The Seasonality of Consumer Prices

by Michael F. Bryan and Stephen G. Cecchetti

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Introduction

Early in 1993, the Consumer Price Index (CPI) reversed course and increased at an annualized rate of roughly 4⅓ percent—about 1½ percentage points above its average growth rate during the previous six-month period. The prospect of rising inflation sent shock waves through capital markets and attracted the attention of monetary policymakers. The minutes of the Federal Open Market Committee (FOMC) meeting of May 18, 1993 document a commitment to shift the stance of monetary policy if the inflation statistics continued their ascent:

> In the view of a majority of the members, wage and price developments over recent months were sufficiently worrisome to warrant positioning policy for a move toward restraint should signs of intensifying inflation continue to multiply.

But in the months immediately following the FOMC's "asymmetric directive," the growth rate of the CPI moderated sharply, averaging less than 2½ percent per annum in the final six months of 1993. For the year as a whole, the CPI rose only about 2¾ percent, approximately ¼ percentage point *below* 1992's rate.

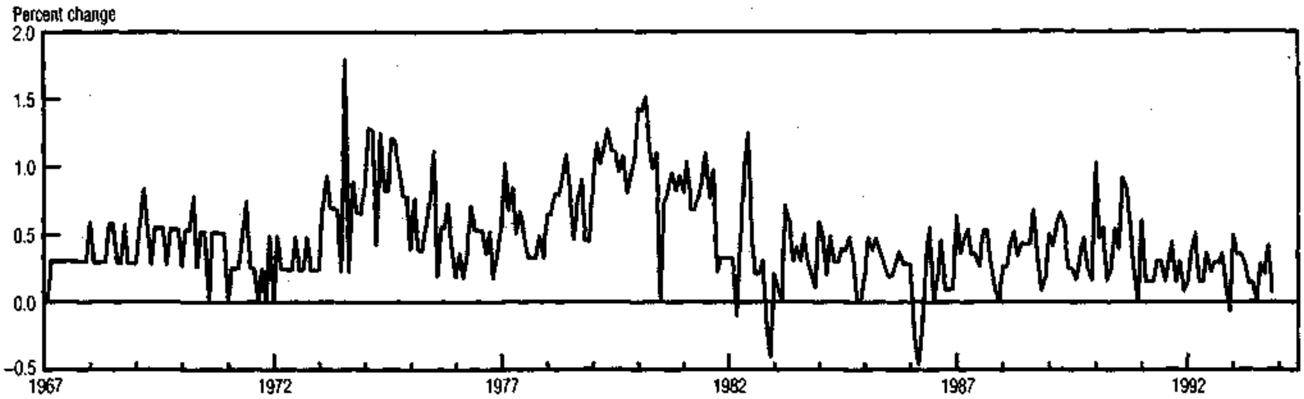
A popular interpretation of these events is that the inflationary scare of 1993 was a result of "seasonal" price increases that were not part of a more persistent inflationary process. In fact, several studies have identified a pattern of large price increases during the first several months of every year followed by a more moderate inflation performance over the balance of the year.[1] Indeed, prior to this recent experience, economists generally presumed that, relative to the real economy, prices contained little seasonal variation.

These observations raise an important question. Has the seasonality in prices changed substantially over the past quarter century? Perhaps seasonal variability was obscured by a dominant cyclical variability in prices over much of the post–World War II period. We do, in fact, find that seasonal price movements have become more prominent in the relatively stable inflation environment that has prevailed since 1982. Furthermore, we find that a substantial share of price seasonality is idiosyncratic in nature, which implies that seasonal patterns in

■ 1 See, for example, Biehl and Judd (1993).

FIGURE 1

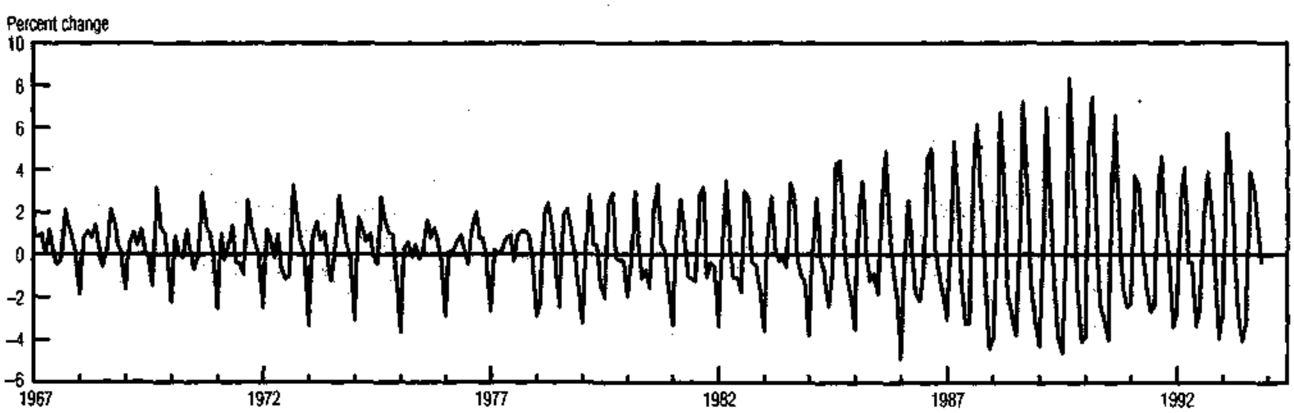
CPI, All Items
(not seasonally adjusted)



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

FIGURE 2

Women's Apparel Prices
(not seasonally adjusted)



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

individual price series are partially negated in the process of aggregation.

