by a large increase in activity from the third quarter to the fourth followed by a substantial downturn in activity from the fourth quarter to the first. These seasonal fluctuations account for more than three quarters of the variation in the rate of growth of real GNP.

Barsky and Miron also demonstrate that the important stylized facts about business cycle fluctuations hold for seasonal fluctuations as well. Over both the seasonal cycle and the business cycle, output movements across sectors are highly correlated, production smoothing is essentially absent, labor productivity is highly procyclical, nominal money and real output move together, and prices vary less than quantities. As demonstrated in Beaulieu and Miron (1990b), these similarities between seasonal cycles and business cycles hold for all developed countries.

This paper expands the set of stylized facts about seasonal cycles by examining the manufacturing sector of the U.S. economy. We present estimates of the seasonal patterns in monthly data for 2-digit industries, and we demonstrate the similarity of the seasonal cycle and the business cycle in manufacturing with respect to several key stylized facts about business cycles. The results are an important addition to those in Barsky and Miron because the monthly data available for the manufacturing sector display several features of interest that are hidden in the quarterly data. The most important feature is a sharp slowdown in July followed by a significant rebound in August.

We argue that the seasonal pattern in manufacturing, particularly the July slowdown, is not easily explained by technology or preference shifts, as in the neo-classical seasonal business cycle models of Braun and Evans (1990) or Chatterjee and Ravikumar (1990). The reason is that the summer slowdown is too dramatic to be plausibly attributed to exogenous factors like the weather. We suggest instead that the slowdown results from synergies across different economic agents, as in the models of Hall (1989) or Cooper and Haltiwanger (1990). Based on this interpretation, we suggest that procylical labor productivity over the seasons more likely represents labor hoarding than technology shocks, and the similarity of the seasonals in production and shipments provides strong evidence against the production smoothing and cost smoothing models of inventory accumulation.

The remainder of the paper is organized as follows. Section 2 explains our estimation procedures and describes the data. Section 3 presents estimates of the seasonal patterns in production, shipments, employment, hours, wages and prices in twenty 2-digit manufacturing industries. Section 4 shows that the seasonal cycle in manufacturing displays important stylized facts about the business cycle. In Section 5 we conclude by discussing the implications of the results about seasonal cycles for the analysis of business cycles.

2. Estimation Procedures and Description of the Data

2.1 Estimation Procedures

The results in Beaulieu and Miron (1990a) indicate that the seasonality in aggregate time series is better characterized as stationary fluctuations around seasonal dummies than as unit roots at seasonal frequencies. These results also show that it is difficult to reject the hypothesis of a unit root at frequency zero. We demonstrate in an appendix available on request that the same conclusions apply to the 2-digit level data considered here.[1] Following Barsky and Miron (1989),

[1] The tests for unit roots are conducted using the procedure developed in Hylleberg, Engle, Granger and Yoo (1990). The results of these tests are in some cases sensitive to the treatment of residual autocorrelation. When one includes only those lags of the dependent variable necessary to produce an insignificant Q-statistic for the residuals, or, alternatively, only those lags that are significant if included in the regression, then one consistently rejects the presence of unit roots. If instead one includes a large number of lags to insure that no residual autocorrelation is present, then one rejects seasonal unit roots much less frequently. This last result presumably reflects low power.

therefore, we assume

$$x_t = \sum_{k=1}^{12} \xi_k d_t^k + \beta(B)\eta_t \tag{1}$$

where x_t is the log growth rate X_t, $\beta(B)$ is square summable, and η_t is white noise. We estimate the ξ_k in (1) by OLS. Since $\beta(B)$ need not equal one, we correct the standard errors using the Newey and West (1987) procedure.[2]

In order to consider the relation between the seasonal dummy components of different variables we estimate IV regressions of one variable on the other and a constant, with seasonal dummies as the only instruments. When the sample is balanced, the estimated coefficient on the explanatory variable is the same as that obtained by regressing the seasonal dummy pattern in one variable on the seasonal dummy pattern in the other variable. The IV regression, however, gives the proper degrees of freedom. For purposes of comparison we also examine the relation between the non-seasonal dummy components of the data by regressing one variable on the other, with seasonal dummies included as regressors. This produces the same coefficient as using seasonal dummy adjusted data. In both cases we use the Newey and West procedure to obtain consistent estimates of the standard errors.

2.2 Description of the Data

The data set used in this paper consists of monthly series on production, shipments, hours, employment, wages and prices in twenty 2-digit manufacturing industries. The data are seasonally unadjusted and cover the period 1967–1987. We describe the series briefly here; the Data Appendix provides additional details. All of the data are available on request from the authors.

There are two possible measures of monthly production in 2-digit manufacturing industries. The first is shipments plus the change in inventories, which we refer to as Y4. The second is the

[2] This procedure for calculating standard errors assumes there is no unit root in the stochastic component of $\Delta \ln X_t$. This assumption is violated if the secular growth in $\ln X_t$ is due to a deterministic time trend rather than a unit root. See Quah and Wooldridge (1988) for an analysis of the effects of overdifferencing.

Federal Reserve Board's Index of Industrial Production, which we refer to as IP. As documented in Miron and Zeldes (1989), the time series properties of these two series are radically different. IP is generally a smoother, more persistent series than is Y4. In particular, the true seasonal patterns in production are probably understated in those IP series that are estimated from data on labor input, since the Fed assumes there are no seasonals in technology or in labor hoarding. We therefore focus on the Y4 measure of output. We have conducted most of the estimation reported in this paper with the IP measure as well, and we report these results where relevant. Most of our conclusions are not sensitive to the choice of output measure. The shipments and inventories series that we use are the ones reported by the Bureau of Economic Analysis of the Department of Commerce (BEA).

We consider two measures of hours and two measures of employment. The hours measures are average weekly hours of production workers and total production worker hours (employment of production workers time average weekly hours of production workers). The two employment series are production worker employment and total employment including overheard labor. The data are from the Bureau of Labor Statistics' (BLS) Establishment Survey. We note for future reference that the hours and employment measures produced by BLS include all paid hours and employment, including that for workers on vacation. The wage series that we examine is average hourly earnings including overtime.

The price series that we employ are the wholesale price indices compiled by the BLS. These series are based on a commodity classification system different from that used by BEA (the Standard Industrial Classification), so there is not always a price index whose coverage matches precisely the goods included in a particular 2-digit SIC industry. Sometimes the best proxy covers a group of goods that is too broad (e.g., Textiles, Petroleum), while at other times the best proxy is too restrictive (e.g., Primary Metals). Table A2 in the data appendix lists the price series that we use as proxies for the SIC industries. Our conclusions about price seasonality are unaffected by the imperfect match between industry classification systems.

3. Univariate Seasonal Patterns

Tables 1–8 report the estimated seasonal patterns in the variables described in Section 2 above, along with summary statistics from the regressions used to estimate the seasonal patterns. There are three summary statistics. The standard deviation of the fitted values of the regression is an estimate of the variability of the deterministic seasonal component of the series. The standard deviation of the residuals is an estimate of the variability of the business cycle component of the series.[3] The R^2 of the regression is an estimate of the fraction of the variation in each series explained by deterministic seasonals. The entries in the last twelve columns of the tables are the demeaned estimated coefficients on the seasonal dummies. The growth rates are measured at monthly rates.

The tables indicate that seasonality is a dominant source of variation in the growth rates of quantity series in 2-digit manufacturing. Seasonal dummies typically explain 50-70 percent of the variation in production and shipments and 40-60 percent of the variation in hours and employment. The seasonals are much less important for wages, explaining 30-40 percent of the total variation and displaying standard deviations of the seasonal component of 0.4 percent as opposed to 7-8 percent for production and shipments. For prices, the seasonals usually explain less than 10 percent of the total variation and display standard deviations of only 0.2-0.3 percent.[4] The result that quantities are highly seasonal while wages and especially prices are essentially aseasonal is consistent with the findings in Barsky and Miron (1989) and Beaulieu and Miron (1990b).

The seasonal patterns documented in Table 1 demonstrate a high degree of comovement across 2-digit industries, producing a large aggregate seasonal cycle in manfacturing.[5] There are two

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[3] Throughout this paper, we use both the terms "business cycle" and "non-seasonal" to refer to the non-seasonal dummy component of a series. See Beaulieu and Miron (1990a) and Miron (1990) for discussion of this approach. Ghysels (1988) shows that frequency domain decompositions of the variation in endogenous variables cannot be justified from the perspective of dynamic economic theory. Plosser (1979) analyzes models of stochastic seasonality.

[4] The seasonality of prices is statistically significant at the 1 percent level in most cases, however.

[5] As noted by Long and Plosser (1987, Table 1, p.334), the comovement of output across industries is substantially

main features of this seasonal pattern, consisting of a midsummer slowdown and a late fall to early winter slowdown. Production is marked by a pronounced increase in June, a dramatic slowdown in July, and a strong recovery in August. Production declines rapidly in November and December but then recovers in January or February. There is also a noticeable decline in April in most 2-digit industries. The timing of shipments is similar in most respects to that in production (see Table 2). Shipments grow strongly in June, decline dramatically in July, and recover in August and September. Shipments decline strongly again in November through January and recover in February and March.

The four different measures of labor input presented in Tables 3–6 all follow roughly the same seasonal pattern as production, although the amplitude of the seasonal is considerably smaller and there is a discrepancy between the behavior of production and labor input in January. Labor input is high in the early fall but then declines in the late fall or early winter, especially January, whereas production tends to recover in January. Consistent with the behavior of output, labor input grows in June, falls in July, and then recovers in August. Comparing the two measures of employment, production worker employment is more variable than total employment over both the seasonal cycle and the business cycle.

