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Durability Versus Concentration as an Explanation for Price Inflexibility

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Abstract. We document the extent of price rigidity across United States manufacturing industries in the 1980s and early 1990s and compare rigidity across different phases of the business cycle. We measure price rigidity in three ways – each under four different sets of assumptions. We take an approach that relies on disaggregated data; we look at price patterns for over 4000 individual manufactured commodities. Both durability and seller concentration are found to be important factors explaining differences in price rigidity across industrial product classes. Using our data, we replicate the regression results found in Carlton (1986) that were based on actual transaction prices from the 1960s.

Key words: Price rigidity, market concentration, administered pricing, product durability.

I. Introduction

The relationship between market structure and price flexibility has been the topic of a long, interesting empirical literature for over sixty years. The theory that administered prices behave differently during the various phases of a business cycle from prices in the market (or auction) sector of the economy dates from Means (1935). In particular, Means argued that firms with some market power would choose to lower output rather than price during a recessionary period, while firms in the market sector would be forced to lower price. Using four-firm and eight-firm concentration ratios to represent market power, Bureau of Labor Statistics producer price data, and a sample of thirty-seven four-digit industries (obtained after applying four strict selection criteria), Means (1939) found a statistically significant positive relationship between price change and concentration for the period 1929–1932.

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That is, the more concentrated industries in the sample had prices that fell less during the 1930s Depression than those of more competitive industries. Means mentioned durability as being positively correlated with concentration (an issue that we address in our paper), but dismissed durability as a causal factor. Although Thorp and Crowder (1941) and Neal (1942) produced sets of disconfirming results for the Depression years (and, in fact, durability came back in the running as an important factor in the Thorp and Crowder study), it appears that later studies (such as Yordon, 1961; Weiss, 1966; Phlips, 1969; Ripley and Segal, 1973; and Qualls, 1975, 1978, among others) were influenced primarily by Means. Even Carlton (1986) did not look at durability as a possible explanation for variation in price rigidity across industries (he considered a number of other industry characteristics, including seller concentration).

Meanwhile, there is a rich theoretical literature on the relationship between durability and pricing. Tirole (1988) argues (following Coase, 1972) that a durable-good monopolist is generally better off with sticky, rather than flexible, prices. Due to the ability of consumers of durables to arbitrage intertemporally, a durable-good producer needs to signal to those consumers that price will not drop continuously as the unsold stock of the product is unloaded. Stokey (1979) argues that if consumers have complete information and if they expect price to drop, they will delay their purchase of a durable good. Conlisk et al. (1984) and Sobel (1991) develop a model that looks at the pricing pattern of a durable-good monopolist over time. They show that price remains constant for a length of time, drops for a period, and then returns to the initial level. In an earlier paper (Caucutt, Ghosh and Kelton 1994), we found that product durability is an important factor in explaining variation across industries in relative price variability (dispersion). Although the empirical administered-pricing literature has not completely ignored durability and other product characteristics, durability has taken a back seat in this literature to seller concentration.

In this paper, we have three purposes:

- detailed documentation of the extent of price inflexibility or rigidity across U.S. manufacturing industries in the 1980s and early 1990s;
- determination of whether either durability or concentration has a significant influence on rigidity; and
- determination of whether pricing behavior differs significantly during the 1990–1991 recession from behavior during an expansionary period of equal length following the recession.

We use the Bureau of Labor Statistics (BLS) individual-commodity monthly price series. We have varying-length time records for 4,048 manufactured commodities. According to the 1982 *Handbook of Methods*, the BLS attempts to collect transaction prices. Companies are requested to report prices less all discounts, allowances, rebates, or free deals. List prices are used if transaction prices are unattainable (about 20% of the time). According to the 1994 *Sources and Methods, Producer Price Indices*, the BLS currently collects on a monthly basis 80,000 price quotations for 3,200 individual commodities. Nevertheless, it has been argued (by Stigler and Kindahl, 1970, among others) that BLS price indices are not ideal for studying price rigidity. Stigler and Kindahl constructed an impressive series of actual transaction prices for the 1960s; they are for large buyers often buying on long-term contracts. Carlton also made use of these Stigler and Kindahl data for his 1986 paper on price rigidity.

On the other hand, compared to the thousands of individual commodities tracked by the Bureau of Labor Statistics, the very small size of the Stigler and Kindahl sample detracts from its appeal. Carlton's regression of price rigidity on concentration had only 27 product-class observations (none of which were consumer goods). In using BLS data, we are able to have in our sample 950 (out of 1,250 or so in total) different product classes. Furthermore, the Stigler and Kindahl data are old. To study recent pricing behavior, the BLS data would seem to be superior. In using the BLS data we are also encouraged by Weiss's (1977) results; in an attempt to resolve the Means (1935, 1939, 1972) and Stigler and Kindahl (1970, 1973) controversy over administered pricing, Weiss (1977) correlated price indices from the two data sets and found that, across forty series, the estimated correlation coefficient between BLS and the Stigler and Kindahl data was approximately 0.8. We are also encouraged by our ability to replicate (more or less, as we discuss below) Carlton's regression results – using Carlton's sample of product classes but our recent BLS data.

Our use of price indices leads to an understatement of price rigidity, with the degree of understatement directly related to the number of reporters for a particular price series. We illustrate this problem for one of our rigidity measures in the next section. We do work, however, with individual commodities, eliminating the need for further aggregation. (This is in contrast to earlier studies, for example, Qualls 1975, that use "prepackaged" four-digit indices.) On the other hand, since the products selected by Stigler and Kindahl (1970) were only those thought characterized by price rigidity in the first place, relying on Carlton's figures for the manufacturing sector as a whole would also be misleading; price rigidity should be generally lower for the sector as a whole than for his sample of products.

II. The Extent of Price Rigidity in U.S. Manufacturing: 1982–1994

In this section, we look at all individual manufactured commodities tracked by BLS for any subset of months during the period January 1982 through July 1994; we do not consider any primary agricultural or mining commodities. We have three basic measures of price rigidity. Two of them are based on the idea of a price "spell," although the notion of a spell is not as clear with price indices as it is for actual prices. In this section, a spell is defined as a period of at least two consecutive months over which the price index is unchanged. (In our section on regression results, we consider alternative definitions of spells, and check our results' sensitivity to how we define spells and their length.)

Our first rigidity measure is average spell length, that is, the average number of months over which the monthly price index does not change. We denote this measure by ASL. This is the main variable that Carlton (1986) used to capture rigidity. The problem with relying solely on this variable, though, particularly in our case with variable-length price series, is that it would say, in a comparison of two series, that a commodity has more rigid prices with a single spell of, say, ten months, than one with five spells, each of nine months in duration. Thus, we take as a second basic measure of price rigidity the percent of months (for which we have data) that are in a spell; we denote this measure by $PCTS$. Even so, neither of these measures would speak to the case in which two series have prices that change monthly, that is, to the case in which there are no spells at all. It would seem then that the average amplitude of monthly price change could be compared across products. So, for our third rigidity variable (which measures flexibility rather than rigidity), we have average absolute monthly price change, measured as the average absolute value of the first difference of logarithmically transformed monthly price indices, that is the average of $|\ \Delta P_t\ |$ over the time record, where

$$|\Delta P_t| = |\log(P_t/P_{t-1})|.$$

We denote this measure as PA for price-change amplitude.