Figure 1 shows monthly movements for the CPI without seasonal adjustment. Though monthly consumer prices are certainly volatile, there is little obvious seasonal movement in the aggregate data. However, prices of most components display a distinct seasonal pattern, and for some, such as women's apparel (figure 2), the seasonal pattern is a prominent feature of the data.

In this paper, we reevaluate the evidence of seasonality in consumer prices in light of the relatively stable inflation seen in the United States during the past 10 years. In section I, we describe and catalog deterministic seasonality in individual consumer prices. Section II considers seasonality in aggregate prices and the procedure used by the U.S. Labor Department's Bureau of Labor Statistics (BLS) for adjusting individual price data to eliminate seasonal variation. We show that this procedure allows idiosyncratic noise to become incorporated into the price data. We consider the use of a limited-influence estimator, the median CPI, as a method of reducing seasonal noise.[2] We then briefly describe the case of stochastic seasonality in consumer prices before concluding in section III.

■ 2 See also Bryan and Cecchetti (1994).

TABLE 1

Deterministic Seasonality in the CPI, 1967–1993 (using Newey–West correction)

	Jan. 1967– Nov. 1993		Jan. 1967– Dec. 1981		Jan. 1982– Nov. 1993	
Months	α_s	t-stat	α_s	t-stat	α_s	t-stat
Jan.	0.054	1.50	−0.009	−0.27	0.139	2.80
Feb.	0.002	0.09	0.011	0.29	−0.007	−0.25
Mar.	0.102	0.27	0.019	0.39	0.000	0.01
April	0.029	0.88	0.014	0.33	0.050	0.92
May	0.018	0.56	0.014	0.38	0.024	0.47
June	0.067	2.53	0.077	3.21	0.055	1.12
July	−0.053	−1.46	−0.052	−0.89	−0.054	−1.83
Aug.	−0.006	−0.19	−0.058	−1.31	0.059	1.75
Sept.	0.121	3.00	0.074	1.34	0.181	4.21
Oct.	0.024	0.80	0.039	0.76	0.007	0.29
Nov.	−0.100	−3.09	−0.038	−1.09	−0.176	−4.53
Dec.	−0.165	−4.00	−0.091	−1.98	−0.278	−6.53
R^2	0.068		0.032		0.320	
Wald	88.040		44.650		330.600	
p-value	0.000		0.000		0.000	

SOURCE: Authors' calculations.

I. The Deterministic Seasonality of Prices

Miron (1990) identifies broad classifications of seasonal variation for a variable x_t, the most common being deterministic seasonality, specified as

$$(1) \qquad x_t = \sum_{s=1}^{S} \alpha_s d_t^s + \varepsilon_t,$$

where d_t^s is a dummy for season s ($d_t^s = 1$ in season s of period t, 0 otherwise), α_s is the mean of x_t in season s, S is the number of seasons per year (four for quarterly data and 12 for monthly data), and ε_t is a stationary stochastic process.[3]

Although data on real output and nominal money exhibit substantial deterministic seasonal variation, it is curious to note the absence of a deterministic seasonal pattern in aggregate prices. For example, Barsky and Miron (1989) find that seasonal dummies explain nearly 88 percent of the quarterly variation in U.S. real GDP, more than 92 percent of real final sales, and more than 50 percent of the nominal money stock during the postwar period. Beaulieu and Miron (1990) obtain similar results at a monthly frequency for retail sales, industrial production, and money growth for a broad cross-section of countries.

However, seasonal variation has accounted for only a small share of the variation in aggregate prices in the postwar period (for example, less than 4 percent of the monthly variation in the CPI). Perhaps exogenous seasonal increases in aggregate supply fortuitously coincide with increases in seasonal demand, resulting in the substantial seasonality of real spending and output while virtually eliminating the seasonal behavior of prices. This explanation has been dismissed as implausible by Barsky and Miron (1989) and Mankiw and Miron (1990).[4] Alternatively, it may be that aggregate supply is perfectly elastic. By extension, then, interest-rate targeting policies that do not adjust for fluctuations in the real rate of interest at a seasonal frequency may have real effects that are manifested in exaggerated seasonal output and employment fluctuations (Mankiw and Miron [1990]).

But the observed lack of seasonality in prices has been influenced by the predominant cyclical pattern of inflation during the 1970s and early 1980s, a pattern that has since been dramatically reduced. And as U.S. inflation has settled into a more stable pattern, seasonal variation has become a relatively more important and more obvious source of monthly price fluctuations. That is, there is certainly less appearance of price stickiness at a seasonal frequency since 1982.

We use equation (1) to estimate the deterministic seasonal pattern in the monthly CPI over the 1967 to 1993 period and over two subperiods: 1967 to 1981, and 1982 to 1993 (table 1). For the full period, we find that deterministic seasonality accounts for about 7 percent of the monthly variation in the CPI—similar to the results found by Beaulieu and

3 Throughout the paper, we examine seasonality in the log difference of prices. In contrast, the BLS applies a two-sided ARIMA X-11 filter to the level of prices that includes both past and future data. In limited instances where a trend shift in the data is suspected, the BLS seasonally adjusts using intervention analysis (see Buszuwski and Scott [1988]). We chose our method for two reasons: First, since our major interest is inflation, our goal is to seasonally adjust the growth rate of prices, not their levels. Second, we wish to model seasonality as either a deterministic or a simple stochastic process, in order to preserve the timing patterns in the data.

4 This explanation may not be as implausible as it initially seems. We find substantially more seasonality in energy prices after the collapse of OPEC price controls. It may well have been that OPEC price targets, which were managed by production quotas, operated at a seasonal frequency to maintain a constant price of oil. This accentuated seasonal behavior in energy prices may be an important seasonal cost fluctuation for a broad range of commodities in the post–1981 period.

