Commodity price volatility: trends during 1975–84

Analysis of 156 Producer Price Indexes confirms that prices fluctuate most for crude materials and are most stable for finished goods; the volatility index for food consistently exceeds the corresponding index for nonfood items

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It has long been observed that commodity prices exhibit wide ranges of variability. Some prices persistently fluctuate sharply from month to month because of special supply or demand factors (or both) relating to respective commodity markets. In such cases, supply and demand are said to be "price inelastic," meaning that a small shift in supply or in demand results in a large price change. This occurs most frequently in competitive markets for goods which have only limited substitutes. For example, agricultural products and their derivatives are subject to sharp price changes because of the influence of weather on production and marketing. Demand (and hence prices) for basic materials traded internationally may change rapidly because of exchange rate movements, political turmoil, or large purchases by governments.

These are the primary factors which have been cited as causing commodity price instability. (Note that we are discussing microeconomic factors relating to particular products, not macroeconomic factors.) It is believed that these factors affect certain commodities more than others. Likewise, the volatility of prices for these commodities is generally regarded as persistent.

We intend to test these widely held beliefs by analyzing short-term price movements for a broad range of goods over a 10-year period. A judgmental sample of 156 Producer Price Indexes for commodity groupings was chosen for this purpose.[1] For each index series, monthly percent changes were computed from January 1975 to December 1984 (seasonally adjusted data were used if available between 1979 and 1984). Data were excluded for the pre-1975 period, which was marked by a series of major grain- and oil-related "shocks."[2]

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Measurement methods

Our choice of a mathematical tool to measure volatility depends on how we define volatility. If the definition "noting or subject to constant or sharp fluctuation"[3] is used, a logical measure would be the *mean of the absolute values of the monthly percent changes*. Because this measure implicitly assumes a flat price level as a reference standard, we call it the "static volatility index" in this article.

In the context of substantial inflation, however, prices for most goods will show a persistent upward trend. In such a case, the static volatility index is biased because it inappropriately counts the more-or-less regular price increases as though they were irregular deviations. To distinguish the trend of a time series from the truly random movements that characterize its volatility *per se*, we need to modify the above definition to read: "noting or subject to constant or sharp fluctuations that are serially independent."

Accordingly, we will place primary emphasis on an alternative measure of volatility, namely, the *standard deviation of the monthly percent changes*. This measure focuses

on the variability of the rate of price changes, as opposed to the variability of the price level. We call this measure the "dynamic volatility index" to indicate that its magnitude is not affected by any underlying trend in the time series. The dynamic index will be used for making ordinal comparisons between commodities. The static volatility index, although flawed, does convey useful information and plays a subsidiary role in the analysis. The absolute or cardinal magnitude of the static index carries more meaning than does that of the dynamic index; the static index value may be used to judge the significance of a given monthly change for a particular commodity in a historical context.

To produce objective indices of price volatility, the values of the commodities were combined to yield unweighted averages (that is, each commodity counts the same) for various Producer Price Index stage-of-processing categories. There were two major issues to resolve: Which types of commodities tend to be most volatile and what are their patterns of volatility? Does price volatility (or stability) persist for certain commodities over time? To answer the second question, the volatility index for each series was calculated for two subperiods: the 1979–81 period of high inflation and the 1982–84 period when the rate of inflation decelerated.

Volatility indices: the results

Table 1 shows the dynamic and the static indices for the 156 commodity groupings studied for the full 1975–84 period. Commodities are ranked from most to least volatile according to the dynamic index. For the two subperiods 1979–81 and 1982–84, only the dynamic indices are shown. Unless otherwise stated, references to volatility indices in this article are for the dynamic measure for the 1975–84 period.

As expected, the volatility indices vary widely. Over the entire interval studied, 1975–84, the least volatile reading was 0.4 percent; the most volatile was 16.5 percent. The unweighted mean value of all the volatility indices was 2.4. However, when these values are distributed by frequency, we see that a substantial majority of the cases fall below 2.0 percent. (See exhibit 1.) The value associated with the largest number of cases (14), that is, the mode, is 0.8, while the median value is 1.1 percent (that is, just as many cases show readings larger than 1.1 as those showing smaller readings). The reason the mean is much higher than the median is that the frequency distribution is skewed, with several observations showing very high values. An interesting aspect of this distribution is that it conforms roughly to the classical Chi-Square distribution.