The behavior of manufacturing activity in the fourth quarter appears to differ from that of GNP as documented by Barsky and Miron. Although both peak in the fourth quarter, the peak in manufacturing occurs in October while that in GNP likely occurs December, since, as demonstrated in Beaulieu and Miron (1990b), there is a large December increase in retail sales. The difference between the timing of production in the manufacturing and retail sectors probably occurs because manufactured goods ultimately sold at the retail level (e.g., Food, Apparel, Furniture, Paper, Printing, Leather) take several months to be transported from manufacturers to retailers.

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lower in the non-seasonal components of the data than in the seasonal components (we confirm this observation using our data set). In this sense, therefore, the seasonal cycle displays the business cycle stylized fact even more dramatically than the business cycle itself.

For other components of manufacturing (Lumber, Stone, Clay and Glass, Fabricated Metal), the decline in November or December may reflect the fact that these industries supply materials to the construction industry, which shuts down in early winter due to weather considerations. In most of the remaining industries the reason for the slowdown around November is not apparent.

The most interesting feature of the monthly manufacturing seasonal is the dramatic July slowdown and August/September recovery. Total manufacturing declines 13.0 percent in July and then increases 7.05 percent in August and another 5.4 percent in September. The July slowdown is present across all industries, with only Petroleum displaying a decrease in production of less than 4.0 percent. These dramatic changes in the rate of production are masked in the quarterly data used by Barsky and Miron. Over roughly the same time period, GNP declines only 0.80 percent from the second quarter to the third.

One class of explanations for the summer slowdown relies on shifts in preferences or technology. For instance, workers may prefer vacations in July. This shift in preferences raises the marginal cost of production, so firms optimally avoid production in July.[6] Similarly, exogenous shifts in the technology may dictate reallocation of production away from low productivity periods, as in the real business cycle models of Kydland and Prescott (1982), Long and Plosser (1983), or Prescott (1986). Braun and Evans (1990) and Chatterjee and Ravikumar (1990) present models of the seasonal cycle based on these kinds of shifts in preferences and technology, and they suggest that their models explain many features of the quarterly seasonal patterns documented by Barsky and Miron. In particular, Braun and Evans estimate an 8 percent drop in productivity in the first quarter corresponding to the 8 percent drop in GNP documented by Barsky and Miron over the same period, while Chatterjee and Ravikumar parameterize their model with a 20 percent drop in productivity in the first quarter.

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[6] This hypothesis is called into question to some degree by the marked absence of any movement in real wages in July, although if firms smooth wages over the year (Hall and Lilien (1979)), the shadow cost of labor might be seasonal even though measured wages are smooth.

These models run into more difficulty when applied to the monthly results presented above. The only obvious reason for similar seasonal changes in preferences and productivity across all industries is the weather, but there is no aspect of the weather that differs as dramatically between June and August relative to July as do the rates of manufacturing production. It is also difficult to account for the winter slowdown in terms of the weather, since the declines in output are concentrated in the fall rather than the winter, and output increases strongly in February, arguably the month with the worst weather in many parts of the country.

To support this point, we have examined data on average monthly temperature for the forty-eight continental United States. Although the highest temperature does occur in July in all states except Florida (August), the absolute value of the change in temperature is generally smaller between July and August than adjacent months. On average, the change is $-1.5°F$ from July to August while the average change in months other than January and February is on the order of $8 - 9°F$. The data on precipitation provide even less basis for attributing the July slowdown to weather, since there is no consistency across states in the pattern of precipitation during June, July and August. Based on these facts, it follows that any function relating productivity to weather would have to be implausibly non-linear. This point is demonstrated even more forcefully by the European data presented in Beaulieu and Miron (1990b). In most countries industrial production declines 50-80 percent in the summer slowdown period, and the slowdown occurrs in August in some countries but July in others despite the fact that July is the warmest month in all places.

An alternative explanation for the summer slowdown relies on synergies across firms or workers that make it optimal to have all activity shut down at the same time (Hall (1989)). These synergies can occur for a number of reasons. Firms may find it desirable to close at the same time as their upstream or downstream partners. Under such conditions there may be two equilibrium outcomes, one where all firms operate throughout the year at a lower average level and another where all firms close for July. In the second case, each firm closes because otherwise, given that all others have closed, it would have to stockpile raw materials and inventory intermediate and final goods in order to operate during the slowdown period. These added costs may outweigh the benefits of smoothing production. In a similar vein firms may wish to have all workers on vacation at the same time so that retooling or maintenance can take place more easily (Cooper and Haltiwanger (1990)). Finally, different workers in the same family may find it desirable to have vacations in the same period.

It is important to note that we do not dismiss any role for the weather in determining the seasonal pattern of production. Even though we find synergies likely to be important in explaining the magnitude of the seasonal slowdowns, it is likely that the weather is crucial in determining the timing of the slowdowns. For example, July may well be slightly preferable to August or June as a vacation month. The claim made here is that the magnitude of the downturn in July is greater than can easily be explained simply as the result of exogenous differences between July and other months. Thus, the weather helps pin down the month in which the synergies take place, but the synergies are critical in determining the magnitude of the slowdown.

To the extent that the seasonal cycle in manufacturing represents a synergistic equilibrium cycle, it perhaps provides a more readily verifiable example of such a cycle than the business cycle phenomenon that such models were originally designed to explain. The identification of a clear example of this kind of cycle may then shifts one's priors as to whether the same kinds of forces are at work in producing the business cycle. We discuss more compelling evidence along these lines in Section 5.

4. Stylized Facts

The analysis above has demonstrated that the seasonal fluctuations in manufacturing display two key business cycle stylized facts: output movements across sectors are highly correlated, and quantities fluctuate considerably more than prices. We now demonstrate that these seasonal fluctuations also exhibit the two key business cycle stylized facts of procyclical labor productivity and an absence of production smoothing.[7] We interpret these stylized facts over the seasonal cycle in light of our discussion above about the likely sources of the seasonal in manufacturing. We discuss in Section 5 the extent to which these conclusions apply to the business cycle as well, given the similarity between the two kinds of cycles.

4.1 Procyclical Labor Productivity

To examine the cyclicality of labor input, we estimate IV regressions of the log growth rate of output on the log growth rate of labor input, using seasonal dummies as the only instruments. For comparison, we also estimate the elasticity of output with respect to labor input over the business cycle. We do this by regressing the log growth rate of output on the log growth rate of labor input, with seasonal dummies included in the regression. Labor input is defined as average weekly hours of production workers times the number of production workers.[8]

Table 9 displays the estimated elasticities of output with respect to labor input. The seasonal variation in output is highly elastic with respect to the seasonal variation in production worker hours for manufacturing as a whole, as well as for the subcategories of Durables and Non-Durables. The result is robust across industries, with twelve industries displaying an elasticity significantly above one. Even in those industries where labor productivity is not procyclical, the elasticity of output with respect to labor input generally exceeds labor's share in output (Hubbard (1986)), in contradiction to the implications of constant returns combined with perfect competition.[9] In all

[7] For evidence on procyclical labor productivity over the business cycle, see, for example, Fair (1969), Sims (1974a), Fay and Medoff (1985), Prescott (1986), and Bernanke and Parkinson (1989), as well as the extensive literature review in Fay (1980). For evidence on the absence of production smoothing, see Blanchard (1983), Blinder (1986), West (1986), Miron and Zeldes (1988), and Eichenbaum (1989). Fair (1989) suggests that much of the evidence against production smoothing results from inappropriate use of data on deflated nominal values. Using physical units data, he finds less evidence against production smoothing. Braun and Krane (1987) make a similar point. Kahn (1990), however, finds significant evidence against production smoothing using the physical units data analyzed by Fair as well as the physical units data from Blanchard (1983).

[8] We have also computed the elasticity of output with respect to labor input using three alternative measures of labor input: total employment times average hours of production workers; production worker employment; and total employment. The results are similar to those reported below, although the elasticities with respect to each of these measures is generally higher than the elasticity with respect to total production worker hours.

[9] The data for IP provide lower estimates of this elasticity. Still, of the thirteen industries for which the data do

but a few cases, the elasticity over the seasonal cycle is greater than the elasticity over the business cycle. Indeed, the estimates in Table 9 do not generally show that labor productivity is procyclical over the business cycle, although they almost always show the elasticity to be in excess of labor's share.[10]

There are several possible explanations for procyclical productivity over the seasonal cycle, just as there are multiple possible explanations over the business cycle. One explanation is variation in the rate of capital utilization. Another possible explanation is labor hoarding, perhaps combined with variation in capacity utilization.[11] A third explanation, emphasized by Ramey (1988), Hall (1988) and Murphy, Shleifer and Vishny (1989), is increasing returns. Finally, as emphasized by Prescott (1986), procyclical productivity can occur in models with constant returns if shifts in the technology raise the marginal product of labor and thereby induce firms to increase labor input and output together, with the increase in marginal productivity implying procyclical productivity.

In light of the discussion above about the causes of the seasonal movements in production and labor input, we find it difficult to account for procyclical productivity purely as the result of Prescott style technology shocks, assuming constant returns. Some part of the procyclicality must result from variation in capital utilization, since it is implausible that the capital stock changes much over the seasons. Under constant returns, however, this factor cannot explain why some estimated elasticities are well above one. Similarly, it is not possible to rule out increasing returns, but we do not have any specific evidence on the quantitative importance of this effect. We find it most likely that labor hoarding plays a significant role in explaining procyclical productivity over the seasonal cycle, especially because of the behavior of production and labor input in July. Many

not put significant weight on production worker hours, five have estimates above one and another insignificantly different from one. All but Paper have elasticities significantly above labor's share in output.

[10] The explanation for the difference between our results and earlier ones is partially sample period, partially the use of growth rates instead of detrended levels, and partially the use of Y4 instead of IP. If we omit the 1980's from the sample, work with quadratically detrended log levels, or work with IP, we obtain results closer to the result in the literature, although the estimated elasticities are still below one. If we make all three adjustments, we obtain an elasticity above one.