TABLE 2

Deterministic Seasonality in 36 CPI Components, 1982–1993 (using Newey–West correction)[a]

	Variances		
	Seasonal	Unconditional	R^2
CPI—all items	**0.01406**	**0.04394**	**0.32**
Food away from home	0.00165	0.01868	0.09
Auto repair	0.00616	0.04310	0.14
Apparel services	0.00773	0.06910	0.11
Personal services	0.00952	0.06754	0.14
Housekeeping services	0.01233	0.14055	0.09
Medical commodities	0.01643	0.06702	0.25
Entertainment commodities	0.02178	0.10541	0.21
Housekeeping supplies	0.02290	0.13655	0.17
Toilet goods	0.02549	0.19028	0.13
Cereals	0.02692	0.09709	0.28
Shelter	0.02785	0.12018	0.23
Entertainment services	0.02902	0.09736	0.30
Other transp. commodities	0.03478	0.28866	0.12
Medical services	0.03849	0.06792	0.57
Dairy	0.03989	0.28452	0.14
Other utilities	0.04266	0.26639	0.16
Household furnishings	0.04366	0.16937	0.26
Alcoholic beverages	0.06237	0.30373	0.21
Other food	0.12482	0.20477	0.61
Public transportation	0.12575	1.12806	0.11
Meats	0.12898	0.76826	0.17
Other transp. services	0.13856	0.27041	0.51
New vehicles	0.16027	0.24708	0.65
Used vehicles	0.27306	0.87139	0.31
Tobacco	0.32535	1.27310	0.26
Other apparel	0.47608	1.79247	0.27
Infants' apparel	0.68437	2.94988	0.23
Books and supplies	0.76361	1.01300	0.75
Footwear	0.83807	1.22939	0.68
Educational services	1.08842	1.37163	0.79
Men's apparel	1.30880	1.58662	0.82
Motor fuel	1.78895	10.13414	0.18
Fruits	1.79705	6.02819	0.30
Gas and electricity	2.15611	2.78571	0.77
Fuel oil	2.71104	14.95497	0.18
Women's apparel	7.70884	9.40582	0.82

a. Variances reported are scaled by 10,000.
SOURCE: Authors' calculations.

Miron (1990). In the earlier, volatile inflation subperiod, deterministic seasonality represents about 3 percent of the monthly variation in consumer prices. Since 1982, however, seasonality accounts for approximately 32 percent of the monthly price movement.

Estimated over the 1982 to 1993 subperiod, the amount of deterministic seasonality in prices, as measured by the seasonal variance, $\sum_{s=1}^{S} (\alpha_s^2)$, differs greatly by item, making it difficult to generalize about seasonal price movements from the 36 consumer items considered here (table 2). For example, the largest seasonal variation in prices occurs in women's apparel (last row), where seasonal fluctuations also represent 82 percent of the total price variation. At the other extreme, food away from home (first row) exhibits a very small amount of seasonal variation. Furthermore, these variations account for only about 9 percent of the total price variation in this category.

In some cases, seasonal variation is relatively large, yet still amounts to a small share of the total variation in the individual price series. For example, fuel oil and motor fuel prices each rank high in terms of deterministic seasonal variation, but in both cases such seasonality accounts for only 18 percent of their total price variation. However, while the seasonal variation in medical services prices is rather small, seasonality contributed to a relatively high proportion of the category's total price variation (57 percent).

A casual reading of the seasonal patterns fails to reveal an easily identifiable origin of the seasonal variation of prices (table 3). Supply fluctuations may explain much of the seasonal behavior in food prices. Specifically, cereal and fruit prices show repeating price declines in the fall, when harvests are generally great, but large positive seasonals in January, when harvests are small. Public transportation prices show a single, large positive seasonal variation in January, and natural gas and electricity prices are generally adjusted upward in early summer (May and June), perhaps a reflection of their regulated environment.

A large share of the price movements, however, is hard to ascribe to obvious patterns in the weather or to the timing of holidays. For example, private education costs exhibit a single large seasonal increase in September, the beginning of the school year, which is offset by generally small and negative seasonals over the remaining 11 calendar months. Prices of books and supplies show large positive seasonal