None of these measures is problem-free. The first two, ASL and $PCTS$, are conservative and sensitive to the number of BLS reporters.[1] The third, PA, may (although we hope to a lesser degree) also be sensitive to the number of reporters and is picking up a trend component as well as monthly oscillation. We do not attempt to combine these three measures into some single rigidity index; rather, we are hoping for consistency of results across the three measures of rigidity.

When a price index was missing for a particular commodity and month, we did not choose to interpolate between values for surrounding months. Rather, we treat a missing value as a break. So, for example, if there is a period of 12 months in which the price index is constant, a missing value in the 13th month, and then another 12 months in which the price index remains constant at the same value as in the preceding 12 months, this situation is treated as two spells each of length 12, rather than one spell of 25 months. In this way, we are being even more conservative in our estimates of price rigidity.

1. Price Rigidity for Selected Manufactured Commodities

Table I gives ASL, $PCTS$, and PA for selected commodities and is meant to give a feel for the variability in price patterns for the 1980s. With one exception, these

[1] We do not know the number of reporters for any of our price series; hence, we cannot account for that variable explicitly in our analyses. However, the number of reporters is clearly important. For example, although each of five reporters, say, may always observe ten-month-long spells of price rigidity, ASL could be as low as 2. In this case, the index could register a change as often as every other month.

Table I. Basic rigidity measures for selected commodities

BLS product	BLS code	Start month	End month	Trend	ASL	$PCTS$	PA
White bread	02110108	1/82	7/94	0.33	2.31	0.25	0.005
Cigarettes	15210103	12/82	7/94	0.67	4.14	0.83	0.014
Railway ties	08490102	1/82	7/94	0.40	4.29	0.69	0.006
Professional periodicals	09320123	1/82	7/94	0.68	2.85	0.74	0.005
Cancer therapy products	06359917	3/82	7/94	1.21	3.89	0.91	0.009
Butane gas	05320105	1/82	7/94	−0.73	2.00	0.01	0.061
Car tires	07120103	1/82	7/94	−0.02	2.29	0.26	0.005
Leather footwear	04340147	1/82	12/93	0.19	5.15	0.97	0.002
Concrete bricks	13313101	1/82	7/94	0.13	3.70	0.74	0.006
Nickel sheets	10220128	1/82	12/85	0.00	48.00	1.00	0.000
Fruit juice cans	10310209	1/82	7/94	0.25	3.26	0.84	0.004
Paper mill machinery	11640105	7/82	7/94	0.35	3.36	0.83	0.003
Rotary wing aircraft	14210203	1/82	7/94	0.43	5.26	0.94	0.005
Contact lenses	15640104	12/83	7/94	−0.04	2.56	0.36	0.006
Dolls	15110156	12/85	7/94	0.14	3.31	0.83	0.003

commodities have close to complete time records of price data. They are also quite heterogeneous with respect to durability and seller concentration.[2] We see from Table I the tremendous variability in rigidity across commodities. At one extreme is butane gas with a price index that varies virtually every month, with no spell of price constancy longer than two months, and with an average monthly price change of approximately 6%. At the other extreme are nickel sheets. For 48 months, between January 1982 and December 1985, which is the entire length of the series, the price index was unchanging – implying an average spell length of 48 months, all months falling within a spell, and zero average absolute monthly price change. The other commodities fall in between – with rather flexible prices for bread and tires, for example, but quite rigid prices for leather shoes and rotary aircraft. In the fifteen figures in Appendix A, we depict graphically the price patterns for the individual commodities listed in Table I.

In Table II we show the breakdown of spells by spell length for these same selected commodities. Most spells for the commodities are short. The price index remains constant for only two or three consecutive months. For bread and butane gas, these short spells are essentially the only spells in their respective time series. Many of the other commodities have over 50% of their total number of spells of length 3 months or shorter. Only cigarettes, leather footwear, concrete bricks, and aircraft have more "intermediate" and "long" spells than short spells.

[2] We measure price trend very roughly as the logarithmically transformed ratio of the monthly price index for the end month divided by the monthly price index for the start month.

Table II. Spell length for selected commodities

BLS product	Number of spells	Number of spells of specific length: 2–3 months	4–6 months	7–9 months	10–12 months	> 12 months
White bread	16	15	1	0	0	0
Cigarettes	28	12	15	1	0	0
Railway ties	24	15	5	2	0	2
Professional periodicals	39	29	10	0	0	0
Cancer therapy products	35	20	10	5	0	0
Butane gas	1	1	0	0	0	0
Car tires	17	16	1	0	0	0
Leather footwear	27	13	7	3	3	1
Concrete bricks	30	14	14	2	0	0
Nickel sheets	1	0	0	0	0	1
Fruit juice cans	39	28	10	1	0	0
Paper mill machinery	36	24	11	0	1	0
Rotary wing aircraft	27	7	14	4	2	0
Contact lenses	18	15	3	0	0	0
Dolls	26	19	5	1	1	0

Table III. Average monthly price change for selected commodities

BLS product	Number of months	Price changes by amplitude range: 0	$0-0.01$	$0.01-0.02$	> 0.02
White bread	148	21	100	24	3
Cigarettes	139	88	10	7	34
Railway ties	148	79	41	19	9
Professional periodicals	150	72	56	10	12
Cancer therapy products	148	101	13	10	24
Butane gas	148	1	15	27	105
Car tires	150	22	105	15	8
Leather footwear	143	112	24	2	5
Concrete bricks	150	81	43	11	15
Nickel sheets	47	47	0	0	0
Fruit juice cans	150	88	44	8	10
Paper mill machinery	144	85	51	2	6
Rotary wing aircraft	150	115	18	7	10
Contact lenses	127	28	76	16	7
Dolls	103	60	37	3	3

In Table III we show the breakdown of monthly price changes by amplitude ranges. Here we break down the number of months in each time record by the amplitude of the monthly price change, that is, by ranges on $|\Delta P_t|$. Again, we note the variability across products. Large monthly price changes are common over our time period for butane gas but are rare for most of the other commodities. We note, however, the 34 times in 12 years that the price of cigarettes changed (primarily rose) more than 2%.