[11] Our definition of labor hoarding includes unmeasured variation in effort in addition to overhead labor.

of the hours paid for by firms in July reflect payments to workers on vacation. This constitutes an extreme example of labor hoarding. Rather than incur hiring, firing and training costs associated with labor turnover, firms find it desirable to pay for labor not actually used during the slowdown period. It is immaterial that this labor is hoarded at the beach rather than at the factory.

4.2 The Co-movement of Production and Sales

We next evaluate the comovement of production and sales over the seasonal cycle and the business cycle. Figure 1 presents estimates of the seasonals in production and shipments for all twenty-three 2-digit industries and aggregates. Each picture plots the seasonals in the log growth rate of shipments and the log growth rate of production.[12] The figures show that the seasonals in production and shipments are strongly similar in almost every 2-digit industry, consistent with the results in Miron and Zeldes (1988).[13] To quantify the comovement of production and sales over the seasonal cycle and the business cycle, we present estimates in Table 10 of the empirical elasticity of output with respect to shipments. The results demonstrate a high coherence of the two series over both the seasonal cycle and the business cycle, with the absence of producting smoothing even more marked over the seasonal cycle.[14] The estimated elasticities of output with respect to shipments are almost equal to one in a number of industries and insignificantly different from one in many others.

The coincidence of production and sales over the seasons provides striking evidence against the standard production smoothing model of inventory accumulation. The results are also difficult

[12] For consistency with the rest of the paper, we present graphs of log growth rates rather than of detrended log levels as in Miron and Zeldes (1988). We have examined similar graphs for the log levels of output and shipments; they also show a strong similarity of the seasonals in production and shipments.

[13] We have also computed analogous graphs using IP data. These graphs show strong similarities in the timing of the seasonals in production and shipments, but in many cases the amplitude of the seasonal in production is damped relative to that in shipments. As a rule, however, this dampening occurs in exactly those industries for which IP data are estimated on the basis of labor input. Since it is express Federal Reserve Board policy to assume there are no seasonals in the relation between labor input and output, these data do not suggest any qualification to the conclusions offered above. Kayshap and Wilcox (1989), Krane (1990) and Kahn (1990) show that the seasonals in production and shipments are similar in many cases using physical units data.

[14] We also find, consistent with Blinder's results for the business cycle, that over the seasonal cycle inventory investment is generally procyclical.

to reconcile with cost smoothing models such as Eichenbaum (1989). As Miron and Zeldes (1988) emphasize, even if seasonality in costs makes it optimal to produce seasonally, it does not follow that the timing of the seasonal in production need match the timing of the seasonal in sales. In addition, as emphasized above, the seasonals in production, especially the July decrease, are not easily explained as the result of shifts in technology or costs. This point is re-inforced by the marked absence of any seasonality in price variables.

5. The Seasonal Cycle and the Business Cycle

The results presented above show that seasonal fluctuations are a dominant source of variation in manufacturing activity, with both seasonal and cyclical fluctuations displaying the well known stylized facts of output comovement across sectors, procyclical labor productivity, a strong absence of production smoothing, and significantly greater volatility of quantities than prices. We have argued that the observed seasonal patterns are not easily explained by technology or preference shifts alone because the summer slowdown is too dramatic to be plausibly attributed to exogenous factors like the weather. We find instead that synergies across workers, firms, or industries are likely to be important in determining the magnitude of the seasonal fluctuations. Based on this interpretation, we conclude that the seasonal cycle presents important evidence of labor hoarding as well as strong evidence against production or cost smoothing models of inventory accumulation. We are able to reach stronger conclusions about the seasonal cycle stylized facts than one ordinarily obtains for the business cycle stylized facts because it is easier to identify the ultimate causes of seasonal cycles than those of business cycles.

The key remaining question is whether, given the similarity of the seasonal cycle and the business cycle with respect to these key stylized facts, we can draw similar conclusions about the mechanisms producing business cycle variation or about the explanation for the stylized facts over the business cycle. For example, if one accepts the view that the seasonal cycle results mainly from synergies rather than, say, technology shocks, does this imply that business cycles are also due to such synergies? The general similarity between the seasonal cycle and the business cycle suggests that the same economic propagation mechanisms may be operative in both cases, even if different exogenous forces are ultimately responsible for the fluctuations. It is nevertheless possible the similarity is mere coincidence.

In Beaulieu, Mackie-Mason, and Miron (1990) we provide evidence that the same propagation mechanisms are indeed operative with respect to seasonal and business cycle fluctuations. This evidence consists of a strong correlation across industries between the amount of seasonal variation and the amount of business cycle variation in the 2-digit manufacturing data examined above.[15] This additional fact is difficult to reconcile with the "coincidence" hypothesis. If, for example, the seasonal variation in manufacturing were due to synergies while the business cycle variation were due to technology shocks, the cross-sectional correlation documented by Beaulieu, Mackie-Mason and Miron would be unlikely to occur unless the industries with large technology shocks over the business cycle also tended to be ones with important synergies over the seasonal cycle. There is no obvious reason for this condition to hold. If, instead, however, the desire to operate at the same time as an upstream or downstream industry is an important consideration in determing the timing of an industry's production, this desire is likely to influence the magnitude of both seasonal and business cycle fluctuations.

To the extent that one accepts that the same propagation mechanism is operative over the two kinds of cycles, it then follows that the correct explanation for the business cycle stylized facts is the same as the explanation for these facts over the seasonal cycle. In order to make this conclusion compelling, it is necessary to provide explicit models that incorporate both seasonal and cyclical variation and conduct more detailed tests of these models. The evidence provided above is meant to spur such future research.

[15] A similar result holds across countries.

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Table 1: Seasonal Patterns, Y4

	Summary Statistics			Seasonal Coefficients											
	Std. Dev., Seasonal	Std. Dev., Non-Seasonal	R^2	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Food	3.914	2.492	.712	-2.14	3.97	2.00	-2.40	1.01	3.08	-5.55	7.08	3.71	-1.33	-4.91	-4.53
Tobacco	9.456	13.472	.330	2.27	5.17	5.08	-5.53	2.48	9.39	-17.08	14.57	9.49	-2.47	-11.21	-12.15
Textiles	10.254	3.881	.875	-0.10	9.69	4.47	-6.81	1.11	3.96	-23.22	20.89	2.74	-0.04	-5.01	-7.68
Apparel	10.478	6.007	.753	13.66	11.39	1.50	-5.62	-1.52	4.10	-9.81	15.84	-2.85	-0.15	-2.53	-24.02
Lumber	6.487	5.625	.571	1.33	11.54	3.27	2.36	-2.69	5.33	-9.83	8.69	-0.77	-3.88	-9.90	-5.45
Furniture	8.906	5.070	.755	5.57	7.62	-0.71	-2.17	-0.98	-0.28	-16.62	21.44	-0.88	1.41	-7.36	-7.03
Paper	5.041	2.628	.786	5.98	4.22	1.06	-1.27	-1.85	3.03	-10.88	7.75	-0.46	1.97	-3.30	-6.26
Printing	3.486	3.960	.437	-2.56	5.24	-0.18	1.50	-2.06	0.56	-4.58	5.06	3.32	1.38	-1.13	-6.55
Chemicals	4.636	3.054	.697	1.58	7.44	0.89	0.29	-3.36	0.53	-10.85	5.50	4.58	-2.64	-2.87	-1.09
Petroleum	1.583	3.268	.190	-2.50	1.02	-0.66	1.86	1.67	2.00	-0.96	0.17	0.83	-2.31	0.92	-2.05
Rubber	6.906	4.470	.705	4.61	8.99	-0.97	-0.49	-4.50	3.98	-14.41	9.54	4.11	3.30	-7.20	-6.97
Leather	7.084	8.644	.402	5.45	4.55	1.51	-6.55	4.06	-3.69	-11.38	15.86	-2.32	4.00	-5.18	-6.31
Stone,Clay,Glass	5.416	3.564	.698	0.44	7.43	3.14	2.83	-0.68	3.12	-9.70	6.39	1.47	1.06	-5.89	-9.61
Primary Metal	5.424	4.480	.594	7.68	5.38	3.42	-0.72	-1.37	-0.27	-13.56	2.75	4.14	1.17	-3.49	-5.14
Fab Metal	7.394	5.262	.664	-0.05	10.95	1.89	-2.09	-0.68	2.75	-17.23	11.91	2.42	1.62	-6.13	-5.34
Machinery	8.473	4.095	.811	-6.86	11.94	4.11	-7.35	-1.44	4.85	-19.67	5.74	11.24	-4.19	-0.87	2.50
Elec Machinery	8.313	4.118	.803	-3.54	10.43	2.81	-5.73	0.25	3.99	-20.08	12.24	7.31	0.72	-4.12	-4.29
Trans Equip	9.000	6.443	.661	5.13	8.96	2.49	-3.89	0.78	0.76	-19.96	0.58	15.79	5.47	-4.74	-11.37
Instruments	7.486	6.526	.568	-1.07	7.10	3.76	-4.93	-0.39	5.60	-18.95	9.59	7.85	-1.38	-2.75	-4.43
Other	8.413	6.407	.633	-0.34	8.69	3.92	-3.34	1.01	4.47	-16.45	15.34	16.76	-2.46	-7.84	-9.75
Non-Durables	4.216	1.502	.887	0.49	5.43	1.35	-1.39	-0.50	2.36	-8.30	7.35	2.72	-0.77	-3.31	-5.42
Durables	6.901	2.764	.862	0.52	9.25	2.93	-3.50	-0.43	2.62	-17.21	6.79	7.84	0.82	-4.26	-5.37
Total	5.539	1.797	.905	0.38	7.44	2.20	-2.49	-0.45	2.55	-13.00	7.05	5.40	0.05	-3.80	-5.34

Notes:
1. The sample period is 1967:5-1987:12.
2. Data are in log growth rates.