TABLE 3

Deterministic Seasonality in Individual CPI Components, 1982–1993 (using Newey–West correction)[a]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	R^2
CPI—all items	0.14	−0.01	0.00	0.05	0.02	0.05	−0.05	0.06	0.18	0.01	−0.18	−0.28	0.32
	0.05	0.03	0.05	0.05	0.05	0.05	0.03	0.03	0.04	0.03	0.04	0.04	
Cereals	0.36	0.02	−0.16	0.13	−0.02	0.04	0.06	0.11	−0.27	−0.15	−0.17	0.07	0.28
	0.09	0.07	0.05	0.07	0.05	0.06	0.06	0.07	0.05	0.03	0.06	0.06	
Meats	0.79	−0.38	0.05	−0.36	−0.40	0.25	0.38	0.14	0.01	−0.46	−0.11	0.09	0.17
	0.29	0.31	0.23	0.20	0.22	0.24	0.28	0.24	0.09	0.16	0.20	0.26	
Dairy	0.29	−0.03	−0.30	−0.34	−0.24	−0.12	0.07	0.15	0.16	0.23	0.06	0.08	0.14
	0.13	0.08	0.06	0.17	0.11	0.18	0.06	0.11	0.11	0.13	0.09	0.12	
Fruits	3.90	0.51	−0.59	0.71	0.00	−0.82	−1.13	−0.87	−0.79	−0.92	−0.62	0.61	0.30
	0.78	0.46	0.53	0.48	0.48	0.74	0.49	0.60	0.50	0.19	0.56	0.43	
Other food	0.90	0.46	−0.12	−0.14	−0.15	−0.19	−0.14	0.03	−0.13	0.19	−0.48	−0.24	0.61
	0.09	0.15	0.06	0.05	0.07	0.05	0.06	0.05	0.06	0.05	0.07	0.07	
Food away	0.07	0.02	0.05	0.05	0.01	0.00	−0.01	−0.02	−0.01	−0.06	−0.05	−0.04	0.09
from home	0.06	0.02	0.02	0.02	0.02	0.03	0.04	0.02	0.03	0.02	0.02	0.02	
Alcoholic	0.48	0.46	0.12	0.01	−0.10	−0.09	−0.09	−0.15	−0.07	−0.11	−0.34	−0.33	0.21
beverages	0.30	0.15	0.07	0.06	0.06	0.06	0.05	0.04	0.05	0.23	0.07	0.05	
Shelter	0.17	0.00	0.01	0.02	0.02	0.13	0.28	0.14	−0.22	−0.02	−0.23	−0.30	0.23
	0.09	0.04	0.10	0.14	0.13	0.10	0.07	0.04	0.09	0.04	0.06	0.13	
Fuel oil	2.55	−1.83	−2.51	−1.56	−0.87	−0.80	−1.37	0.27	1.53	2.27	1.39	0.93	0.18
	1.82	1.72	0.63	0.48	0.51	0.54	0.43	0.78	0.92	0.98	0.44	0.55	
Gas and	0.58	−0.24	−0.04	−0.38	1.46	3.30	0.09	−0.06	0.11	−2.76	−2.08	0.03	0.77
electricity	0.19	0.23	0.18	0.17	0.15	0.49	0.17	0.18	0.14	0.40	0.24	0.18	
Other utilities	0.56	0.08	−0.02	0.02	−0.05	0.05	0.03	0.06	−0.17	−0.06	−0.15	−0.36	0.16
	0.27	0.09	0.10	0.10	0.06	0.18	0.11	0.09	0.06	0.09	0.08	0.12	
Household	0.00	0.32	0.23	0.17	−0.20	−0.20	−0.01	−0.27	0.25	0.15	−0.17	−0.26	0.26
furnishings	0.12	0.11	0.10	0.13	0.08	0.09	0.12	0.12	0.10	0.08	0.09	0.10	
Housekeeping	0.09	0.09	−0.22	0.22	0.08	0.03	−0.20	−0.28	0.03	−0.05	0.02	0.18	0.17
supplies	0.10	0.08	0.11	0.08	0.12	0.03	0.11	0.06	0.08	0.10	0.06	0.10	
Housekeeping	−0.05	0.28	0.03	0.15	−0.07	−0.04	−0.04	−0.05	0.05	−0.08	−0.13	−0.06	0.09
services	0.06	0.21	0.08	0.20	0.05	0.09	0.04	0.06	0.05	0.04	0.03	0.03	
Men's	−1.89	−0.01	1.29	0.70	0.16	−1.21	−1.26	0.49	1.90	1.02	0.18	−1.37	0.83
apparel	0.11	0.31	0.12	0.13	0.10	0.20	0.21	0.21	0.17	0.17	0.07	0.13	
Women's	−3.71	1.45	4.20	0.64	−1.67	−2.71	−2.72	2.54	4.78	1.18	−1.02	−2.97	0.82
apparel	0.23	0.68	0.59	0.42	0.24	0.43	0.48	0.48	0.62	0.39	0.17	0.39	
Infants'	−0.91	1.14	1.01	0.97	−0.31	−0.60	−1.48	0.60	0.57	0.06	−0.23	−0.83	0.23
apparel	0.46	0.82	0.40	0.54	0.29	0.29	0.47	0.35	0.26	0.31	0.28	0.21	
Other	1.06	0.79	−0.09	0.13	−0.45	−0.51	0.48	0.24	0.24	0.27	−0.40	−1.75	0.27
apparel	0.55	0.25	0.12	0.20	0.13	0.39	0.26	0.15	0.21	0.37	0.21	0.72	
Footwear	−1.27	0.24	1.24	0.64	0.04	−0.82	−1.12	−0.19	1.43	1.10	−0.26	−1.05	0.68
	0.18	0.15	0.17	0.14	0.12	0.18	0.13	0.16	0.23	0.31	0.25	0.13	
Apparel services	0.10	0.10	0.03	0.00	0.09	−0.06	−0.14	−0.07	−0.06	0.14	0.00	−0.12	0.11
	0.08	0.07	0.03	0.06	0.07	0.12	0.07	0.07	0.05	0.06	0.06	0.02	
New vehicles	0.09	−0.27	−0.36	−0.13	−0.01	−0.18	−0.27	−0.36	−0.36	0.60	0.91	0.36	0.65
	0.06	0.12	0.07	0.10	0.08	0.08	0.07	0.09	0.06	0.11	0.10	0.12	
Used vehicles	−0.92	−0.79	−0.20	0.54	0.82	0.65	0.27	0.00	0.03	0.13	0.00	−0.52	0.31
	0.26	0.26	0.17	0.16	0.21	0.24	0.21	0.14	0.11	0.08	0.10	0.17	
Motor fuel	−1.07	−1.67	−1.89	1.70	2.57	1.61	−0.62	0.19	0.36	0.08	−0.26	−1.02	0.18
	0.88	0.69	0.74	1.14	0.37	0.64	0.49	0.71	0.65	0.63	0.37	0.45	
Auto repair	0.00	0.13	0.05	0.00	−0.05	−0.04	−0.03	−0.04	0.17	0.01	−0.07	−0.13	0.14
	0.04	0.04	0.07	0.06	0.05	0.04	0.04	0.03	0.05	0.04	0.05	0.08	

TABLE 3 (cont.)