2. Price Rigidity Across Major Industry Groups

For this section, we pool our commodity data by two-digit major industry group. We first assign to each of the over 4,000 individual commodities a (1982) SIC five-digit product-class code; the classification was fairly straightforward. The BLS eight-digit commodity code along with a descriptive title were, for the most part, sufficient for classification. We also relied heavily on the 1982 Census of Manufactures *Numerical List of Manufactured Products*. In the next section, we discuss our regressions based on five-digit observations. For this section, however, we compute two-digit, major-industry-group statistics, by averaging over any price data assigned to a five-digit category within a given two-digit group. For example, the ASL value for SIC Group 20, Food and kindred products, is calculated simply as the total number of months in spells across all manufactured food products divided by the total number of spells across all manufactured food products. The $PCTS$ value is found by dividing the total number of months in spells across all manufactured food products by the total number of months of commodity price data for food commodities. Finally, the PA value is computed as the average of all monthly price changes (absolute values) in food products. Note that this aggregation procedure implicitly weights most heavily those commodities that have the longest time records of data.[3]

Although Table IV masks the extreme variability in rigidity across individual commodities, it gives a more general picture of the extent of price rigidity in U.S. manufacturing. The average length of spell is a bit less than four months; 50–60% of months are in spells; and, over the last twelve years, the price index has varied on average about 1% per month, or a little less. Tobacco products, by our first two measures of rigidity, have the greatest price inflexibility, with an average spell length of 4.75 months and 83% of months in spells. The machinery, electric-equipment, and miscellaneous groups also have average spell lengths of over four months. Food, petroleum, and lumber show the greatest price flexibility with relatively short average spell lengths – of around three months. Overall, we take Table IV to indicate a certain amount of price rigidity, but less than that recorded by Carlton (1986). With respect to average spell length, there is considerable variation about the mean for each industry group. Standard deviations range between two and three and a half months across the groups.

[3] An alternative approach would be to average over commodity averages – which would weight all commodities equally regardless of the amount of data. Of course, a “minimum-data” rule could be imposed in order to exclude products with very short records.

Table IV. Basic rigidity measures for major manufacturing industry groups

Major industry group	SIC code	ASL	Standard deviation	$PCTS$	PA
Food and kindred products	20	3.25	2.84	0.34	0.020
Tobacco products	21	4.75	2.92	0.83	0.007
Textile mill products	22	3.30	2.73	0.51	0.006
Apparel and other textile products	23	3.59	2.47	0.72	0.004
Lumber and wood products	24	3.07	2.31	0.34	0.015
Furniture and fixtures	25	3.32	2.42	0.60	0.005
Paper and allied products	26	3.48	3.19	0.50	0.007
Printing and publishing	27	3.72	3.08	0.66	0.005
Chemicals and allied products	28	3.60	2.72	0.53	0.012
Petroleum and coal products	29	3.15	2.41	0.23	0.031
Rubber and miscellaneous plastics products	30	3.51	2.60	0.58	0.007
Leather and leather products	31	3.42	2.36	0.56	0.010
Stone, clay, and glass products	32	3.94	3.19	0.66	0.005
Primary metal industries	33	3.59	3.29	0.46	0.014
Fabricated metal products	34	3.95	3.16	0.70	0.005
Industrial machinery and equipment	35	4.23	3.59	0.78	0.004
Electronic and other electric equipment	36	4.02	3.26	0.67	0.006
Transportation equipment	37	3.61	3.06	0.64	0.004
Instruments and related products	38	3.35	2.19	0.63	0.005
Miscellaneous manufacturing industries	39	4.23	3.30	0.75	0.005

The message from the PA column is interesting. Whereas Food and kindred products, Lumber and wood products, and Petroleum and coal products come out high on flexibility as they do according to ASL and $PCTS$, Chemicals and allied products and Primary metal industries have relatively high monthly price fluctuations as well. These latter two industry groups have only “intermediate” flexibility according to our first two measures of rigidity.

From Table V we learn that prices, on the whole, are equally sticky downward and upward, consistent with Carlton’s findings for the 1960s. The average upward change is approximately equal to the average downward change – for each of the two-digit industry groups (note that the values in the first column of numbers are averages over both months in which there is a price change and months in which there is not). The single exception might be Leather and Leather Products, for which the average downward monthly change exceeds the average upward monthly change by about half a percent.

In Table VI we show the breakdown of spells by spell length for the two-digit manufacturing groups. Again, as for the selected commodities in the previous section, the vast majority of spells across the manufacturing sector are short. Except for tobacco products, between 59% (miscellaneous manufacturing) and

Table V. Symmetry of price change for major manufacturing industry groups

Major industry group	PA	Average up change	Average down change
Food and kindred products	0.020	0.026	−0.029
Tobacco products	0.007	0.022	−0.023
Textile mill products	0.006	0.010	−0.010
Apparel and other textile products	0.004	0.009	−0.010
Lumber and wood products	0.015	0.019	−0.020
Furniture and fixtures	0.005	0.008	−0.009
Paper and allied products	0.007	0.012	−0.010
Printing and publishing	0.005	0.011	−0.009
Chemicals and allied products	0.012	0.020	−0.022
Petroleum and coal products	0.031	0.036	−0.038
Rubber and miscellaneous plastics products	0.007	0.012	−0.013
Leather and leather products	0.010	0.017	−0.022
Stone, clay, and glass products	0.005	0.011	−0.009
Primary metal industries	0.014	0.022	−0.022
Fabricated metal products	0.005	0.010	−0.009
Industrial machinery and equipment	0.004	0.010	−0.012
Electronic and other electric equipment	0.006	0.013	−0.013
Transportation equipment	0.004	0.008	−0.007
Instruments and related products	0.005	0.009	−0.008
Miscellaneous manufacturing industries	0.005	0.013	−0.016

80% (lumber and wood) of spells are no longer than three months. Then, in Table VII, we show the percentage breakdown of monthly price changes. The “big” (greater than 2%) monthly swings are found in Food and Kindred Products (25.7% of price changes are that high), Lumber and wood products, Petroleum and coal products, and Primary metal industries. As shown in Table VIII, we compute, for each major manufacturing group, a correlation coefficient between length of spell and price change (log(P_t/P_{t-1})) at the end of the spell. Our results are generally consistent with Carlton’s (1986) findings, in that we find a positive and significant (at at least the 5% level of significance) relationship for 13 of the 20 groups. Only for Primary metal industries is this relationship estimated to be negative and significantly so. Generally, the longer the price index remains constant, the greater the jump in price at the end of the run.