Table 2: Seasonal Patterns, Shipments

	Summary Statistics			*Seasonal Coefficients*											
	Std. Dev., Seasonal	Std. Dev., Non-Seasonal	R^2	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Food	4.14	2.30	.764	-4.93	5.81	2.19	-4.28	1.23	3.73	-7.13	3.83	5.56	-1.86	-2.47	-1.69
Tobacco	10.70	15.68	.318	-24.24	9.07	9.19	-7.41	6.92	7.64	-15.86	9.04	3.05	-7.88	2.94	7.52
Textiles	10.24	2.96	.923	-5.49	10.45	7.29	-7.18	0.52	7.07	-22.56	18.44	4.86	-0.90	-6.07	-6.42
Apparel	11.94	4.37	.882	6.24	19.88	0.73	-10.56	-4.85	10.93	-3.60	15.30	-2.20	-0.28	-4.35	-27.24
Lumber	6.40	4.39	.680	-0.73	10.83	6.03	3.62	-0.05	4.44	-7.93	6.20	-0.97	-1.78	-11.34	-8.31
Furniture	9.04	3.60	.864	-1.46	11.86	0.49	-3.60	-0.73	2.93	-16.83	20.61	0.94	-0.43	-6.80	-6.98
Paper	4.62	2.21	.814	2.51	5.83	1.24	-2.59	-0.63	4.46	-10.11	7.18	0.75	-1.01	-3.43	-4.20
Printing	4.44	2.70	.730	-8.28	6.42	0.18	1.19	-1.58	0.90	-5.25	5.85	5.65	1.22	-1.25	-5.05
Chemicals	5.32	3.14	.742	2.37	6.78	4.45	-1.04	-2.10	0.48	-11.98	6.26	5.38	-5.47	-4.14	-0.98
Petroleum	1.66	2.78	.263	-3.03	0.79	-1.27	1.07	0.93	3.05	-2.43	1.27	0.04	-1.53	0.48	0.63
Rubber	6.49	3.25	.800	2.59	9.30	1.81	-0.02	-1.95	4.33	-13.52	7.73	3.08	2.39	-7.76	-7.97
Leather	8.64	5.56	.707	14.07	7.50	-4.95	-8.68	-2.06	6.01	-0.83	14.31	-5.10	2.43	-9.71	-12.98
Stone,Clay,Glass	6.73	3.18	.818	-1.72	7.30	7.57	2.61	1.08	5.02	-10.43	8.07	1.18	-0.04	-9.08	-11.56
Primary Metal	5.75	4.96	.574	4.86	7.13	4.04	-1.72	0.40	2.20	-15.01	3.24	4.31	-0.48	-4.42	-4.55
Fab Metal	6.22	3.05	.807	-2.43	9.51	3.77	-1.85	0.35	4.17	-13.50	8.40	3.58	-0.73	-6.08	-5.18
Machinery	9.86	3.81	.870	-13.11	12.41	7.70	-8.07	-1.07	8.85	-20.02	2.80	11.89	-5.00	-3.33	6.94
Elec Machinery	8.06	2.75	.895	-9.86	10.38	3.11	-6.08	-0.51	8.55	-16.99	8.34	8.95	-2.65	-1.83	-1.40
Trans Equip	10.58	16.14	.748	-4.24	11.53	4.02	-3.73	1.34	3.49	-26.77	0.84	18.91	3.53	-3.23	-5.70
Instruments	7.60	2.60	.895	-11.71	7.96	5.75	-6.27	1.64	7.61	-14.64	7.36	8.45	-4.09	-1.52	-0.53
Other	11.01	15.58	.796	-7.60	14.10	7.76	-5.44	-0.98	9.99	-19.39	16.73	8.40	-0.73	-9.68	-13.17
Non-Durables	4.35	1.53	.890	-2.08	6.58	2.18	-2.76	-0.40	3.64	-8.54	6.41	3.46	-1.68	-2.98	-3.84
Durables	7.54	2.65	.890	-5.36	10.31	4.89	-3.86	0.29	5.51	-18.19	5.42	9.14	-0.87	-4.37	-2.89
Total	5.93	1.86	.911	-3.79	8.50	3.60	-3.34	-0.02	4.63	-13.60	5.90	6.40	-1.24	-3.70	-3.34

Notes:
1. The sample period is 1967:5-1987:12.
2. Data are in log growth rates.

Table 3: Seasonal Patterns, Total Production Worker Hours

	Summary Statistics			*Seasonal Coefficients*											
	Std. Dev., Seasonal	Std. Dev., Non-Seasonal	R^2	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Food	3.657	1.127	.913	-5.54	-1.54	0.33	-0.81	2.68	4.38	3.16	6.86	0.81	-5.25	-3.05	-2.03
Tobacco	7.716	4.514	.745	-8.21	-4.66	-4.37	-4.28	1.00	3.64	-5.58	20.98	7.78	0.22	-5.78	-0.74
Textiles	2.343	2.440	.480	-4.45	1.62	0.85	-0.96	1.43	1.94	-4.62	3.77	0.20	-0.21	0.50	-0.08
Apparel	3.087	2.186	.666	-4.81	3.58	1.54	-1.81	1.59	1.95	-5.91	5.24	-0.23	0.74	-0.11	-1.78
Lumber	2.687	2.081	.625	-5.37	2.14	1.64	1.18	2.85	4.41	-2.02	1.92	-1.02	-1.49	-3.04	-1.20
Furniture	2.822	2.150	.633	-6.22	0.72	1.10	-1.19	0.17	2.23	-4.45	5.06	0.94	0.90	-0.48	1.23
Paper	1.429	1.040	.654	-3.14	-0.80	0.71	-0.39	0.75	2.55	-1.70	1.06	0.59	-0.98	0.43	0.92
Printing	1.408	0.724	.791	-4.08	0.35	1.25	-0.76	0.02	0.19	-0.63	1.06	0.58	-0.37	0.77	1.63
Chemicals	0.847	0.754	.558	-1.88	0.28	0.76	0.25	-0.32	1.17	-1.15	0.21	0.64	-0.86	0.52	0.37
Petroleum	2.650	5.165	.208	-6.17	-0.92	2.39	3.70	2.61	2.56	1.59	1.18	0.28	-1.19	-0.91	-2.75
Rubber	1.926	2.519	.369	-2.74	-0.28	0.55	-0.55	-1.05	2.23	-3.74	3.29	2.19	-0.08	-0.17	0.35
Leather	3.343	2.259	.687	-3.85	0.36	0.46	0.01	3.44	3.40	-7.51	5.33	-2.51	0.35	1.29	-0.77
Stone,Clay,Glass	2.624	1.667	.713	-6.34	-0.14	2.99	3.23	2.31	2.64	-1.18	1.34	-0.25	-0.68	-1.47	-2.44
Primary Metal	1.410	2.006	.330	-0.69	0.14	0.98	0.56	-0.29	1.09	-2.86	0.81	2.08	-2.25	0.79	1.26
Fab Metal	2.074	1.506	.655	-4.18	-0.19	1.07	-1.06	1.38	1.75	-4.06	2.30	1.89	-0.37	0.39	1.09
Machinery	1.707	1.519	.558	-2.72	0.65	0.68	-1.70	0.25	0.83	-3.13	0.05	2.37	-0.79	1.18	2.33
Elec Machinery	1.653	1.620	.510	-3.40	-0.06	0.58	-1.31	0.78	1.22	-2.95	1.77	2.07	0.13	0.22	0.94
Trans Equip	3.709	3.723	.498	-5.91	-1.14	2.42	-1.52	2.40	0.62	-5.61	2.53	7.73	-0.93	2.67	3.80
Instruments	1.444	1.172	.603	-3.04	0.15	0.67	-1.22	0.74	1.28	-2.61	1.36	0.91	-0.25	1.20	0.82
Other	3.487	1.587	.828	-6.34	1.77	2.45	-0.41	1.43	1.94	-5.02	6.11	1.92	1.47	-0.70	-4.61
Non-Durables	1.948	1.113	.754	-4.10	0.43	0.82	-0.73	1.14	2.31	-1.99	3.79	0.50	-1.28	-0.43	-0.46
Durables	1.893	1.463	.626	-4.03	0.16	1.28	-0.64	1.13	1.52	-3.52	0.90	2.49	-0.62	0.20	1.13
Total	1.820	1.215	.692	-4.10	0.24	1.14	-0.70	1.15	1.87	-2.90	2.08	1.67	-0.84	-0.09	0.47

Notes:
1. The sample period is 1967:5-1987:12.
2. Data are in log growth rates.