For the most part, rankings of commodities according to volatility were similar whether the dynamic or the static indices were used. The dynamic volatility indices were generally larger, but this itself has no significance, given that different quantities are being measured. What is notable is that the correlation coefficient for the two sets of indices is .981, a very high reading. There were only two cases where one index was three times as great as the other: photographic supplies (5.2 dynamic versus 1.5 static) and primary nickel (3.0 versus 0.9). Both these cases were marked by a few isolated months of extreme price change. It would appear, then, that the static index may be useful as far as indicating when volatility in a given series is less "typical," that is, limited to a relatively few periods.

Exhibit 1. Frequency distribution of commodity price volatility indices

Standard deviation of monthly percent changes, 1975–84	Number of cases
0.0 – 0.4	7
0.5 – 0.9	58
1.0 – 1.4	22
1.5 – 1.9	13
2.0 – 2.4	2
2.5 – 2.9	9
3.0 – 3.4	6
3.5 – 3.9	5
4.0 – 4.4	5
4.5 – 4.9	5
5.0 – 5.4	2
5.5 – 5.9	5
6.0 – 6.4	3
6.5 – 6.9	2
7.0 – 7.4	4
7.5 – 7.9	1
8.0 – 8.4	1
8.5 – 8.9	1
9.0 – 9.4	3
9.5 and over	2

It is commonly observed that when many statistical series are aggregated into a single measure, the volatile fluctuations of the components tend to cancel each other out. Other things being equal, the more components a series contains, the more stable the group will be. In this article, the volatility of the three principal stage-of-processing groups and their components were computed in two ways: (1) by simply averaging the volatility measures of the commodities within each stage-of-processing group; and (2) by measuring the volatility of the groups themselves. Because of the statistical phenomenon described earlier, the second method of computation resulted in lower volatility indices, compared with the first method of simple unweighted averaging. Furthermore, the relative differences between these two methods were generally more pronounced in those stage-of-processing categories with many commodities, for example, in the intermediate goods group.

The stabilizing impact of aggregation also has an indeterminate effect on the results shown for many of the commodity price volatility indices. Some "commodities" in this study are more broadly defined than others. For example, both apparel and electronic components include many specific items and are quite stable, as would be expected.

Table 2 shows volatility indices for the three major stage-of-processing categories and their principal components, each calculated under both methods. The results of the second method (shown in parentheses) illustrate how the ag-

gregation process imparts a stabilizing influence. Because the volatility of the stage-of-processing categories as measured by the second method depends so heavily on the number of items they include, the following discussion is based on results of the first method, that is, the average of the component series' volatility. (These average volatility indices for the stage-of-processing categories are shown in table 1.)

Patterns and trends. The results shown in table 2 permit some general inferences. First, prices for crude materials are consistently the most volatile. This was true in all three periods, and in both food and nonfood categories. This result was expected, partly because of the predominance of agricultural products within the crude materials category and partly because demand for basic industrial materials fluctuates relatively sharply in response to real and perceived changes in demand for manufactured goods. Second, prices for finished goods tend to be more stable than those for either intermediate or crude materials. This pattern held for food as well as nonfood categories, and in all periods. Within the finished goods category, prices for capital equipment items were the least volatile. Because purchase orders for most types of machinery are placed several months ahead of delivery, demand does not exhibit as much short-term fluctuation as does demand for consumer goods or materials; therefore, prices change less often. From these two observations, we may conclude that the price volatility of a particular good is likely to be strongly correlated with its level in the production chain; crude goods being the most volatile, and finished goods, the least.

Another pattern confirmed in table 2 is that food prices are consistently more volatile than nonfood goods prices at all stages of processing and during each period. This follows from the earlier observation that weather and marketing peculiarities cause agricultural product prices to fluctuate more than industrial products. The volatility in processed food prices (particularly in meats) simply reflects the relatively high proportion of total manufacturing costs accounted for by the foodstuff inputs.