III. The Effects of Concentration and Durability

In this section, we look at whether price rigidity can be explained – at least in part – by market concentration, product type, and product durability. In passing, we answer the question of whether concentration and durability are themselves correlated. The five-digit product class is our unit of analysis; to construct our

Table VI. Spell length for major manufacturing industry groups

Major industry group	Number	Percent of spells of specific length 2–3	4–6	7–9	10–12	> 12
Food and kindred products	3609	76.4	15.7	4.8	1.7	1.4
Tobacco products	300	41.7	41.3	10.0	5.7	1.3
Textile mill products	1838	74.4	18.2	4.6	1.8	0.9
Apparel and other textile products	2157	66.8	23.6	5.5	3.0	1.2
Lumber and wood products	1195	79.8	14.5	3.2	1.3	1.3
Furniture and fixtures	1513	74.8	16.9	5.2	1.9	1.3
Paper and allied products	1547	74.1	16.9	4.7	2.5	1.9
Printing and publishing	1670	67.1	23.0	5.5	2.3	2.1
Chemicals and allied products	3893	69.1	20.8	5.9	2.6	1.6
Petroleum and coal products	504	78.2	16.1	2.6	2.2	1.0
Rubber and miscellaneous plastics products	982	70.0	20.4	5.9	2.2	1.5
Leather and leather products	841	70.7	20.8	4.8	2.4	1.3
Stone, clay, and glass products	1677	64.2	22.6	7.3	3.1	2.8
Primary metal industries	2749	72.1	18.4	5.6	1.8	2.1
Fabricated metal products	5187	63.8	22.5	7.6	3.9	2.2
Industrial machinery and equipment	8784	60.0	24.2	8.7	4.2	2.9
Electronic and other electric equipment	5129	62.1	24.0	7.4	4.1	2.4
Transportation equipment	853	70.0	20.2	5.5	2.7	1.6
Instruments and related products	1036	71.6	20.0	5.9	1.9	0.6
Miscellaneous manufacturing industries	1142	58.9	24.5	9.2	5.0	2.4

measures of price rigidity, we aggregate up over the individual-commodity values in the same way that we did for entire two-digit industry groups. For example, to construct ASL, we divide the total number of months in spells by the total number of spells for all commodities assigned to that five-digit product class. We require at least three spells in order to compute ASL. We also require for any of our rigidity variables at least 36 months (3 years) of data in order to include a particular product class in our sample.

We use, as our measure of concentration, in our regressions, the 1982 four-firm concentration ratio, denoted CR_4.[4] We chose to work with the concentration ratio for consistency with Carlton (1986) as well as with previous studies. As for product type, we divided our sample into consumer goods and producer goods. Most of our product classes could easily be identified as either consumer or producer classes. For products that are used both for final consumption and as intermediate inputs in further production (for example, sugar and tires), a decision was made on the basis of who purchased the greatest value of output of the product class in question

[4] Actually, we conducted our regression analyses alternatively with the Herfindahl-Hirschman index (HHI), but none of our results is affected by this choice. The correlation coefficient between these two indices is estimated to be approximately 0.95 for our sample.

Table VII. Average monthly price change for major industry groups

Major industry group	No. months	Price changes by amplitude range			
		0	$0 - .01$	$.01 - .02$	$> .02$
Food and kindred products	33495	24.8	35.2	14.3	25.7
Tobacco products	1683	66.8	15.4	5.3	12.4
Textile mill products	11608	36.6	45.8	10.0	7.6
Apparel and other textile products	10602	53.4	34.2	6.9	5.5
Lumber and wood products	10747	23.2	39.0	14.7	23.1
Furniture and fixtures	8287	42.4	43.7	8.5	5.4
Paper and allied products	10578	36.8	43.1	10.3	9.8
Printing and publishing	9227	49.8	36.4	6.9	6.9
Chemicals and allied products	25726	40.0	31.6	11.1	17.3
Petroleum and coal products	6802	16.2	29.7	14.0	40.1
Rubber and miscellaneous plastics products	5838	43.8	37.5	9.5	9.2
Leather and leather products	5018	41.9	33.5	9.9	14.7
Stone, clay, and glass products	9773	51.8	33.7	7.7	6.8
Primary metal industries	21144	34.1	32.9	11.9	21.0
Fabricated metal products	28458	54.2	32.3	7.2	6.3
Industrial machinery and equipment	46431	63.3	25.4	6.3	5.0
Electronic and other electric equipment	29885	53.1	30.1	7.9	9.0
Transportation equipment	4745	47.3	42.2	6.6	3.8
Instruments and related products	5398	45.7	40.1	8.5	5.7
Miscellaneous manufacturing industries	6311	59.9	26.5	6.5	7.1

– final consumers or other producers. In making the decision, we relied on the input-output table for the U.S. economy. We classified our products as well as nondurables or durables. By *nondurable*, we mean that the product is fully used up in consumption or production. By *durable*, we mean that it is not.[5]

1. Overall View

In Tables IX and X we simply look at average rigidity, as captured by ASL, $PCTS$, and PA, respectively, for twelve groups of product classes.[6] For each type of product (consumer nondurables, producer nondurables, and so forth), rigidity, as measured by average spell length or percentage of months in spells, rises with seller concentration. When rigidity is measured by average absolute monthly price

[5] We also conducted our basic analyses using a three-way, versus two-way, durability-classification scheme. That is, we classified each five-digit product class as a nondurable, a semidurable, or a durable. None of our conclusions regarding the effect of concentration is altered. Moreover, with respect to each dependent variable and for both producer goods and consumer goods, durable goods had significantly greater rigidity than nondurables; and, in all but one regression (where the coefficient was nonsignificant), semidurables had significantly greater rigidity than nondurables as well.

[6] Although our CR_4 cutoff values are arbitrary, the HHI cutoffs are taken from the September 1992 *Merger Guidelines*.

Table VIII. Correlation between spell length and end-of-spell price change for major manufacturing industry groups

Major industry group	Correlation	p-value
Food and kindred products	0.022	0.2040
Tobacco products	0.278	0.0001
Textile mill products	0.015	0.5441
Apparel and other textile products	0.110	0.0001
Lumber and wood products	0.011	0.7030
Furniture and fixtures	0.090	0.0006
Paper and allied products	0.081	0.0020
Printing and publishing	0.226	0.0001
Chemicals and allied products	0.066	0.0001
Petroleum and coal products	−0.020	0.6680
Rubber and miscellaneous plastics products	0.014	0.6620
Leather and leather products	0.034	0.3470
Stone, clay, and glass products	0.112	0.0001
Primary metal industries	−0.116	0.0001
Fabricated metal products	0.092	0.0001
Industrial machinery and equipment	0.059	0.0001
Electronic and other electric equipment	0.103	0.0001
Transportation equipment	0.097	0.0060
Instruments and related products	0.141	0.0001
Miscellaneous manufacturing industries	0.065	0.0360

change, however, this is not true. Rigidity rises, stays the same, or falls, depending on product type, as concentration rises. We can also see from Tables IX and X that durability and rigidity are related. Producer durables have higher rigidity than producer nondurables – with rigidity measured in *any* of the three ways we have measured it. Likewise, consumer durables have higher rigidity than consumer nondurables – with rigidity measured in any of the three ways. Of all product types, the consumer durables seem to have the least price flexibility. For the twelve consumer-durable product classes whose HHI exceeds 1800, the average spell length approaches five months.[7]

In Table XI, we present ordinary-least-squares regression results. For the five-digit observations in the regressions, the dependent measures have estimated correlation coefficients as follows: 0.67 (ASL with $PCTS$), −0.25 (ASL with PA), and −0.54 ($PCTS$ with PA). As for average spell length, both concentration and durability have statistically significant positive effects – for both consumer goods and producer goods. In fact, they "tie" in importance in the following sense:

[7] Those twelve product classes are as follows: 23283 (men's and boys' jeans), 23521 (hats and hat bodies), 25158 (conventional waterbeds), 36321 (household refrigerators), 36521 (records, tapes, and video discs), 37112 (trucks), 37512 (motorcycles), 37993 (golf carts), 38516 (contact lenses), 39142 (flatware), 39951 (metal caskets and coffins), and 39953 (other caskets, coffins, and metal vaults).