Table 4: Seasonal Patterns, Average Weekly Hours of Production Workers

	Summary Statistics			*Seasonal Coefficients*											
	Std. Dev., Seasonal	Std. Dev., Non-Seasonal	R^2	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Food	0.89	0.65	.656	-1.93	-0.67	0.27	-0.43	1.36	0.52	0.34	0.79	0.29	-1.35	0.18	0.63
Tobacco	2.43	3.03	.392	-3.37	-0.47	0.76	-0.42	2.08	2.28	-5.51	3.31	2.30	0.65	-0.78	-0.83
Textiles	1.44	2.05	.331	-3.44	1.53	0.76	-1.32	1.33	1.03	-1.94	1.37	0.02	0.03	0.43	0.21
Apparel	1.38	1.80	.370	-3.39	2.02	1.09	-1.53	1.19	0.80	-0.64	0.73	-0.87	0.56	0.24	-0.19
Lumber	1.31	1.35	.485	-3.03	1.65	0.85	0.21	1.00	0.99	-1.77	1.06	-0.17	-0.10	-1.20	0.49
Furniture	1.89	1.61	.581	-5.15	1.13	1.20	-1.10	0.65	1.42	-1.79	2.10	0.04	0.51	-0.55	1.55
Paper	0.81	0.69	.578	-2.08	-0.54	0.54	-0.45	0.53	0.68	-0.43	0.26	0.69	-0.47	0.20	1.07
Printing	1.00	0.54	.779	-2.82	0.19	1.03	-0.84	0.33	0.10	0.06	0.75	0.33	-0.62	0.36	1.12
Chemicals	0.60	0.44	.648	-1.37	0.05	0.29	0.16	-0.26	0.27	-0.63	-0.05	0.94	-0.54	0.64	0.50
Petroleum	0.94	1.61	.253	-1.84	-0.06	0.77	1.11	0.06	0.22	0.97	-1.14	1.42	-0.57	-0.07	-0.85
Rubber	0.88	1.07	.403	-1.88	-0.25	0.51	-0.77	0.51	0.68	-1.36	1.05	0.57	-0.07	0.10	0.91
Leather	1.19	1.43	.410	-2.46	-0.02	0.29	-0.39	2.20	1.48	-1.17	-0.52	-1.08	0.37	0.64	0.66
Stone,Clay,Glass	1.09	0.88	.602	-3.05	0.65	1.44	0.59	0.83	0.58	-0.74	0.57	-0.01	0.03	-0.65	-0.23
Primary Metal	0.76	0.87	.431	-0.96	0.10	0.32	0.01	-0.35	0.55	-0.93	-0.56	1.31	-1.08	0.62	0.97
Fab Metal	1.25	1.01	.605	-2.92	-0.02	0.91	-1.23	1.28	0.65	-1.73	0.88	0.50	0.05	0.25	1.37
Machinery	1.22	0.94	.627	-2.70	0.29	0.54	-1.51	0.62	0.41	-1.50	0.45	0.99	-0.12	0.65	1.89
Elec Machinery	1.14	0.91	.609	-2.63	0.03	0.64	-1.23	0.84	0.67	-1.63	0.96	0.57	-0.03	0.66	1.14
Trans Equip	1.79	1.85	.484	-4.19	-0.07	1.06	-1.46	1.93	0.34	-1.51	-1.24	1.98	0.57	0.14	2.46
Instruments	0.98	0.83	.583	-2.37	0.20	0.64	-1.10	0.60	0.39	-1.24	0.59	0.80	-0.15	0.87	0.77
Other	1.06	1.06	.499	-2.57	0.45	1.10	-1.06	0.56	0.42	-1.40	1.18	0.49	0.50	0.32	0.02
Non-Durables	0.87	0.84	.519	-2.42	0.31	0.62	-0.71	0.85	0.66	-0.53	0.66	0.15	-0.39	0.29	0.52
Durables	1.15	0.92	.610	-2.89	0.29	0.77	-0.91	0.87	0.59	-1.50	0.40	0.83	-0.04	0.25	1.34
Total	1.03	0.84	.599	-2.73	0.27	0.76	-0.85	0.88	0.63	-1.11	0.47	0.56	-0.13	0.24	1.01

Notes:
1. The sample period is 1967:5-1987:12.
2. Data are in log growth rates.

Table 5: Seasonal Patterns, Total Employment

	Summary Statistics			Seasonal Coefficients											
	Std. Dev., Seasonal	Std. Dev., Non-Seasonal	R^2	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Food	2.20	0.59	.932	-2.66	-0.64	0.07	-0.19	1.04	2.99	2.11	4.22	0.18	-2.86	-2.36	-1.88
Tobacco	5.14	2.87	.763	-4.08	-3.36	-4.33	-3.18	-0.89	1.21	0.09	14.68	4.52	-0.38	-4.28	-0.00
Textiles	1.02	0.80	.620	-0.91	0.11	0.07	0.32	0.09	0.84	-2.42	2.17	0.13	-0.19	0.08	-0.29
Apparel	2.00	0.83	.853	-1.32	1.40	0.41	-0.24	0.36	1.08	-4.77	4.07	0.53	0.22	-0.32	-1.43
Lumber	1.47	1.13	.632	-2.17	0.40	0.76	0.87	1.64	3.07	-0.19	0.75	-0.81	-1.18	-1.63	-1.51
Furniture	1.11	0.96	.569	-0.96	-0.35	-0.10	-0.04	-0.39	0.74	-2.32	2.59	0.68	0.37	0.03	-0.28
Paper	0.63	0.55	.568	-0.86	-0.24	0.14	0.04	0.15	1.56	-0.94	0.65	-0.21	-0.35	0.18	-0.11
Printing	0.33	0.29	.549	-0.83	0.06	0.09	-0.06	-0.18	0.34	-0.37	0.10	-0.05	0.27	0.33	0.30
Chemicals	0.35	0.37	.466	-0.46	0.10	0.31	0.05	0.01	0.88	-0.05	0.09	-0.49	-0.24	-0.08	-0.12
Petroleum	1.44	3.85	.123	-3.30	-0.33	1.04	1.54	1.95	1.86	0.59	-0.12	-1.07	-0.54	-0.45	-1.18
Rubber	1.02	1.61	.287	-0.72	-0.06	0.03	0.20	-1.22	1.34	-1.87	1.78	1.24	-0.05	-0.21	-0.45
Leather	2.46	1.34	.772	-1.41	0.34	0.10	0.39	1.04	1.75	-5.82	5.32	-1.18	0.01	0.59	-1.12
Stone,Clay,Glass	1.39	0.98	.666	-2.67	-0.64	1.27	2.15	1.25	1.78	-0.30	0.61	-0.29	-0.62	-0.72	-1.82
Primary Metal	0.60	1.18	.207	0.21	0.04	0.51	0.45	0.10	0.59	-1.47	-0.22	0.42	-0.99	0.13	0.23
Fab Metal	0.79	0.85	.466	-1.03	-0.15	0.14	0.10	0.08	0.94	-1.76	1.08	1.00	-0.32	0.13	-0.21
Machinery	0.45	0.83	.226	-0.03	0.25	0.13	-0.20	-0.22	0.48	-0.98	-0.28	0.68	-0.49	0.33	0.34
Elec Machinery	0.45	0.91	.199	-0.60	-0.11	-0.06	-0.08	-0.01	0.59	-0.77	0.49	0.86	0.11	-0.29	-0.14
Trans Equip	1.49	2.14	.326	-1.18	-0.80	0.91	-0.03	0.29	0.34	-2.58	-0.76	3.76	-1.06	0.27	0.84
Instruments	0.37	0.55	.313	-0.45	-0.09	0.00	-0.06	0.06	0.85	-0.67	0.44	-0.18	-0.06	0.18	-0.03
Other	2.15	0.87	.860	-3.07	0.96	1.10	0.42	0.70	1.27	-3.08	4.03	1.13	0.85	-0.78	-3.54
Non-Durables	0.99	0.46	.824	-1.34	0.07	0.15	-0.01	0.25	1.42	-1.03	2.31	0.12	-0.66	-0.54	-0.74
Durables	0.65	0.79	.404	-0.87	-0.12	0.38	0.18	0.21	0.84	-1.38	0.37	1.06	-0.44	-0.07	-0.16
Total	0.73	0.60	.595	-1.06	-0.04	0.29	0.10	0.22	1.08	-1.24	1.17	0.67	-0.53	-0.26	-0.40

Notes:

1. The sample period is 1967:5-1987:12.
2. Data are in log growth rates.

Table 6: Seasonal Patterns, Production Employment

	Summary Statistics			*Seasonal Coefficients*											
	Std. Dev., Seasonal	Std. Dev., Non-Seasonal	R^2	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Food	3.03	0.85	.927	-3.61	-0.88	0.07	-0.38	1.32	3.86	2.82	6.07	0.52	-3.90	-3.23	-2.66
Tobacco	6.17	3.37	.771	-4.84	-4.19	-5.13	-3.86	-1.08	1.37	-0.07	17.67	5.48	-0.43	-5.00	0.08
Textiles	1.13	0.89	.619	-1.00	0.10	0.09	0.36	0.10	0.92	-2.68	2.40	0.18	-0.23	0.07	-0.29
Apparel	2.21	0.91	.854	-1.41	1.56	0.45	-0.28	0.40	1.15	-5.27	4.52	0.63	0.18	-0.35	-1.59
Lumber	1.64	1.27	.627	-2.34	0.49	0.79	0.97	1.85	3.42	-0.25	0.86	-0.85	-1.39	-1.84	-1.69
Furniture	1.27	1.11	.570	-1.08	-0.41	-0.11	-0.09	-0.48	0.81	-2.66	2.96	0.90	0.39	0.07	-0.32
Paper	0.79	0.69	.565	-1.06	-0.26	0.17	0.05	0.21	1.87	-1.26	0.80	-0.10	-0.51	0.23	-0.15
Printing	0.49	0.43	.567	-1.27	0.15	0.22	0.08	-0.31	0.10	-0.69	0.30	0.25	0.25	0.41	0.51
Chemicals	0.40	0.54	.357	-0.50	0.23	0.47	0.09	-0.07	0.91	-0.52	0.27	-0.30	-0.32	-0.12	-0.14
Petroleum	1.97	5.08	.131	-4.33	-0.86	1.62	2.59	2.55	2.34	0.63	-0.03	-1.14	-0.63	-0.83	-1.90
Rubber	1.28	2.03	.284	-0.86	-0.03	0.04	0.22	-1.57	1.54	-2.38	2.24	1.62	-0.01	-0.27	-0.55
Leather	2.71	1.49	.769	-1.39	0.38	0.16	0.40	1.25	1.92	-6.34	5.85	-1.44	-0.02	0.65	-1.43
Stone,Clay,Glass	1.68	1.24	.647	-3.30	-0.79	1.55	2.65	1.48	2.07	-0.44	0.77	-0.24	-0.71	-0.82	-2.21
Primary Metal	0.77	1.43	.224	0.27	0.04	0.66	0.55	0.06	0.54	-1.93	-0.25	0.76	-1.17	0.18	0.29
Fab Metal	1.03	1.05	.492	-1.26	-0.17	0.16	0.17	0.10	1.11	-2.33	1.42	1.38	-0.42	0.14	-0.28
Machinery	0.72	1.09	.304	-0.02	0.36	0.14	-0.20	-0.37	0.42	-1.62	-0.40	1.39	-0.68	0.53	0.44
Elec Machinery	0.70	1.25	.238	-0.78	-0.09	-0.06	-0.08	-0.06	0.55	-1.32	0.81	1.49	0.16	-0.43	-0.20
Trans Equip	2.29	3.20	.339	-1.72	-1.07	1.36	-0.07	0.47	0.28	-4.10	-1.28	5.76	-1.50	0.53	1.34
Instruments	0.57	0.76	.362	-0.68	-0.05	0.03	-0.12	0.15	0.89	-1.37	0.76	0.11	-0.10	0.33	0.05
Other	2.66	1.06	.863	-3.77	1.33	1.34	0.64	0.87	1.52	-3.62	4.93	1.44	0.97	-1.02	-4.63
Non-Durables	1.30	0.58	.833	-1.68	0.11	0.20	-0.02	0.30	1.65	-1.46	3.14	0.35	-0.89	-0.73	-0.98
Durables	0.92	1.04	.440	-1.13	-0.13	0.51	0.27	0.27	0.93	-2.02	0.50	1.66	-0.59	-0.06	-0.22
Total	0.99	0.77	.620	-1.36	-0.03	0.38	0.15	0.28	1.23	-1.79	1.61	1.11	-0.71	-0.34	-0.54