Deterministic Seasonality in Individual CPI Components, 1982–1993 (using Newey–West correction)[a]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	R^2
Other transp.	0.10	–0.07	–0.29	–0.10	0.11	0.02	–0.29	0.19	0.05	–0.20	0.30	**0.19**	0.12
commodities	0.23	0.10	0.13	0.14	0.14	0.13	0.13	0.12	0.09	0.11	0.16	0.07	
Other transp.	**0.30**	**–0.19**	**–0.30**	**–0.30**	–0.16	0.01	0.03	–0.13	**–0.45**	**0.93**	**0.44**	–0.17	0.51
services	0.06	0.07	0.07	0.04	0.10	0.09	0.10	0.11	0.14	0.10	0.14	0.08	
Public	**0.57**	–0.16	–0.24	–0.34	–0.38	–0.42	0.22	–0.21	–0.14	0.21	0.67	0.23	0.11
transportation	0.18	0.18	0.14	0.35	0.18	0.43	0.22	0.15	0.19	0.28	0.34	0.31	
Medical	–0.01	**0.21**	**0.26**	0.16	0.01	–0.09	–0.04	**–0.13**	–0.09	–0.09	–0.12	–0.05	0.25
commodities	0.04	0.07	0.02	0.07	0.07	0.04	0.06	0.03	0.05	0.05	0.05	0.05	
Medical	**0.38**	**0.31**	–0.05	**–0.17**	**–0.19**	**–0.12**	**0.19**	0.05	**–0.16**	0.00	0.03	**–0.26**	0.57
services	0.03	0.03	0.06	0.04	0.04	0.03	0.03	0.04	0.03	0.03	0.05	0.03	
Entertainment	**0.21**	0.10	0.16	0.14	**–0.21**	–0.11	0.04	–0.10	–0.03	0.16	–0.11	**–0.25**	0.21
commodities	0.07	0.11	0.09	0.07	0.07	0.04	0.04	0.08	0.07	0.07	0.13	0.06	
Entertainment	0.23	0.04	–0.14	**0.15**	**–0.27**	0.08	–0.04	–0.06	0.26	0.14	–0.17	**–0.22**	0.30
services	0.10	0.05	0.06	0.05	0.06	0.08	0.07	0.06	0.11	0.07	0.07	0.07	
Tobacco	**1.34**	0.05	–0.34	–0.37	–0.20	–0.07	**0.89**	–0.53	–0.72	–0.14	–0.24	0.33	0.26
	0.30	0.13	0.13	0.14	0.20	0.26	0.27	0.23	0.41	0.25	0.17	0.28	
Toilet goods	0.18	0.15	0.04	0.24	**–0.26**	–0.14	0.16	–0.16	–0.12	0.00	0.08	–0.18	0.13
	0.09	0.10	0.11	0.12	0.07	0.13	0.15	0.08	0.13	0.08	0.10	0.11	
Personal	**0.17**	0.10	–0.18	0.03	0.04	–0.06	**–0.17**	0.01	0.07	–0.04	0.01	0.01	0.14
services	0.06	0.05	0.09	0.05	0.08	0.05	0.07	0.05	0.06	0.04	0.07	0.05	
Books and	**1.02**	**0.26**	**–0.53**	**–0.50**	**–0.53**	**–0.37**	**–0.48**	–0.21	**2.48**	–0.04	**–0.56**	**–0.54**	0.75
supplies	0.11	0.07	0.06	0.05	0.05	0.10	0.06	0.17	0.46	0.04	0.05	0.06	
Educational	–0.21	**–0.37**	**–0.37**	**–0.39**	**–0.42**	**–0.42**	**–0.31**	0.15	**3.38**	–0.02	**–0.52**	**–0.50**	0.79
services	0.09	0.07	0.05	0.04	0.07	0.07	0.05	0.22	0.58	0.11	0.04	0.05	
Number of significant (+)	12	7	5	4	3	2	3	2	7	6	3	2	
Number of significant (–)	4	3	8	7	8	7	9	4	5	5	9	15	
Total	16	10	13	11	11	9	12	6	12	11	12	17	

a. Standard errors appear below numbers. Bold type indicates statistical confidence at the 99 percent level.

SOURCE: Authors' calculations.

adjustments in September and January, coinciding with the start of each school term. New car models and their attendant price adjustments are generally introduced in the fall, and in fact, new car price seasonals are positive and large in the fourth quarter of the year. Shelter prices post large positive seasonal adjustments in July and August, when household migrations are prominent. And apparel prices show pronounced seasonal price fluctuations that coincide with the fashion seasons—large positive adjustments in March/April and September/October, and large negative adjustments during "off-season" periods.

In general, though, there is little commonality in seasonal price movements—the aggregate CPI exhibits small seasonal variation relative to the seasonals in individual component prices; only food away from home prices demonstrated less seasonal movement than did the aggregate CPI from 1982 to 1993.[5] In no month was there a statistically significant deterministic seasonal for a majority of prices (table 3). The most common, statistically significant seasonal price variations occurred in December, when 15 of the 36 components had significant, negative seasonals, against only two significant, positive seasonals. In January, 12 statistically significant, positive seasonals were detected against only four significant, negative seasonals.

5 The aggregate CPI in this study has been constructed using the 36 components and applying 1985 weights, such as in Bryan and Cecchetti (1994).