Table IX. Rigidity measures for groups of product classes using CR_4 (no. of observations in parentheses)

	Type of product class			
	Nondurables		Durables	
Concentration	Consumer	Producer	Producer	Consumer
	3.373 (49)	3.011 (70)	3.631 (242)	3.710 (77)
$CR_4 \leq 40$	0.455 (51)	0.406 (75)	0.619 (246)	0.672 (78)
	0.014 (51)	0.012 (75)	0.005 (246)	0.005 (78)
	3.220 (39)	3.238 (55)	3.795 (160)	4.108 (36)
$40 < CR_4 \leq 60$	0.490 (40)	0.393 (62)	0.611 (163)	0.710 (37)
	0.011 (40)	0.018 (62)	0.008 (163)	0.005 (37)
	3.835 (36)	3.944 (33)	3.865 (132)	4.343 (31)
$CR_4 > 60$	0.606 (36)	0.499 (35)	0.626 (135)	0.723 (31)
	0.008 (36)	0.012 (35)	0.007 (135)	0.005 (31)

Table X. Rigidity measures for groups of product classes using HHI (no. of observations in parentheses)

	Type of product class			
	Nondurables		Durables	
Concentration	Consumer	Producer	Producer	Consumer
	3.443 (86)	3.164 (105)	3.659 (371)	3.897 (104)
$HHI \leq 1000$	0.492 (89)	0.400 (116)	0.615 (377)	0.684 (106)
	0.013 (89)	0.014 (116)	0.006 (377)	0.005 (106)
	3.553 (19)	3.265 (38)	3.906 (109)	3.763 (28)
$1000 < HHI \leq 1800$	0.574 (19)	0.467 (41)	0.616 (111)	0.708 (28)
	0.007 (19)	0.016 (41)	0.007 (111)	0.005 (28)
	3.437 (19)	4.180 (15)	3.939 (54)	4.793 (12)
$HHI > 1800$	0.523 (19)	0.445 (15)	0.650 (56)	0.736 (12)
	0.007 (19)	0.010 (15)	0.007 (56)	0.005 (12)

the standardized coefficient for CR_4 is 0.26, while that for the durability binary variable is 0.25 – for consumer goods. For producer goods, the two standardized coefficients are 0.13 and 0.13, respectively – "tied" again. Note that it is not the case that concentration and durability are correlated. For each of our samples, their estimated correlation coefficient is approximately -0.05, not statistically significant at even the 10% level.

In explaining $PCTS$, the percent of months in spells, concentration and durability again both have statistically significant positive coefficients for consumer goods; in a contest of standardized coefficients (0.25 for concentration versus 0.44 for durability), durability "wins". For producer goods, the standardized coefficients

Table XI. Ordinary least squares results: 1982–1994 (t-statistics in parentheses)

Product type	Obs.	Dep. var.	Intercept	Independent variable CR_4	Dur.	F
Consumer	253	ASL	2.551[a]	0.017[a]	0.666[a]	13.351[a]
			(10.48)	(4.14)	(4.01)	
Producer	668	ASL	2.867[a]	0.009[a]	0.451[a]	12.723[a]
			(17.81)	(3.50)	(3.55)	
Consumer	257	$PCTS$	0.375[a]	0.003[a]	0.215[a]	30.105[a]
			(8.98)	(3.62)	(7.51)	
Producer	692	$PCTS$	0.392[a]	0.001	0.199[a]	37.256[a]
			(13.14)	(1.18)	(8.52)	
Consumer	257	PA	0.018[a]	-0.0001[a]	-0.008[a]	16.473[a]
			(8.09)	(-2.92)	(-5.48)	
Producer	692	PA	0.012[a]	0.00004[b]	-0.008[a]	34.671[a]
			(9.75)	(2.16)	(-8.09)	

[a]Significant at the 1% level.
[b]Significant at the 5% level.
[c]Significant at the 10% level.

are 0.07 and 0.31, and concentration does not have a statistically significant estimated coefficient. Finally, in explaining PA, the average absolute value of monthly price change, for consumer goods, we have -0.17 and -0.32 for standardized regression coefficients for concentration and durability, respectively. Again, durability "wins". For producer goods, the estimated effect of concentration is positive and significant – the *opposite* of what is predicted. The effect of durability is negative, and significantly so, as expected. Overall, considering the results for all three of our dependent measures of rigidity, durability comes in the strongest; its coefficient is always statistically significant and has the expected sign. However, concentration as a variable cannot be dismissed, especially with regard to consumer goods.[8]

[8] For none of our regressions does R^2 exceed 0.20. We are not able to explain more than 20% of the variation in price rigidity across five-digit product classes. We chose to run separate regressions for consumer goods and producer goods in keeping with much of the recent empirical industrial-organization literature (see Mueller and Greer, 1984; Kelton and Weiss, 1989; and Kelton, 1992) in which relationships are assumed to differ systematically across these product types. At the four-digit level of analysis, we could have added other explanatory variables, possibly including price rigidity of input suppliers. Working at this level with additional variables, our R^2 values would undoubtedly have been higher. However, one of our goals in this study was to keep the analysis at as disaggregate a level as possible. We also regressed the estimated correlation coefficient between spell length and end-of-spell price change on concentration and durability. Here, we found nothing of interest for either consumer goods or producer goods – no significant estimated coefficients and pitifully low R^2 values.

2. Sensitivity to Assumptions About Spell Definition

Since our notion of "spell" is somewhat arbitrary, especially given our price-index data, we sought to check, at least in a limited fashion, whether our regression results were sensitive to our definition of spell. Specifically, we ran our analyses under three additional sets of assumptions – sets (2), (3), and (4), respectively (we worked under assumption set (1) in the preceding section):

(1) the price index must not change between two consecutive months for a spell to occur;
(2) the price index must not change for at least three consecutive months for a spell to occur;
(3) the price index must not change by more than 0.1 between two consecutive months for a spell to occur; and
(4) the price index must not change by more than 0.1 between months for three consecutive months for a spell to occur.

We were encouraged by the results. Although the intercept estimates are affected by how we define a spell,[9] our conclusions about the effects of concentration and durability remain unchanged. With few exceptions, both CR_4 and durability have the same effects on rigidity as they do under assumption set (1); durability always has a positive effect, while seller concentration often does, especially for consumer goods.