Table 1. Dynamic and static price volatility indices for selected commodities, by stage of processing

Producer Price Index	1975–84		1979–81	1982–84	Producer Price Index	1975–84		1979–81	1982–84
	Dynamic	Static	Dynamic	Dynamic		Dynamic	Static	Dynamic	Dynamic
Finished goods[1]	1.7	1.3	1.6	1.5	**Capital equipment[1]**	.8	.7	.8	.7
Finished consumer foods[1]	3.5	2.5	3.2	3.3	Heavy trucks	1.7	1.2	1.2	2.0
					Light trucks	1.6	1.2	1.6	1.6
Fresh and dried vegetables	9.1	7.4	9.3	10.6	Photographic equipment	1.5	.8	.7	2.4
Eggs	7.0	5.2	7.2	7.7	Fixed wing utility aircraft	1.4	1.0	1.9	1.0
Fresh fruits	6.3	4.9	4.9	7.1	Chemical industry machinery	1.1	.7	1.2	.5
Processed poultry	4.8	3.3	6.4	2.5	Food products machinery	.9	.8	.9	.8
Pork	4.4	3.4	4.6	3.9	Oilfield and gasfield machinery	.9	.8	.8	.5
Beef and veal	4.1	3.1	3.5	2.5	Mining machinery and equipment	.9	.8	.7	.4
Fish	4.1	2.8	2.7	6.3	Printing trades machinery	.8	.7	1.0	.9
Roasted coffee	3.6	2.2	2.8	.8	Transformers and power regulators	.8	.7	1.0	.6
Shortening and cooking oils	3.0	1.8	1.2	4.0	Woodworking machinery	.8	.6	.9	.5
Confectionery end products	1.3	.7	1.2	1.5	Metal forming machine tools	.7	.7	.7	.4
Soft drinks	1.0	.7	1.3	.6	Commercial furniture	.7	.6	.7	.5
Other cereals	1.0	.6	1.2	.7	Railroad equipment	.6	.6	.6	.6
Processed fruits and vegetables	.9	.7	.9	.7	Pumps and compressors	.6	.6	.6	.3
Dairy products	.8	.7	.6	.4	Textile machinery	.6	.5	.7	.5
Bakery products	.6	.6	.5	.4	Metal cutting machine tools	.5	.7	.5	.4
Finished consumer goods, excluding foods[1]	1.3	1.0	1.3	1.2	Construction machinery and equipment	.5	.6	.5	.3
					Industrial material handling equipment	.5	.5	.5	.2
Platinum and karat gold jewelry	5.7	3.7	7.1	3.7	Agricultural machinery and equipment	.4	.6	.3	.4
Natural gas	3.7	2.7	1.8	1.8	Integrating and measuring instruments	.4	.5	.5	.3
Fuel oil #2	3.0	2.2	3.4	3.3	Office and store machines	.4	.4	.5	.3
Gasoline	2.6	2.0	2.8	2.7					
Tobacco products	2.1	1.3	1.3	3.1	**Intermediate goods[1]**	2.2	1.5	2.6	1.7
Small arms, ammunition	1.4	1.0	1.5	1.8					
Cosmetics, and so forth	1.3	1.0	1.6	1.6	**Intermediate foods and feeds[1]**	5.4	3.5	5.0	3.6
Tires and tubes	1.1	.8	1.0	.7					
Home electronic equipment	.9	.6	1.0	.7	Crude vegetable oils	9.1	6.4	4.5	9.9
Sanitary papers, and so forth	.8	.7	.9	.6	Refined sugar	7.3	3.6	11.1	1.2
Passenger cars	.8	.7	1.0	.8	Prepared animal feeds	4.4	3.1	3.5	2.6
Soaps, synthetic detergents	.8	.6	1.0	.7	Confectionery materials	3.2	2.3	3.4	3.3
Luggage and small leather goods	.8	.6	.8	1.0	Flour	2.8	1.9	2.7	1.0
Textile housefurnishings	.8	.6	.8	.6					
Footwear	.7	.6	.9	.6	**Intermediate goods, excluding foods**	2.0	1.4	2.4	1.6
Toys, games, and so forth	.7	.6	.8	.6					
Floor coverings	.7	.5	.8	.7	Primary silver	16.5	9.8	26.4	13.3
Sporting, athletic goods	.6	.5	.7	.5	Primary gold	9.4	5.8	13.6	8.4
Prescription drugs	.5	.7	.6	.7	Primary lead	7.0	4.8	9.3	6.9
Over-the-counter drugs	.5	.7	.7	.3	Primary tin	5.7	4.0	3.9	7.2
Alcoholic beverages	.5	.5	.6	.5	Inedible fats and oils	5.5	4.1	6.0	4.2
Household furniture	.4	.5	.4	.3					
Household appliances	.4	.4	.4	.3					
Apparel	.4	.4	.3	.4					