TABLE 4

Idiosyncratic Seasonality in 36 CPI Components, 1982–1993

	Ratio[a]
Auto repair	0.59917
Food away from home	0.76243
Entertainment services	1.02518
Apparel services	1.11776
Personal services	1.19945
Housekeeping services	1.36387
Entertainment commodities	1.41811
Shelter	1.75476
Other utilities	2.01226
Medical commodities	2.02691
Cereals	2.62600
Toilet goods	2.64553
Household furnishings	2.69258
Housekeeping supplies	2.89405
Medical services	3.06386
Alcoholic beverages	3.22595
Dairy	3.65126
Other transportation commodities	4.12955
Other food	7.05639
Meats	9.20606
Other transportation services	11.97717
Public transportation	12.26934
New vehicles	16.25136
Used vehicles	19.42488
Tobacco	25.24895
Other apparel	26.94287
Infants' apparel	45.54596
Books and supplies	45.94267
Footwear	55.30488
Educational services	69.04402
Men's apparel	88.35469
Motor fuel	122.08662
Fruits	124.72690
Gas and electricity	146.80739
Fuel oil	192.29498
Women's apparel	532.12456

a. Ratio of idiosyncratic seasonal variance to common seasonal variance.
SOURCE: Authors' calculations.

Moreover, the items that showed negative seasonal price adjustments during the final two months of the year were generally *not* the same items that tended to rise in price during the first few months of the following year.

The proportion of the monthly aggregate price variation accounted for by seasonality was similar to that of a large number of its components, which directly implies that the unconditional variation in the CPI is also quite small relative to its components. That is, individual goods prices have negative unconditional and seasonal covariances. These results contrast with a number of recent observations on the seasonality of industrial production, shipments, retail sales, and other real magnitudes as documented by Barsky and Miron (1989), Beaulieu and Miron (1990), and Miron (1990). Those variables show a positive correlation in seasonality across sectors and countries, parallel to the comovement in data that is generally presumed to characterize the business cycle.

We can examine the idiosyncratic nature of seasonal price movements directly using the linear decomposition of an individual price movement, p_{it},

$$(2) \quad p_{it} = P_t^a + S_t + s_{it} + \varepsilon_{it},$$

where P_t^a is the average seasonally adjusted price change, S_t is the average seasonal price movement, and s_{it} and ε_{it} are mean zero, idiosyncratic seasonality and noise, respectively. That is, aggregate seasonally *unadjusted* price movements can be defined as

$$(3) \quad P_t^u = \Sigma w_i p_{it} = P_t^a + S_t,$$

where the w_i's are base-period weights that sum to unity over all goods n. We can estimate S_t directly in the aggregate unadjusted index and subtract it from the deterministic seasonal in the individual components to obtain an estimate of the idiosyncratic seasonals. Table 4 reports the ratio of the idiosyncratic seasonality to the common seasonal variance for each of the 36 components (var $[s_{it}]$/var $[S_t]$). In only two of the 36 cases—auto repair and food away from home—was the common price seasonal variance larger than the idiosyncratic seasonal variance. In half of the cases, we find that the idiosyncratic seasonality has more than five times the variance of the common seasonal.

Our finding that deterministic seasonality in prices is largely idiosyncratic in nature may be one reason why studies that have used aggregate price statistics have tended to dismiss the amount of seasonality in price movement. Further, the idiosyncratic tendencies of seasonal price movements have important ramifications for the adjustment of such data.

TABLE 5

Deterministic Seasonality in the Seasonally Adjusted CPI, 1982–1993 (using Newey–West correction)

	Pre-1994 Procedure		Post-1993 Procedure	
	α_s	t-stat	α_s	t-stat
Jan.	0.0016	3.21	0.0008	1.71
Feb.	–0.0003	–0.88	–0.0005	–1.28
Mar.	–0.0011	–1.93	–0.0008	–1.31
April	0.0004	0.60	0.0002	0.32
May	0.0001	0.21	0.0002	0.39
June	0.0003	0.41	0.0007	1.10
July	0.0001	0.30	0.0001	0.26
Aug.	–0.0003	–0.88	–0.0002	–0.50
Sept.	–0.0003	–0.77	–0.0002	–0.53
Oct.	0.0008	2.35	0.0005	1.73
Nov.	–0.0005	–1.15	–0.0002	–0.54
Dec.	–0.0009	–1.43	–0.0006	–1.00
R^2	0.101		0.053	
Wald	44.470		30.590	
p-value	0.0000		0.0012	

SOURCE: Authors' calculations.

II. Aggregate Deterministic Seasonality

The BLS seasonally adjusts the CPI indirectly—by first filtering the disaggregated components, then aggregating upward to arrive at the seasonally adjusted price index. Seasonal adjustment at the component level allows the BLS to capture the wide range of seasonal patterns that exist in the price data. Moreover, seasonally adjusting the index in this way ensures that seasonally adjusted subindexes will aggregate to the seasonally adjusted aggregate index. However, not all components are adjusted, as they must first pass certain statistical criteria; otherwise, they are introduced into the "seasonally adjusted" aggregate index on an unadjusted basis.[6]

Because of the BLS's selective approach to seasonal adjustment, 26 of the 60 CPI subindexes (roughly 20 percent of the weighted index) were left unadjusted prior to January 1994. Yet, because not all of the components were seasonally adjusted, the BLS may have inadvertently introduced a seasonal pattern into the aggregate price series by eliminating only large seasonal price fluctuations, while allowing the small, otherwise offsetting seasonal price adjustments to pass into the index unadjusted. The net result may have been a residual seasonal variation in the price data that became conspicuous when the cyclical variation in prices subsided.

Indeed, over the 1982 to 1993 subperiod, deterministic seasonality can be detected in the *seasonally adjusted* CPI (table 5). Specifically, seasonally adjusted consumer prices tended to rise about 2 percentage points (annualized), or about 50 percent more, during January and tended to decline by a cumulatively similar amount during November and December. Such seasonality accounts for more than 10 percent of the variation in the *seasonally adjusted* CPI over the period.