3. The Carlton (1986) Sample

In Table XII, we list the small subset of 16 product classes that compose the intersection of the Carlton (1986) sample (of 27 product classes) and our sample (of 950 or so product classes).[10] For this group of product classes, all of which are producer goods, we regress average spell length on seller concentration and a durability binary variable. Interestingly, we find Carlton's results; concentration has a significantly (at the 10% level) positive effect on rigidity, and durability can be ignored. The estimated coefficient on durability is negative and nonsignificant – a very misleading result in light of what we have found for manufacturing as a whole. In Table XIII, we present our results (both including durability as a regressor

[9] Under assumption set (1), the mean average spell length for the 921 product classes in the regression analysis is 3.65 (months). Under assumption sets (2)–(4), respectively, those mean values are 5.12, 3.77, and 5.16. Moreover, under assumption set (1), the mean percent of months in spells for the 949 product classes in the regression is 58.1%. Under assumption sets (2)–(4), respectively, the mean percentages are 43.0%, 64.9%, and 49.0%. As measured by ASL, rigidity is highest under assumption sets (2) and (4). As measured by $PCTS$, rigidity is highest under sets (1) and (3).

[10] Actually, these are the 16 classes for which we are able to compute an average spell length. There is a seventeenth product class for which we are able to compute $PCTS$ and PA, but not ASL, since we require at least three spells for a product class before we are willing to assume that ASL is meaningful for that class.

Table XII. Intersection of CGK and Carlton samples

Product class	SIC code	ASL	$PCTS$	PA	CR_4	Dur.
Plywood	24365	2.00	0.02	0.043	52	D
Fiberboard	26611	2.89	0.35	0.008	64	D
Chlorine	28121	2.46	0.15	0.033	49	ND
Caustic soda	28123	2.00	0.06	0.031	50	ND
Acetylene	28132	7.14	0.99	0.003	72	ND
Oxygen	28136	13.29	0.97	0.004	86	ND
Sulfuric acid	28193	2.25	0.09	0.010	53	ND
Organic pigments	28653	3.60	0.45	0.007	55	ND
Industrial chemicals, n.e.c.	28695	2.83	0.27	0.022	26	ND
Gasoline	29111	2.00	0.02	0.049	27	ND
Cement	32410	2.24	0.23	0.008	32	D
Hot rolled sheet and strip	33123	2.64	0.26	0.008	66	D
Hot rolled bars	33124	3.19	0.41	0.008	50	D
Steel pipes and tubes	33170	4.06	0.73	0.007	22	D
Carbon steel castings	33252	3.53	0.69	0.004	26	D
Fasteners	34524	4.04	0.67	0.006	15	D

Table XIII. Ordinary least squares results: CGK and Carlton (t-statistics in parentheses)

Regression	Obs.	Dep. var.	Intercept	CR_4	Dur.	R^2
CGK	16	ASL	0.745	0.071[c]	−0.568	0.29
			(0.37)	(2.06)	(−0.42)	
CGK	16	ASL	0.264	0.075[b]		0.28
			(0.16)	(2.35)		
Carlton[d]	27	ASL	4.97[a]	16.12[a]		0.22
			(3.12)	(6.08)		

[a] Significant at the 1% level.
[b] Significant at the 5% level.
[c] Significant at the 10% level.
[d] Source: Carlton, Dennis W. (1986) ‘The Rigidity of Prices’, *The American Economic Review*, **76**, 637–658.

and not including it) for these 16 product classes – along with Carlton’s regression results.[11]

[11] We were puzzled at first by the size of our estimated intercept coefficient. Its value, it turns out, is strongly influenced by the oxygen product class (28136); in a regression without this product class, the estimated intercept coefficient is 2.6 (with or without the durability binary variable).

Table XIV. Basic rigidity measures for major manufacturing industry groups: July 1990–March 1991 recession

Major industry group	ASL	St. dev.	$PCTS$	PA
Food and kindred products	2.48	0.90	0.18	0.018
Tobacco products	3.58	1.16	0.48	0.007
Textile mill products	2.79	1.18	0.38	0.006
Apparel and other textile products	3.04	1.48	0.46	0.003
Lumber and wood products	2.57	1.13	0.26	0.011
Furniture and fixtures	2.51	0.91	0.42	0.004
Paper and allied products	2.86	1.31	0.36	0.006
Printing and publishing	2.89	1.29	0.44	0.006
Chemicals and allied products	2.74	1.09	0.32	0.014
Petroleum and coal products	2.39	0.61	0.12	0.076
Rubber and miscellaneous plastics products	2.44	0.84	0.38	0.008
Leather and leather products	3.03	1.37	0.41	0.006
Stone, clay, and glass products	2.92	1.43	0.42	0.005
Primary metal industries	2.76	1.25	0.23	0.017
Fabricated metal products	3.04	1.38	0.49	0.004
Industrial machinery and equipment	3.01	1.40	0.47	0.004
Electronic and other electric equipment	3.17	1.48	0.44	0.006
Transportation equipment	2.64	0.76	0.33	0.004
Instruments and related products	2.70	1.13	0.40	0.006
Miscellaneous manufacturing industries	3.23	1.41	0.51	0.004

IV. Price Rigidity Over the Business Cycle

Finally, we undertook to determine whether price rigidity or the effects of durability and concentration on price rigidity differed in any important ways between the recession of July 1990–March 1991 and an expansionary period of equal length following the recession. The motivation for looking specifically at a recession comes from the administered-pricing literature written initially in response to perceived differences in pricing behavior across markets during the 1930s Depression.

As in the last section, we are encouraged by the robustness of our results.[12] First, in a comparison of Tables XIV and XV, we see that, overall, prices exhibit more or less the same amount of rigidity across the business cycle.[13] For some industry groups, prices appear to be more rigid during the recession, while, for others, the opposite conclusion is reached.

We also looked at the effects of seller concentration and durability during the recession relative to their effects during the two expansionary periods surrounding

[12] We return to assumption set (1) in this section in order to be able compare results to those in the previous two sections.

[13] The average spell lengths are shorter than for the twelve-year time period as a whole because the eight-month truncation disallows very long spells.

Table XV. Basic rigidity measures for major manufacturing industry groups: July 1992–March 1993 expansionary period

Major industry group	ASL	St. dev.	$PCTS$	PA
Food and kindred products	2.66	1.18	0.20	0.024
Tobacco products	2.92	1.16	0.39	0.011
Textile mill products	2.90	1.32	0.38	0.004
Apparel and other textile products	3.12	1.57	0.49	0.003
Lumber and wood products	2.81	1.21	0.15	0.026
Furniture and fixtures	2.97	1.48	0.40	0.004
Paper and allied products	2.83	1.39	0.34	0.007
Printing and publishing	2.86	1.21	0.40	0.007
Chemicals and allied products	3.02	1.47	0.36	0.009
Petroleum and coal products	2.48	0.75	0.13	0.029
Rubber and miscellaneous plastics products	3.16	1.68	0.47	0.005
Leather and leather products	2.85	1.42	0.40	0.007
Stone, clay, and glass products	3.10	1.40	0.43	0.004
Primary metal industries	2.82	1.27	0.27	0.011
Fabricated metal products	3.17	1.56	0.44	0.004
Industrial machinery and equipment	3.18	1.48	0.47	0.003
Electronic and other electric equipment	3.03	1.51	0.36	0.005
Transportation equipment	3.03	1.38	0.29	0.004
Instruments and related products	2.87	1.40	0.48	0.004
Miscellaneous manufacturing industries	3.45	1.75	0.42	0.004