See footnote at end of table.

Table 1. Continued—Dynamic and static price volatility indices for selected commodities, by stage of processing

Producer Price Index	1975–84		1979–81	1982–84
	Dynamic	Static	Dynamic	Dynamic
Intermediate goods, excluding foods—Continued:				
Photographic supplies	5.2	1.5	8.4	.8
Primary copper	4.6	3.3	6.4	4.2
Liquefied petroleum gas	3.8	2.7	3.6	3.7
Residual fuel	3.8	2.6	4.8	2.5
Leather	3.6	2.4	5.6	1.8
Primary zinc	3.4	2.4	3.5	4.0
Primary nickel	3.0	.9	4.3	0
Kerosene	2.8	2.2	3.1	3.2
Diesel fuel	2.8	2.0	3.2	3.1
Softwood lumber	2.5	2.0	3.0	2.2
Plywood	2.5	1.9	3.0	1.6
Commercial jet fuel	2.5	1.7	3.3	.9
Paving mixtures and blocks	2.0	1.2	3.1	.9
Asphalt felts and coatings	1.8	1.4	2.3	1.6
Nonferrous wire and cable	1.8	1.1	2.6	.7
Glass containers	1.8	1.1	1.6	1.1
Woodpulp	1.8	.9	1.9	2.0
Gypsum products	1.7	1.3	1.2	2.0
Plastic construction products	1.6	1.1	1.3	2.3
Motor vehicle parts	1.6	.8	2.6	.5
Coke oven products	1.6	.6	1.5	2.0
Mixed fertilizers	1.5	.9	1.2	.7
Refractories	1.3	.7	1.1	1.1
Plastic resins and materials	1.2	.9	1.5	.8
Paint materials	1.2	.8	.6	.9
Hardwood lumber	1.1	.9	.6	1.0
Synthetic rubber	1.1	.9	1.4	.5
Millwork	1.1	.9	1.2	.9
Nonferrous mill shapes	1.1	.9	1.0	1.2
Metal containers	1.1	.8	.9	.5
Industrial chemicals	1.1	.8	1.1	.9
Plastic parts and components	1.1	.6	1.4	.4
Flat glass	1.1	.6	1.0	1.2
Steel mill products	1.0	.8	.9	.6
Portland cement	.9	.9	.6	1.3
Paperboard	.9	.8	.9	.9
Gray fabrics	.9	.7	.9	.5
Processed yards and threads	.9	.7	1.0	.6
Synthetic fibers	.9	.7	.7	.8
Unsupported plastics	.9	.5	1.4	.7
Electric power	.8	.9	.7	.7
Clay construction products, excluding refractories	.8	.7	.9	.6
Switchgear and switchboards	.8	.6	1.1	.6
Paper boxes and containers	.8	.6	1.0	.5
Prepared paints	.8	.5	1.2	.5
Abrasive products	.7	.7	.7	.7
Motors and generators	.7	.7	.7	.6
Foundry and forge shop products	.7	.6	.6	.3
Plastic packaging	.7	.5	.9	.3
Internal combustion engines	.6	.7	.5	.7
Electronic components and accessories	.6	.6	.6	.4
Wiring devices	.6	.6	.6	.3
Cutting tools and accessories	.6	.6	.8	.3
Plumbing fixtures and brass fittings	.6	.6	.6	.6
Paper	.6	.6	.6	.7
Finished fabrics	.6	.5	.5	.4
Concrete products	.5	.6	.5	.4
Mechanical power transmission equipment	.5	.6	.5	.4
Hardware	.5	.6	.4	.3
Fabricated structural metal products	.5	.5	.5	.3
Air conditioning and refrigeration equipment	.5	.5	.5	.4
Heating equipment	.4	.5	.5	.4
Crude materials[1]	5.0	3.5	5.4	3.5
Crude foodstuffs and feedstuffs[1]	6.1	4.3	6.5	4.0
Raw cane sugar	11.5	7.6	15.9	3.5
Cocoa beans	8.4	6.1	6.0	7.5
Green coffee	7.3	4.2	8.2	1.2
Oilseeds	6.6	4.7	5.2	5.8
Hogs	6.5	4.9	7.6	5.7
Live poultry	6.3	4.7	7.6	5.5
Corn	5.3	4.0	5.5	5.1
Wheat	4.1	3.0	4.8	2.3
Cattle	4.0	3.0	3.6	2.7
Fluid milk	1.1	.8	.9	.4
Crude nonfood materials[1]	4.1	2.9	4.5	3.1
Cattle hides	8.7	5.9	11.3	3.7
Aluminum base scrap	7.7	5.7	7.4	7.1
Raw cotton	6.1	4.8	6.1	4.5
Copper base scrap	5.7	4.1	7.1	4.4
Iron and steel scrap	5.5	4.2	6.1	3.8
Crude natural rubber	4.4	3.1	5.6	3.7
Wastepaper	4.3	2.8	3.8	4.5
Crude petroleum	3.0	1.6	4.2	1.2
Potash	2.9	1.9	1.8	3.7
Leaf tobacco	2.6	1.7	2.2	2.0
Iron ore	1.5	.6	1.8	.6
Coal	1.0	.6	.5	.5
Sand, gravel, and so forth	.5	.6	.5	.4