In an effort to reduce the amount of deterministic seasonality in aggregate consumer prices, the BLS broadened its seasonal adjustment procedure in 1994 to allow the seasonal adjustment of a price series, even if it fails to meet the statistical criteria, if the index at the next higher level of aggregation meets the criteria for seasonal adjustment.[7] As a result of the new procedure, only 10 of the 60 major subindexes, or about 5 percent of the weighted CPI, were unadjusted in the seasonally adjusted CPI in 1994. This procedural change reduced but did not eliminate the residual, deterministic seasonality in the adjusted CPI. While no single month reveals a statistically significant seasonal at the 5 percent level of significance, Wald tests of the joint significance of the deterministic seasonals showed seasonality at the 99 percent confidence level. Moreover, deterministic seasonality still accounts for slightly more than 5 percent of the variation in the seasonally adjusted CPI using the new BLS procedures.[8]

6 Specifically, the BLS seasonally adjusts a series if seasonality is demonstrated by an F statistic greater than 7. While this may seem an unusually rigorous criterion (the unconditional probability of which is roughly 10^{-6}), the BLS notes that the F statistic is biased in autocorrelated data such as these. The BLS further notes that this criterion is commonly used by other statistical organizations, such as Statistics Canada.

7 In addition, the BLS dropped a rule prohibiting the seasonal adjustment of a series if it failed the statistical criteria in either of the prior two years.

8 Buszuwski and Gallagher (1995) note that residual seasonality in the seasonally adjusted CPI appears to originate in the energy components of the index, specifically fuel oil and natural gas. Moreover, the authors claim that these price movements are the result of interventions (or trend adjustments) in the data. Our specification for deterministic seasonality makes no distinction between different "types" of price movements as long as they can be observed at the seasonal frequency.

TABLE 6

Deterministic Seasonality in the Seasonally Adjusted CPI and the Seasonally Adjusted Median CPI, 1967–1993 (using Newey–West correction, new procedure)

	1967–1993				1982–1993			
	CPI		Median CPI		CPI		Median CPI	
	α_s	t-stat	α_s	t-stat	α_s	t-stat	α_s	t-stat
Jan.	0.0005	1.46	0.0003	1.27	0.0008	1.71	0.0004	1.45
Feb.	–0.0001	–0.38	–0.0002	–0.86	–0.0005	–1.28	–0.0001	–0.30
Mar.	–0.0004	–0.88	–0.0005	–1.72	–0.0008	–1.31	0.0001	0.22
April	–0.0002	–0.48	0.0001	0.43	0.0002	0.32	0.0005	1.00
May	–0.0003	–0.70	–0.0002	–0.56	0.0002	0.39	–0.0003	–0.64
June	0.0008	2.12	0.0004	1.26	0.0007	1.10	0.0004	1.07
July	–0.0003	–0.71	0.0000	0.02	0.0001	0.26	0.0001	0.23
Aug.	0.0000	0.00	0.0004	1.45	–0.0002	–0.50	0.0000	0.28
Sept.	0.0001	0.40	–0.0002	–0.66	–0.0002	–0.53	–0.0006	–1.59
Oct.	0.0002	1.08	0.0002	0.49	0.0005	1.73	0.0000	–0.02
Nov.	0.0000	0.02	0.0000	–0.17	–0.0002	–0.54	–0.0002	–0.48
Dec.	–0.0003	–0.81	0.0000	–0.53	–0.0006	–1.00	–0.0004	–1.45
R^2	0.010		0.01		0.05		0.05	
Wald	24.820		15.18		30.58		31.97	
p-value	0.0090		0.174		0.0013		0.0008	

SOURCE: Authors' calculations.

Bryan and Cecchetti (1994) demonstrate how the median in the cross section of consumer price changes reduces idiosyncratic noise in individual prices and improves the inflation signal in the aggregate price change statistic.[9] Here, we consider residual seasonality in the aggregate price index as a special case of idiosyncratic noise. We test for the existence of deterministic seasonality in the weighted median price change calculated from a cross section of seasonally adjusted data from 36 inclusive components in the CPI. We then compare the results to those of the CPI, similarly constructed (table 6).

Over the full sample, deterministic seasonality was found in the seasonally adjusted CPI at more than a 99 percent confidence level, but at only an 82.6 percent level of confidence for the seasonally adjusted median CPI. However, in the post–1982 subperiod, deterministic seasonality can be observed in both the CPI and the median CPI at the 99 percent confidence level.

We tentatively conclude that due to the predominantly idiosyncratic nature of the deterministic seasonality we observe in consumer price data, the median price change estimate may reduce the influence of such seasonal noise in the aggregate monthly price statistics. These results also have implications for the seasonal adjustment procedures currently employed by the BLS. By selectively seasonally adjusting the component data before constructing the seasonally adjusted index, the BLS risks inadvertently introducing idiosyncratic noise into the aggregate index at a seasonal frequency. This potential problem could be addressed by adjusting the index after aggregation.

An obvious difficulty that arises from this approach is that aggregation anomalies can occur. That is, the weighted sum of the seasonally adjusted index is unlikely to match the seasonally adjusted aggregate index exactly. Such

9 That paper shows how idiosyncratic price disturbances that are manifest as an asymmetric distribution of price changes can be reduced by limited-influence estimators. In that class of estimators, the median has the highest correlation with past money growth and improves CPI forecasts.