Table XVI. Ordinary least squares results: 7/90–3/91 (t-statistics in parentheses)

				Independent variable		
Product type	Obs.	Dep. var.	Intercept	CR_4	Dur.	F
Consumer	185	ASL	2.480[a]	0.005	0.396[b]	2.862[c]
			(9.78)	(1.22)	(2.33)	
Producer	435	ASL	2.542[a]	0.007[a]	0.101	3.799[b]
			(15.30)	(2.65)	(0.76)	
Consumer	220	$PCTS$	0.211[a]	0.002[a]	0.147[a]	10.436[a]
			(4.25)	(2.47)	(4.32)	
Producer	572	$PCTS$	0.270[a]	−0.0003	0.116[a]	11.425[a]
			(8.41)	(−0.55)	(4.75)	
Consumer	220	PA	0.018[a]	−0.0001[b]	−0.010[a]	12.973[a]
			(6.28)	(−2.00)	(−5.03)	
Producer	571	PA	0.014[a]	0.00005	−0.010[a]	18.461[a]
			(6.71)	(1.45)	(−5.90)	

[a] Significant at the 1% level.
[b] Significant at the 5% level.
[c] Significant at the 10% level.

Table XVII. Ordinary least squares results: 11/82–7/90 (t-statistics in parentheses)

Product type	Obs.	Dep. var.	Intercept	Independent variable CR_4	Dur.	F
Consumer	231	ASL	2.689[a]	0.012[a]	0.562[a]	8.163[a]
			(11.18)	(2.88)	(3.46)	
Producer	586	ASL	2.762[a]	0.010[a]	0.515[a]	12.056[a]
			(15.23)	(3.28)	(3.56)	
Consumer	236	$PCTS$	0.375[a]	0.002[a]	0.192[a]	21.601[a]
			(8.47)	(2.98)	(6.38)	
Producer	626	$PCTS$	0.364[a]	0.0003	0.209[a]	38.556[a]
			(11.86)	(0.56)	(8.74)	
Consumer	236	PA	0.020[a]	−0.0001[a]	−0.009[a]	16.472[a]
			(8.11)	(−3.08)	(−5.42)	
Producer	626	PA	0.013[a]	0.00005[b]	−0.008[a]	34.711[a]
			(9.75)	(2.37)	(−8.06)	

[a] Significant at the 1% level.
[b] Significant at the 5% level.
[c] Significant at the 10% level.

Table XVIII. Ordinary least squares results: 3/91–7/94 (t-statistics in parentheses)

Product type	Obs.	Dep. var.	Intercept	Independent variable CR_4	Dur.	F
Consumer	212	ASL	2.590[a]	0.01[a]	0.670[a]	5.584[a]
			(7.28)	(2.60)	(2.77)	
Producer	530	ASL	3.210[a]	0.01[c]	0.146	1.922
			(14.89)	(1.76)	(0.83)	
Consumer	237	$PCTS$	0.304[a]	0.003[a]	0.248[a]	25.488[a]
			(5.88)	(3.31)	(6.95)	
Producer	625	$PCTS$	0.373[a]	0.001	0.193[a]	23.884[a]
			(10.43)	(0.89)	(6.83)	
Consumer	237	PA	0.015[a]	−0.0001[c]	−0.008[a]	13.053[a]
			(6.38)	(−1.85)	(−5.07)	
Producer	625	PA	0.012[a]	0.00003	−0.008[a]	22.264[a]
			(8.18)	(1.29)	(−6.57)	

[a] Significant at the 1% level.
[b] Significant at the 5% level.
[c] Significant at the 10% level.

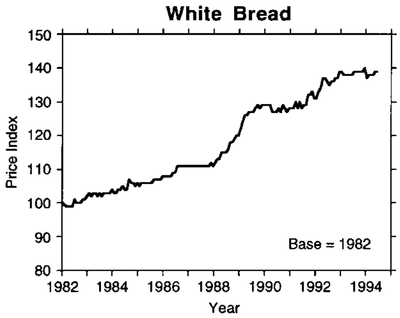
that recession. It turns out that, again, the stage of the business cycle does not matter to our general conclusions. Both concentration and durability are seen to be positively related to rigidity, with durability's having the consistently stronger influence. We report our regression results for the recession, the earlier expansionary period, and the later expansionary period in Tables XVI–XVIII, respectively.

V. Conclusions

Despite our willingness to work with price indices (rather than with individual transaction prices), we find a certain degree of price rigidity in U.S. manufacturing during the last twelve years. Our estimates are undoubtedly quite conservative since a single price change among reporters may induce a change in a price index. Yet, we have been quite comprehensive in scope; we have looked at price patterns for over 4,000 individual commodities.

In terms of explaining rigidity, we have gone farther than Carlton (1986). Whereas seller concentration is found to be a statistically significant positive influence on rigidity, especially as measured by average duration of price constancy, durability is found to be the more compelling influence. However, we would conclude based on this study that both concentration and durability are important explanatory variables – as well as product type.

Appendix A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Price Index
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140
130
120
110
100
90
80
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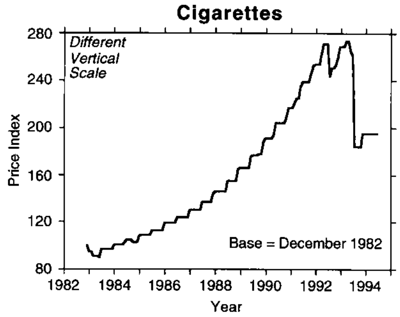
1982 1984 1986 1988 1990 1992 1994
Year


Cigarettes
Different Vertical Scale
Price Index
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240
200
160
120
80
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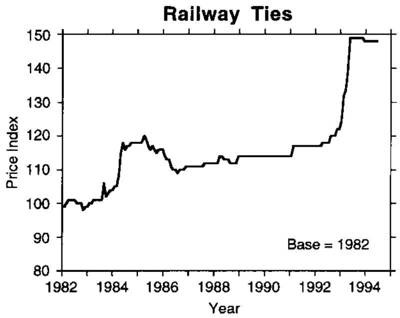
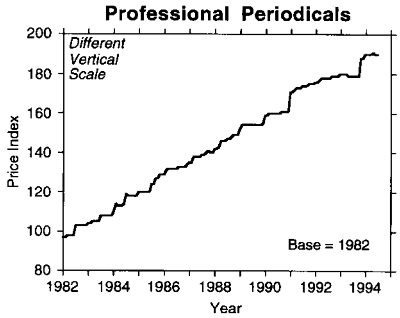
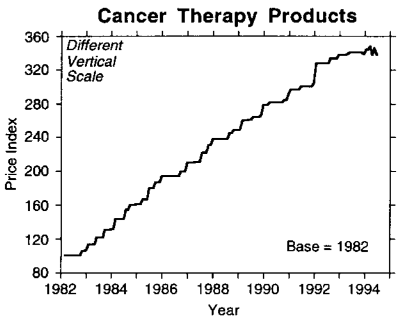
1982 1984 1986 1988 1990 1992 1994
Year