[1]Unweighted averages of the commodity volatility indexes within each stage-of-processing category.

An additional salient feature discerned in table 2 is the stabilizing trend in prices which occurred between 1979–81 and 1982–84. Except for finished consumer foods, all of the stage-of-processing categories showed reduced average volatility indices in the latter period. (Actually, the differences for the finished goods categories were negligible, compared with the differences among crude and intermediate goods.) These results are consistent with the expectation that a trend toward greater price stability at the aggregate level would be mirrored by a similar trend at the commodity level.

This hints at another statistical pattern: Although most of the stage-of-processing categories showed marked decreases in price volatility between the 1979–81 and 1982–84 periods, they maintained roughly the same relative position in each period. In other words, those categories which were most volatile in the 1979–81 period were also most volatile in the 1982–84 period; the least volatile categories exhibited the same pattern.

Persistent volatility. Is price volatility persistent among particular commodities? A casual examination of the data for 1979–81 and 1982–84 intervals does seem to indicate a strong degree of persistence of volatility. The coefficient of correlation between the two intervals for the volatility indexes for all 156 commodities included in this study was .748, meaning that more than 50 percent (R-squared = .560) of the variation in volatility among commodities in the later period could be explained by relative differences in volatility in the earlier period. This would seem to confirm that price volatility is to a large extent a long-term characteristic of certain commodities.

In many cases, the change in commodity volatility during the 1979–81 and 1982–84 periods was caused by special

market conditions. Nearly all cases of major shifts (that is, when one index was at least three times greater than the other) involved decreases from the earlier period to the latter. For example, prices for both refined sugar and raw cane sugar rose very sharply during 1980 because of poor harvests in Cuba, the Soviet Union, and elsewhere. Likewise, prices for photographic supplies have been fairly stable in recent years, in contrast to the drastic changes that occurred in early 1980 in response to similar convulsions in world silver markets. These and other cases demonstrate that there are always instances where market abnormalities can cause temporary surges in price volatility.

Summary of findings

The category with the highest average volatility (6.1 percent) was crude foodstuffs and feedstuffs. Prices for raw cane sugar, cocoa beans, and green coffee beans (all of which are traded internationally) registered volatility indices of more than 7 percent. In contrast, fluid milk prices showed a volatility of only 1.1 percent, probably reflecting the stabilizing effect of Federal price supports. The indices for all other foodstuffs and feedstuffs range from 4 to 7 percent. At the intermediate level, prices for foods and feeds were somewhat more stable than at the crude level, except for vegetable oils (9.1 percent).