BOX 1

The Case of Stochastic Seasonality

As noted by Miron (1990), stochastic seasonality is not qualitatively different or logically separable from stochastic variation at a nonseasonal frequency.[a] Nevertheless, we consider seasonality of the form

(4) $x_t = \epsilon + \Theta\epsilon_{t-s.}$

Seasonality of this type might occur when there is a strong seasonal price pattern with large adjustment costs. This might generate intermittent price changes at a seasonal frequency that persist over a period of a few years. An example might be adjustments to school tuition that occur in the fall and are spread out over several school years. Another potential source of stochastic seasonality is when the seasonal cycle and the business cycle interact, such that the degree of seasonality depends on the irregular stage of the business cycle. Such interactions have been demonstrated by Cecchetti, Kashyap, and Wilcox (1994).

We test for the existence of stochastic seasonality both independently and jointly with deterministic seasonality for the unadjusted CPI. In no case, and in neither of the two subperiods, were we able to identify a stochastic seasonal process in the aggregate index. However, several individual components exhibit stochastic seasonal variation at the 95 percent confidence level, and a few do so at the 99 percent level (table 7), including educational services, books and supplies, entertainment commodities, motor fuel, apparel services, housekeeping supplies, and gas and electricity.

Although we fail to find a significant, stochastic seasonal process in aggregate prices (a result that has been found elsewhere and for other macroeconomic data), we note that some of the component data exhibit significant stochastic variation at a seasonal frequency. This result may reveal those areas where the interaction between the seasonal and cyclical variation in prices is greatest. Obviously, more work in this potentially important area is advisable.

a. A third source of seasonal variation, the seasonal unit root, commonly specified as $x_t = x_{t-s} + e_t$, was not considered here and has little apparent standing in the theory or evidence of seasonal processes. An example of a seasonal unit root is a calendar effect, such as the number of "paydays" varying irregularly from month to month depending on the rotation of the seven-day week around the calendar.

anomalies may be a problem for those agencies, like the BLS, that intend the CPI as a cost-of-living statistic and, therefore, where consistent component estimates are an important consideration. Consequently, this is not a criticism of the BLS approach per se, but a recommendation for economists who use the CPI as a monthly inflation guide. As a high-frequency estimate of inflation, the potential for aggregation anomalies would seem to be of secondary importance to the elimination of transitory noise from the statistic.[10]

III. Conclusion

In this paper, we reevaluate the evidence of seasonality in prices in light of the significant reduction in cyclical price movements that has allowed the seasonal patterns to become evident. We find the existence of seasonality to be substantially greater than previous research has indicated.

One central conclusion is drawn from this analysis. Seasonality in consumer prices is predominantly, although certainly not entirely, idiosyncratic in nature. This result stands in contrast to studies that demonstrate a common seasonal cycle in real economic variables, such as industrial production and retail sales. Furthermore, given the statistical criteria that the BLS uses to seasonally adjust component data, the existence of unadjusted data in the index may inadvertently allow noise into the price index at a seasonal frequency. For economists who are interested in using the index as a high-frequency inflation estimate, this implication argues in favor of seasonally adjusting the index after aggregation.

10 See Buszuwski and Gallagher (1995). An alternative approach is to seasonally adjust all of the subindexes. This is likely to be inferior as a noise-reduction technique, however, because seasonal adjustment coefficients cannot be estimated without error and thus are unlikely to completely eliminate seasonal noise from the aggregate index.

TABLE 7

Stochastic Seasonality in the CPI and Components, 1982–1993 (using Newey–West correction)

	Without deterministic		With deterministic	
	Wald	p-value	Wald	p-value
CPI—all items	0.4121	0.8138	7.4942	0.0236
Cereals	19.6336	0.0001	5.6420	0.0595
Meats	12.8219	0.0016	5.4446	0.0657
Dairy	1.5522	0.4602	1.5523	0.4602
Fruits	8.9438	0.0114	1.8708	0.3924
Other food	43.4812	0.0000	1.9228	0.3824
Food away from home	2.1967	0.3334	0.5165	0.7724
Alcoholic beverages	7.0808	0.0290	3.7931	0.1501
Shelter	49.0183	0.0000	5.2125	0.0738
Fuel oil	2.2181	0.3299	7.1812	0.0276
Gas and electricity	313.7587	0.0000	9.6267	0.0081
Other utilities	2.8059	0.2459	7.0030	0.0302
Household furnishings	4.7049	0.0951	3.9263	0.1404
Housekeeping supplies	28.1663	0.0000	10.8060	0.0045
Housekeeping services	3.4370	0.1793	6.0842	0.0477
Men's apparel	23.0618	0.0000	7.7959	0.0203
Women's apparel	13.5094	0.0012	6.3310	0.0422
Infants' apparel	0.0967	0.9528	1.4833	0.4763
Other apparel	26.0616	0.0000	4.1555	0.1252
Footwear	3.0012	0.2230	1.2125	0.5454
Apparel services	10.9630	0.0042	23.3470	0.0000
New vehicles	7.6641	0.0217	6.2327	0.0443
Used vehicles	4.6747	0.0966	8.9065	0.0116
Motor fuel	1.0181	0.6011	9.8272	0.0073
Auto repair	4.3387	0.1142	2.0889	0.3519
Other transp. commodities	3.6178	0.1638	2.4884	0.2882
Other transp. services	20.7485	0.0000	6.1998	0.0451
Public transp.	1.4668	0.4803	2.5277	0.2826
Medical commodities	1.6251	0.4437	8.2525	0.0161
Medical services	123.7170	0.0000	2.1021	0.3496
Entertainment commodities	4.4067	0.1104	24.3490	0.0000
Entertainment services	12.4474	0.0020	3.6727	0.1594
Tobacco	0.2201	0.8958	9.4616	0.0088
Toilet goods	2.8849	0.2364	5.8198	0.0545
Personal services	2.6919	0.2603	4.5603	0.1023
Books and supplies	293.4063	0.0000	20.9720	0.0000
Educational services	100.6680	0.0000	23.6430	0.0000

SOURCES: Authors' calculations.

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