Railway Ties
Price Index
150
140
130
120
110
100
90
80
Base = 1982
1982 1984 1986 1988 1990 1992 1994
Year


Professional Periodicals
Different Vertical Scale
Price Index
200
180
160
140
120
100
80
Base = 1982
1982 1984 1986 1988 1990 1992 1994
Year


Cancer Therapy Products
Different Vertical Scale
Price Index
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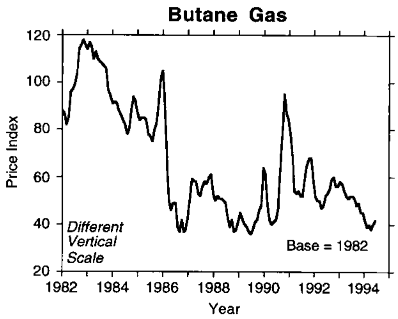
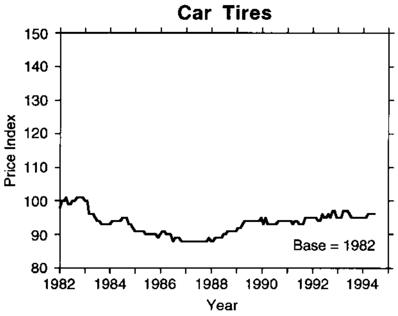
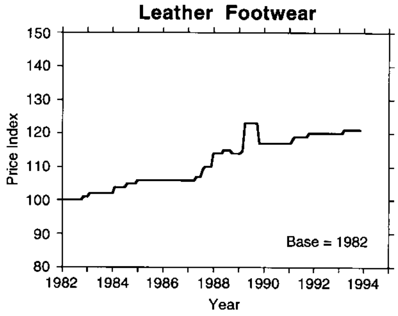
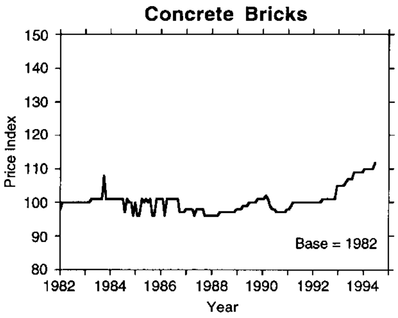
320
280
240
200
160
120
80
Base = 1982
1982 1984 1986 1988 1990 1992 1994
Year


Butane Gas
Different Vertical Scale
Price Index
120
100
80
60
40
20
Base = 1982
1982 1984 1986 1988 1990 1992 1994
Year


Car Tires
Price Index
150
140
130
120
110
100
90
80
1982 1984 1986 1988 1990 1992 1994
Year
Base = 1982


Leather Footwear
Price Index
150
140
130
120
110
100
90
80
1982 1984 1986 1988 1990 1992 1994
Year
Base = 1982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Price Index
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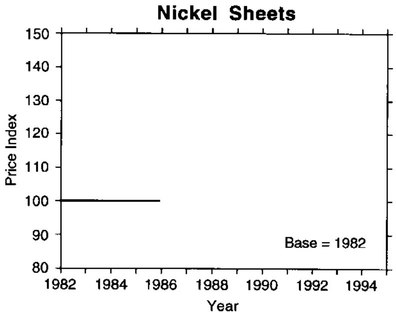
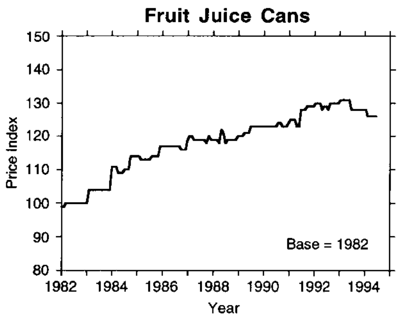
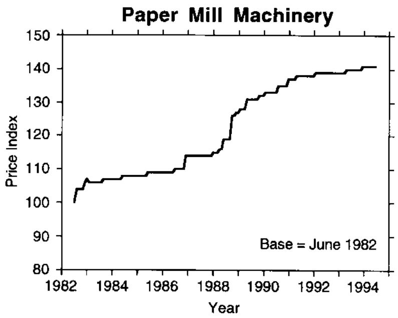
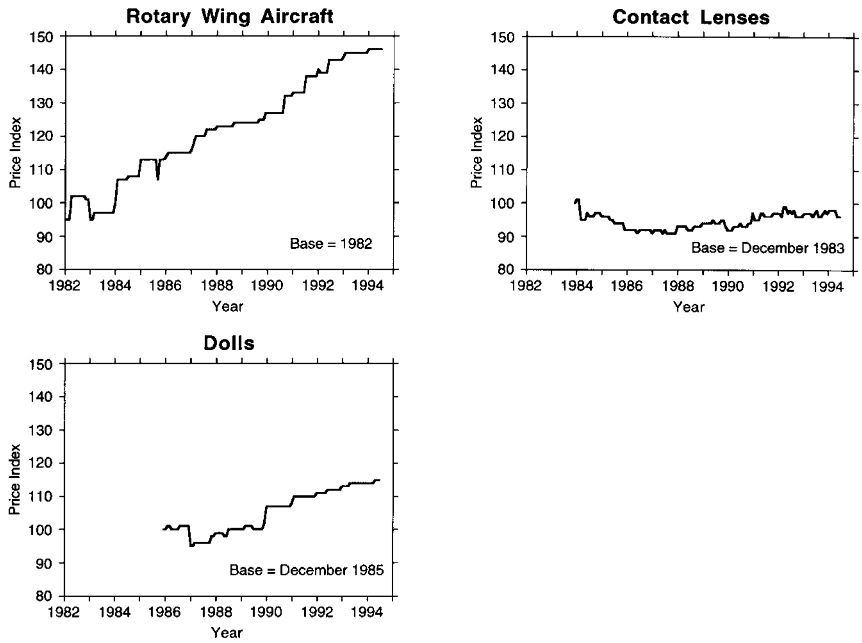
140
130
120
110
100
90
80
1982 1984 1986 1988 1990 1992 1994
Year
Base = 1982


Nickel Sheets
Price Index
150
140
130
120
110
100
90
80
1982 1984 1986 1988 1990 1992 1994
Year
Base = 1982


Fruit Juice Cans
Price Index
150
140
130
120
110
100
90
80
1982 1984 1986 1988 1990 1992 1994
Year
Base = 1982


Paper Mill Machinery
Price Index
150
140
130
120
110
100
90
80
1982 1984 1986 1988 1990 1992 1994
Year
Base = June 1982



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