Notes:
1. The sample period is 1967:5-1987:12.
2. Data are in log growth rates.

Table 7: Seasonal Patterns, Wages

	Summary Statistics			*Seasonal Coefficients*											
	Std. Dev., Seasonal	Std. Dev., Non-Seasonal	R^2	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Food	.480	.441	.542	0.45	-0.30	-0.08	0.24	-0.10	-0.56	-0.22	-0.84	0.32	-0.35	0.84	0.61
Tobacco	2.774	2.162	.622	1.94	1.67	1.42	1.60	0.43	1.48	-1.24	-6.95	-3.15	-1.20	4.05	-0.05
Textiles	.332	.699	.184	0.03	-0.41	-0.25	-0.42	-0.17	-0.07	0.28	0.60	0.61	-0.22	-0.04	0.04
Apparel	.479	.548	.433	0.73	-0.41	0.10	-0.36	-0.48	0.13	-0.68	0.35	0.95	-0.32	-0.18	0.18
Lumber	.550	.672	.401	-0.07	0.01	-0.35	-0.08	0.59	1.29	-0.05	0.14	0.39	-0.86	-0.48	-0.53
Furniture	.336	.487	.323	-0.26	-0.30	0.00	-0.23	0.11	0.32	-0.39	0.52	0.43	-0.41	-0.23	0.43
Paper	.465	.456	.510	-0.39	-0.52	-0.26	0.05	0.02	0.56	0.91	-0.41	0.51	-0.69	0.10	0.11
Printing	.320	.341	.469	-0.32	-0.10	-0.02	-0.34	0.26	-0.12	0.10	0.13	0.77	-0.44	-0.17	0.25
Chemicals	.295	.371	.387	0.00	-0.39	-0.37	0.28	-0.13	0.16	0.43	-0.38	0.49	-0.21	-0.01	0.11
Petroleum	.676	.997	.315	1.49	0.52	-0.18	0.65	-0.82	-0.47	0.03	-0.71	0.64	-0.70	0.07	-0.51
Rubber	.412	.880	.180	-0.08	-0.60	-0.44	-0.21	-0.41	0.14	0.49	-0.17	0.83	-0.27	0.05	0.46
Leather	.428	.523	.401	0.86	0.02	0.09	-0.21	-0.29	-0.25	-0.78	-0.06	0.66	-0.37	0.15	0.17
Stone,Clay,Glass	.324	.438	.353	-0.33	-0.32	0.06	0.68	0.32	0.22	0.08	-0.16	0.32	-0.44	-0.13	-0.31
Primary Metal	.429	.729	.257	-0.12	0.06	-0.44	0.42	-0.22	-0.10	0.14	0.23	0.59	-1.06	0.43	0.07
Fab Metal	.423	.497	.420	-0.44	-0.24	0.11	-0.33	0.41	0.01	-0.52	-0.10	0.71	-0.45	0.07	0.77
Machinery	.382	.448	.421	-0.51	-0.08	-0.02	-0.44	0.13	0.04	-0.30	-0.24	0.76	-0.07	0.01	0.72
Elec Machinery	.360	.433	.409	-0.36	-0.39	-0.06	-0.41	0.04	0.05	0.18	-0.15	0.47	-0.24	-0.00	0.87
Trans Equip	.649	.878	.353	-0.82	-0.64	0.05	-0.58	0.33	0.08	-0.47	-0.51	1.01	0.13	0.00	1.41
Instruments	.342	.436	.381	-0.20	-0.13	-0.21	-0.51	0.12	-0.15	0.12	-0.13	0.38	-0.29	0.15	0.85
Other	.475	.403	.581	0.56	-0.39	-0.26	-0.30	0.09	-0.31	-0.31	-0.58	0.41	-0.24	0.23	1.12
Non-Durables	.410	.392	.523	0.31	-0.54	-0.18	0.10	-0.22	-0.11	0.57	-0.61	0.64	-0.51	0.20	0.33
Durables	.428	.435	.493	-0.33	-0.32	-0.07	-0.27	0.16	0.03	-0.24	-0.40	0.86	-0.42	0.17	0.83
Total	.424	.376	.560	-0.13	-0.44	-0.04	-0.12	-0.01	-0.06	-0.02	-0.56	0.87	-0.45	0.23	0.75

Notes:
1. The sample period is 1967:5-1987:12.
2. Data are in log growth rates.

Table 8: Seasonal Patterns, Prices

	Summary Statistics			*Seasonal Coefficients*											
	Std. Dev., Seasonal	Std. Dev., Non-Seasonal	R^2	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Food	.348	1.589	.046	0.42	0.20	-0.43	-0.19	0.40	0.10	0.41	0.12	-0.55	-0.48	-0.25	0.23
Tobacco	.329	1.763	.034	0.29	0.09	-0.65	-0.26	-0.10	0.40	0.49	-0.51	0.02	-0.07	0.14	0.15
Textiles	.094	.459	.040	0.18	-0.04	-0.06	0.12	0.01	0.12	-0.01	-0.02	-0.09	-0.01	-0.02	-0.17
Apparel	.172	.360	.187	0.41	-0.10	-0.08	0.10	-0.15	0.21	0.03	-0.02	-0.13	0.02	-0.02	-0.27
Lumber	.718	1.775	.141	0.31	1.31	1.23	0.19	-0.39	-0.62	-0.32	0.05	-0.20	-1.33	-0.56	0.34
Furniture	.129	.390	.099	0.37	0.09	-0.14	-0.09	0.01	-0.15	0.02	-0.04	-0.05	0.04	-0.03	-0.04
Paper	.250	.694	.115	0.61	-0.03	0.14	0.33	-0.18	-0.30	-0.04	0.03	-0.16	0.05	-0.23	-0.23
Printing	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chemicals	.223	.937	.053	0.27	0.01	0.41	0.34	0.04	-0.16	-0.11	-0.01	-0.29	-0.04	-0.16	-0.30
Petroleum	.241	2.034	.014	0.09	0.22	-0.16	-0.13	0.32	0.43	0.08	0.03	-0.10	-0.49	-0.18	0.07
Rubber	.142	.644	.047	0.17	0.04	0.02	0.20	-0.06	-0.06	0.19	0.24	-0.07	0.01	-0.13	-0.22
Leather	.372	1.130	.098	0.57	-0.06	0.33	0.78	0.06	-0.62	-0.22	-0.02	-0.09	-0.25	-0.18	-0.29
Stone,Clay,Glass	.378	.602	.282	1.06	0.16	-0.04	0.47	-0.16	-0.22	-0.06	-0.24	-0.26	-0.15	-0.29	-0.26
Primary Metal	.248	1.032	.055	0.40	0.35	0.18	-0.02	-0.25	-0.13	0.17	0.01	-0.03	0.09	-0.41	-0.37
Fab Metal	.219	.824	.066	0.39	0.29	0.17	0.14	-0.16	-0.23	-0.03	0.10	-0.04	-0.01	-0.36	-0.27
Machinery	.096	.443	.045	0.26	-0.01	-0.04	0.06	-0.02	-0.12	0.06	-0.09	-0.06	0.04	-0.01	-0.07
Elec Machinery	.102	.444	.050	0.26	0.09	0.00	-0.08	-0.09	-0.00	0.09	-0.14	-0.01	-0.03	-0.01	-0.08
Trans Equip	.992	.795	.609	0.05	-0.39	-0.31	0.04	-0.22	-0.25	-0.17	-0.27	-1.32	3.07	-0.23	-0.01
Instruments	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Non-Durables	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Durables	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes:

1. The sample period is 1967:5-1987:12, except for Transportation Equipment which is 1969:2-1987:12.
2. Data are in log growth rates.