For the finished consumer foods category, price changes registered an average standard deviation of 3.5 percent. Farm produce items (eggs, fresh fruits, and fresh vegetables) showed the most volatility, falling in the 6- to 9-percent range. Meats, poultry, and fish were in the neighborhood of 4 to 5 percent, while roasted coffee and shortening and cooking oils were between 3 and 4 percent. Other consumer foods were much less volatile.

Crude nonfood material prices averaged a 4.1-percent volatility. The commodities which fluctuated the most (more than 5 percent) were cattle hides, raw cotton, and scrap metal. Prices were relatively stable, at 0.5 to 1.5 percent, for coal, iron ore, and sand and gravel.

Price volatility averaged 2.0 percent for intermediate materials other than foods and feeds. The sharpest movements were for silver, gold, lead, tin, inedible fats and oils, and photographic supplies (all at least 5 percent). Volatility indices averaged between 2 and 4 percent for most intermediate energy goods, while coke oven products and electric power were somewhat more stable. In addition, volatility indices were at least 2.5 percent for copper, zinc, nickel, leather, plywood, and softwood lumber.

Table 2. Volatility indices for selected stage-of-processing groupings

Stage of processing	1975–84		1979–81	1982–84
	Dynamic	Static	Dynamic	Dynamic
Finished goods	1.7 (.4)	1.3 (.5)	1.6 (.4)	1.5 (.3)
Finished consumer foods	3.5 (.9)	2.5 (.8)	3.2 (.9)	3.3 (.7)
Finished consumer goods, excluding foods	1.3 (.6)	1.0 (.7)	1.3 (.7)	1.2 (.4)
Capital equipment	.8 (.3)	.7 (.5)	.8 (.3)	.7 (.2)
Intermediate goods	2.2 (.5)	1.5 (.6)	2.6 (.6)	1.7 (.2)
Intermediate foods and feeds	5.4 (2.4)	3.5 (1.7)	5.0 (2.5)	3.6 (1.3)
Intermediate goods, excluding foods	2.0 (.5)	1.4 (.6)	2.4 (.6)	1.6 (.2)
Crude materials	5.0 (1.5)	3.5 (1.3)	5.4 (1.6)	3.5 (.9)
Crude foodstuffs and feedstuffs	6.1 (2.3)	4.3 (1.9)	6.5 (2.5)	4.0 (1.8)
Crude nonfood materials	4.1 (1.4)	2.9 (1.1)	4.5 (1.5)	3.1 (.7)

NOTE: The indices other than those in parentheses are from table 1, and are the unweighted averages of the commodity volatility indices within each stage-of-processing category. Indices in parentheses reflect the volatility of the stage-of-processing groupings themselves.

Price movements for finished consumer goods excluding foods exhibited an average standard deviation of 1.3 percent. The most volatile component was platinum and karat gold jewelry, which averaged 5.7 percent. Natural gas, home heating oil, and gasoline were somewhat less volatile, ranging from 2.6 to 3.7 percent. Tobacco products led the remainder of consumer nonfood goods with an average of 2.1 percent. Many other items in this category were much more stable, such as apparel and household appliances (0.4 percent each).

The most stable category of all was capital equipment, where price fluctuations registered an average 0.8-percent standard deviation. Items within this grouping showed a fairly uniform set of volatility readings, with half recording standard deviations ranging from 0.6 to 0.9 percent. The most volatile components were trucks (light and heavy), photographic equipment, fixed wing utility aircraft, and chemical industry machinery. □

FOOTNOTES

[1] This sample includes nearly all of the indexes shown in table 2 (plus a few others) of the monthly Producer Price Index news release and the detailed report. Items were omitted if they carried negligible weight or if there were fewer than 6 years of historical data.

[2] For comparison purposes, the same calculations were also made for the unadjusted time series. As expected, the unadjusted indexes tended to be more volatile, but the differences were generally minor.

[3] Taken from the *Random House College Dictionary, Revised Edition*, copyright 1980, p. 1474.