Table 9: Elasticity of Output (Y4) with Respect to Labor Input				
	Seasonal		*Non-Seasonal*	
	Coefficient	*St. Dev.*	*Coefficient*	*St. Dev.*
Food	0.568	.065	0.369	.112
Tobacco	0.779	.166	0.468	.170
Textiles	3.394	.333	0.211	.066
Apparel	1.591	.193	0.499	.191
Lumber	1.413	.151	0.487	.234
Furniture	1.610	.230	0.527	.163
Paper	0.154	.191	0.521	.183
Printing	0.367	.260	-0.188	.436
Chemicals	2.204	.367	1.263	.205
Petroleum	0.416	.138	0.026	.033
Rubber	2.102	.230	0.358	.094
Leather	1.210	.277	0.160	.278
Stone,Clay,Glass	0.886	.094	0.526	.085
Primary Metal	1.366	.212	1.400	.168
Fab Metal	1.961	.275	0.549	.161
Machinery	4.084	.361	0.595	.206
Elec Machinery	3.600	.039	0.372	.141
Trans Equip	0.967	.012	0.819	.102
Instruments	3.347	.382	0.970	.309
Other	1.911	.193	0.092	.215
Non-Durables	1.297	.091	0.461	.104
Durables	2.077	.157	0.898	.085
Total	1.736	.125	0.689	.088

Notes:

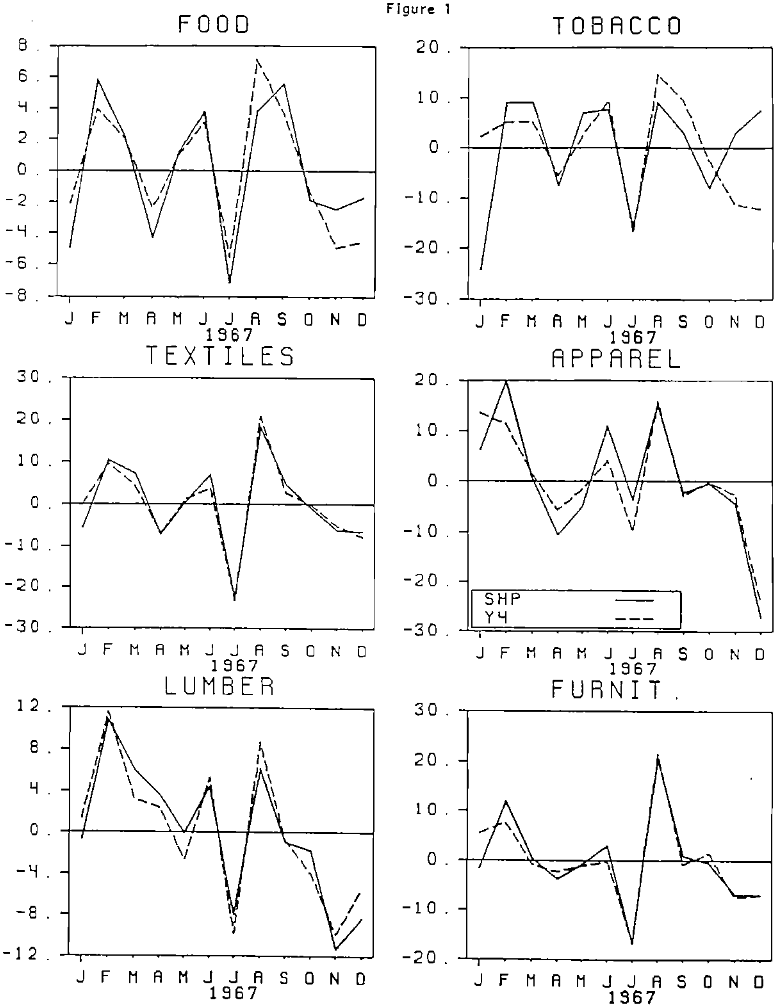
1. The sample period is 1967:5-1987:12.
2. The data are in log growth rates.
3. Seasonal coefficients are from an IV regression of output on total production worker hours using seasonal dummies as the only instuments. Standard errors are corrected.
4. Non–seasonal coefficients are from a regression of output on labor hours and seasonal dummies. Standard errors are corrected.

Table 10: Elasticity of Output (Y4) with Respect to Shipments				
	Seasonal		*Non-Seasonal*	
	Coefficient	*St. Dev.*	*Coefficient*	*St. Dev.*
Food	0.834	.030	0.819	.052
Tobacco	0.365	.064	0.550	.075
Textiles	0.976	.025	0.880	.083
Apparel	0.809	.025	0.918	.066
Lumber	0.966	.040	0.957	.076
Furniture	0.940	.035	0.922	.037
Paper	1.026	.030	0.976	.058
Printing	0.719	.060	0.815	.097
Chemicals	0.836	.279	0.619	.056
Petroleum	0.723	.075	0.806	.090
Rubber	1.040	.043	0.898	.072
Leather	0.584	.063	0.673	.116
Stone,Clay,Glass	0.778	.026	0.694	.082
Primary Metal	0.909	.035	0.719	.029
Fab Metal	1.154	.083	0.947	.109
Machinery	0.825	.031	0.717	.054
Elec Machinery	0.959	.031	1.048	.107
Trans Equip	0.788	.026	0.833	.030
Instruments	0.860	.077	1.033	.235
Other	0.735	.032	0.738	.067
Non-Durables	0.932	.016	0.727	.063
Durables	0.874	.016	0.867	.024
Total	0.896	.013	0.814	.037

Notes:

1. The sample period is 1967:5-1987:12.
2. The data are in log growth rates.
3. Seasonal coefficients are from an IV regression of output on total production worker hours using seasonal dummies as the only instuments. Standard errors are corrected.
4. Non-seasonal coefficients are from a regression of output on labor hours and seasonal dummies. Standard errors are corrected.

Figure 1


FOOD
TOBACCO
TEXTILES
APPAREL
LUMBER
FURNIT.
SHP
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J F M A M J J A S O N D
1967

Figure 1, continued

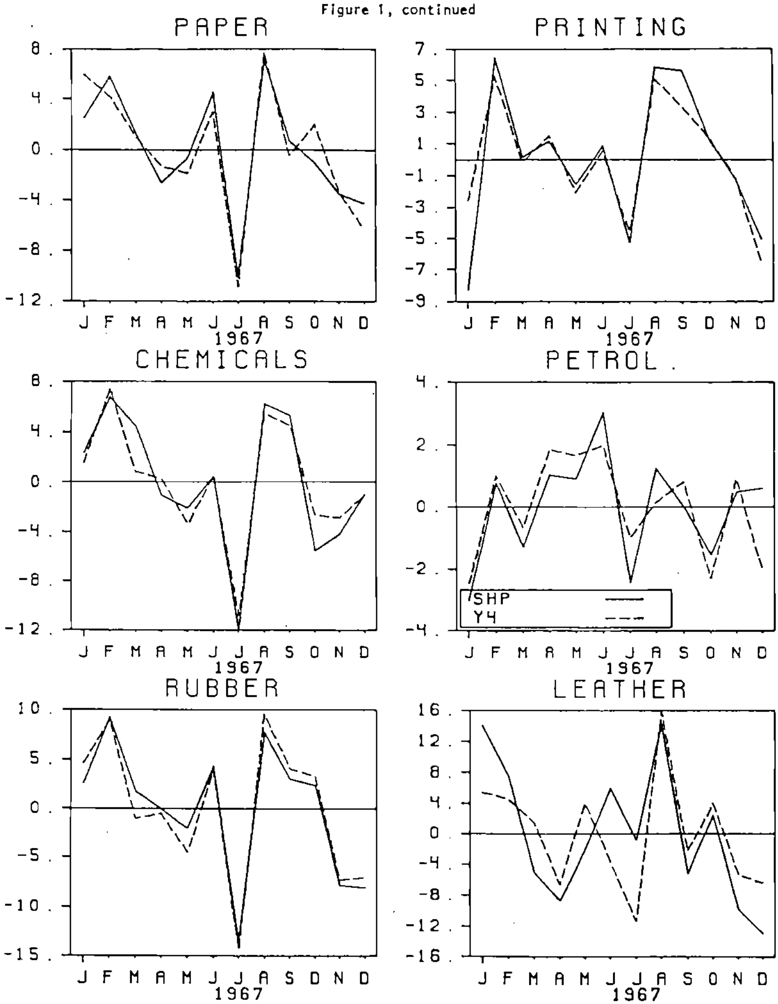


Figure 1, continued

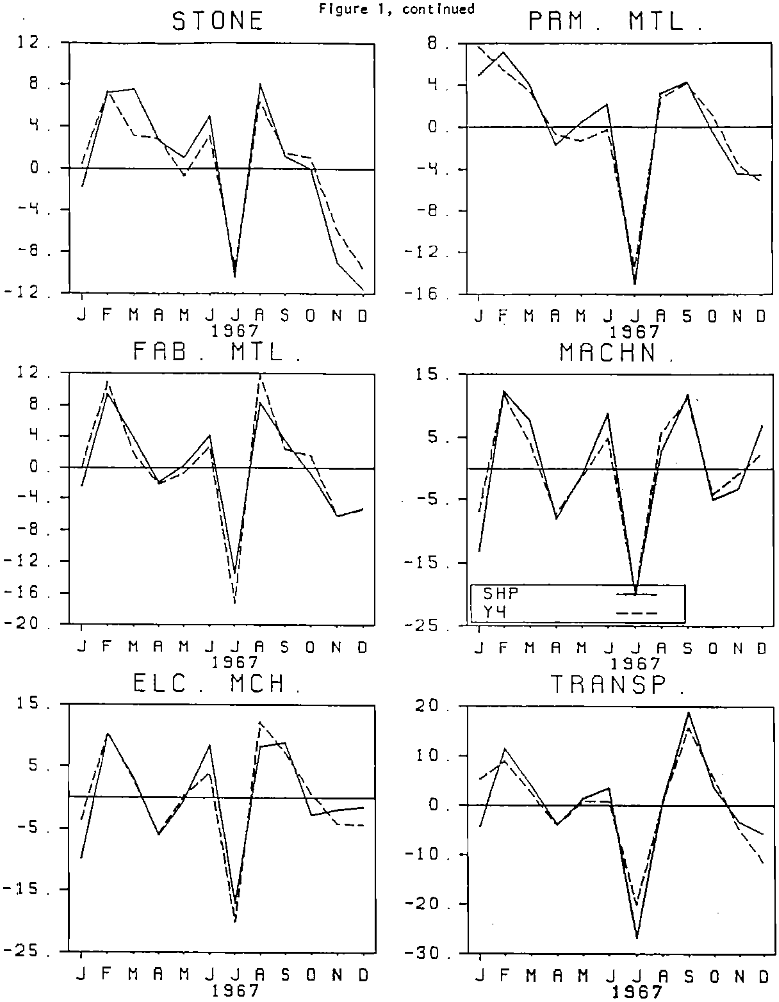
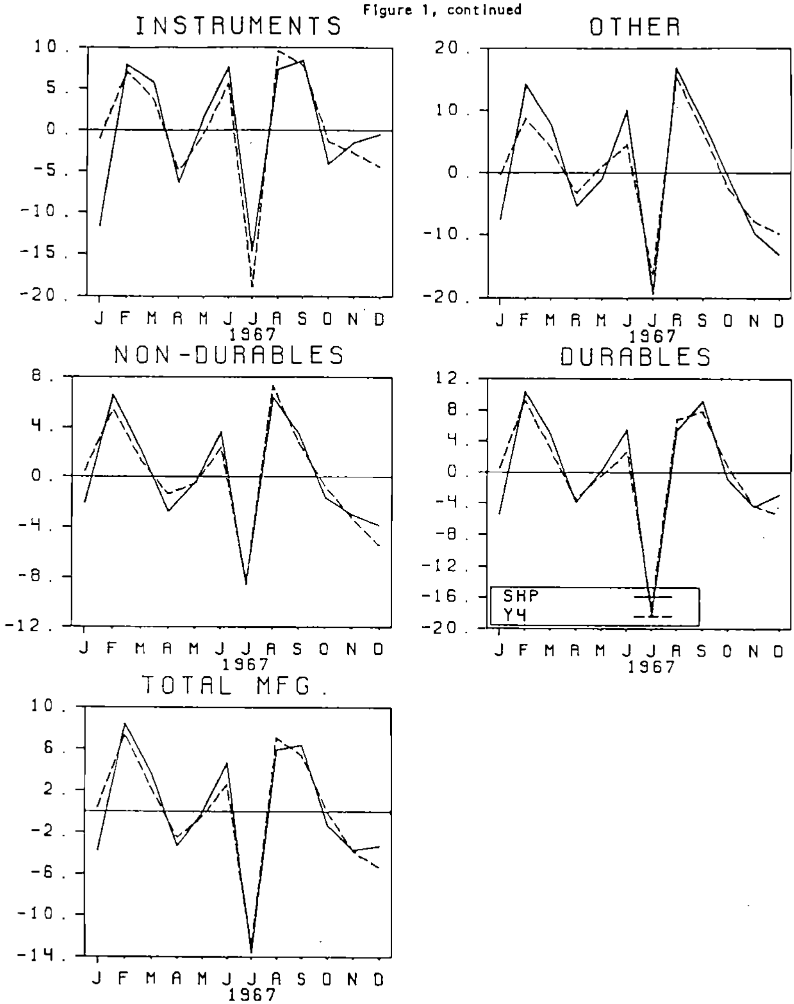


Figure 1, continued



DATA APPENDIX

The data on shipments and inventories used to construct Y4 were obtained on tape from the Bureau of Economic Analysis and the Bureau of the Census of the Department of Commerce. They are published in *Manufacturers' Shipments, Inventories and Orders.* Our sample begins in 1967 because that is the earliest date at which consistent, seasonally unadjusted data on production and shipments are available by 2-digit industry.

The use of real inventories series along with shipments to construct Y4 creates a problem first described by West (1983). In the data published by the Department of Commerce, shipments are valued at market prices but inventories are valued at cost. The natural correction is to divide the finished goods inventory series by the ratio of cost of goods sold to shipments so that the two series are comparable. To calculate the scale coefficient for finished goods, West uses IRS data available in *Source Book: Statistics of Income.* He takes (cost of sales and operations + rent + repairs + depreciation + taxes) and divides by (business receipts). [16] For materials and supplies inventories, Holtz–Eakin and Blinder (1983) divide the cost of materials by the value of shipments found in the *Census of Manufactures.* They create a work–in–progress coefficient that is simply the average of the coefficient on finished goods and that on materials and supplies. Holtz–Eakin and Blinder publish a table of all three coefficients based on 1972 data.[17] Table A1 provides comparable numbers based on 1982 data. These are the correction factors used to produce the Y4 series considered in this paper.

The definition of inventories used in this paper is finished goods plus work-in-progress. As first emphasized by Blinder (1986,p.433-434), there is no one correct definition of output when the production process involves intermediate goods. Blinder argues that the finished goods plus work-in-progress definition is preferable, however, because the price indices produced by BEA assume this definition. Miron and Zeldes (1989) demonstrate that the time series properties of the Y4 series based on finished goods only are quite similar to those of the Y4 series based on finished goods plus work-in-progress.

The shipments series are corrected for the number of production days but not for holidays. The data on inventories used to create Y4 are not adjusted for the number of days in the month and therefore include a small production day effect.

All other data were obtained from DRI. The Industrial Production Index originates from the Board of Governors of the Federal Reserve System. The industries that are estimated primarily from production worker hours data are Apparel, Lumber, Leather, Fabricated Metals, Electrical

[16] Actually, he multiplies finished goods by the inverse of this number.

[17] To be most accurate, the coefficients should be calculated for every year in the sample. Following the notation of Holtz–Eakin and Blinder, let P_t denote the market price of the good in year t (0 = base year) and let U_t^f denote the unit cost of the good. f_t denotes finished goods. The same analysis can be repeated for work–in–progress and materials and supplies. Then, after deflating and dividing by the inventory scale coefficient, the value of finished goods inventories becomes:

$$P_0 \frac{U_t^f/P_t}{U_0^f/P_0} f_t$$

Only in the base year does one get the proper value $P_0 f_t$. This inaccuracy, however, is at most second order. The change in any inventory data from month to month is small compared to shipments in that month. Moreover, comparing Holtz–Eakin and Blinder's 1972 numbers to Table A1 suggests that changes in these markups are not large.

Machinery, Transportation Equipment, and Instruments (see Miron and Zeldes (1989, Table 1)).

Average Production Worker Hours, Production Worker Employment and Total Employment originate from the BLS's *Employment and Earnings.* Total Production Worker Hours are simply Average Production Worker Hours times Production Worker Employment.

As stated in the text the price series are the wholesale price indices compiled by BLS using a different commodity classification system than the SIC. Table A2 lists the particular series we use to proxy for the prices of 2-digit industry output. BLS has recently produced price series based on the SIC codes; unfortunately, at the 2–digit level these series go back only to January, 1984.

Data on average monthly temperature and percipitation are from *Statewide Average Climatic History, Historical Climatology Series 6-1*, National Climatic Data Center, Ashville, NC.

Table A1: Inventory Adjustment Coefficients				
	SIC Code	Finished Goods	Work-in-Progress	Materials & Supplies
Food	20	.79628	.74074	.68519
Tobacco	21	.66769	.55487	.44205
Textiles	22	.83922	.72176	.60430
Apparel	23	.76221	.63480	.50738
Lumber	24	.86658	.74918	.63178
Furniture	25	.75868	.61203	.46538
Paper	26	.80429	.69391	.58352
Printing	27	.60932	.48752	.36571
Chemicals	28	.71309	.62760	.54210
Petroleum	29	.86411	.87527	.88643
Rubber	30	.75978	.63208	.50437
Leather	31	.74869	.62731	.50592
Stone,Clay,Glass	32	.80283	.64654	.49024
Primary Metal	33	.90859	.78292	.65724
Fab Metal	34	.78163	.63944	.49725
Machinery	35	.75041	.59817	.44593
Elec Machinery	36	.74304	.58532	.42759
Trans Equip	37	.81990	.70797	.59604
Instruments	38	.68595	.51553	.34510
Other	39	.73752	.60659	.47566
Non-Durables	–	.79540	.71702	.63864
Durables	–	.79196	.65139	.51081
Total	–	.79490	.68572	.57654

Notes:

1. See Data Appendix for method of calculation.
2. The Finished Goods Coefficient is calculated from data in *Source Book: Statistics of Income.*
3. The Materials & Supplies Coefficient is calculated from data in *1982 Census of Manufactures,* Vol. I.
4. The Work–in–Progress Coefficient is the average of Finished Goods and Materials & Supplies coefficients.

Table A2: Price Sources			
	SIC Code	BLS Code	Classification Description
Food	20	02	Processed Foods and Feeds
Tobacco	21	152	Tobc. Prodc, incl stemmed and redried
Textiles	22	03	Textile Products and Apparel
Apparel	23	0381	Apparel
Lumber	24	08	Lumber and Wood Products
Furniture	25	12	Furniture and Household Durables
Paper	26	09	Pulp, Paper, and Allied Products
Printing	27	—	
Chemicals	28	06	Chemicals and Allied Products
Petroleum	29	05	Fuels and Related Products and Power
Rubber	30	07	Rubber and Plastics Products
Leather	31	04	Hides, Skins, Leather and Related Prod.
Stone,Clay,Glass	32	13	Nonmetallic Mineral Products
Primary Metal	33	101	Iron and Steel
Fab Metal	34	10	Metals and Metal Products
Machinery	35	11	Machinery and Equipment
Elec Machinery	36	117	Electrical Machinery & Eqp
Trans Equip	37	14	Transportation Equipment
Instruments	38	—	
Other	39	—	
Non-Durables	—	—	
Durables	—	—	
Total	—	—	

Notes:

1. All data available for 1967:5-1987:12, except for Transportation Equipment, which is available for 1969:1-1987:12.
2. Source: DRI, @*USPRICE: Guide to the U.S. Prices Data Bank*, December 1987.