

MACROECONOMIC ADVISERS'  
**MACRO FOCUS**



## RESIDUAL SEASONALITY IN CORE CONSUMER PRICE MEASURES

### INTRODUCTION AND SUMMARY

Some have noted the recent tendency for the seasonally-adjusted CPI to show relatively larger increases early in the year and relatively smaller increases later in the year, but what has escaped attention and what is potentially more important for assessing the economy and monetary policy prospects is that the core PCE price index, the Fed's preferred price measure, does in fact exhibit significant residual seasonality.<sup>1</sup> January's 0.3% increases in the core CPI and the core PCE price indexes, coming on the heels of the run up in inflation early last year and subsequent reversal, raise the issue of whether the latest readings reflect a statistical regularity about which we might be relaxed or signal something more threatening about the underlying trend in consumer price inflation. In this Macro Focus we explore the notion of "residual seasonality," and discuss its significance and sources, with special focus on the core PCE price index.

By *residual seasonality* we mean the occurrence of a significant seasonal pattern in a seasonally-adjusted series. For the purpose of this commentary, we define residual seasonality narrowly as the tendency for inflation to rise significantly faster over the first three months of each year than over the subsequent nine months of the year in seasonally-adjusted series.<sup>2</sup>

As we discuss more fully below, virtually all of the residual seasonality in the overall CPI, and some of the residual seasonality in the overall PCE price index, is owed to the indexes' respective energy components, and especially to the motor fuels components. There is some, but relatively little, residual seasonality in the core CPI, or the CPI excluding energy.

While residual seasonality is strongly evident in the data for the core PCE price index back to 1981, and for the core CPI back to 1991, understandably our focus is on more recent trends. (Hereinafter we will use the short-hand "PCE" for PCE price index.) Over the past 7 years the core PCE has, on average, risen more than 6 tenths of a percentage point faster (annualized) in the three months ending in March than in the nine months ending in December. It is this observation that got our attention in the first place! Over the same period, the core CPI has, on average, risen only a quarter point faster (annualized) in the first three months of the year than over the last nine months. These inflation rates are summarized in Table 1 and shown in Figure 1.

A series of statistical tests provides solid, but not overwhelming evidence of the statistical significance of residual seasonality in the core PCE price index, specifically the tendency for core PCE inflation to be higher during the first quarter. The appendix provides the excruciating details on several different methods that were used to isolate a Q1 effect on core PCE infla-

<sup>1</sup> See for example: Greg Ip, "Economists Point to Quirks in Inflation Calculations", The Wall Street Journal, February 21, 2006

<sup>2</sup> It should be noted that for the CPI and PCE price indexes, seasonal adjustment occurs directly only for fairly detailed components, and series that are the aggregation of seasonally-adjusted series are said to be "indirectly" seasonally adjusted. All of the key series (total, core, market-based core, etc.) that we refer to in this report as "seasonally adjusted" are aggregates, with the exception of the motor fuels prices, and are not themselves subject to direct seasonal adjustment. The majority of price indexes used in the PCE price index are corresponding seasonally-adjusted CPI component indexes.

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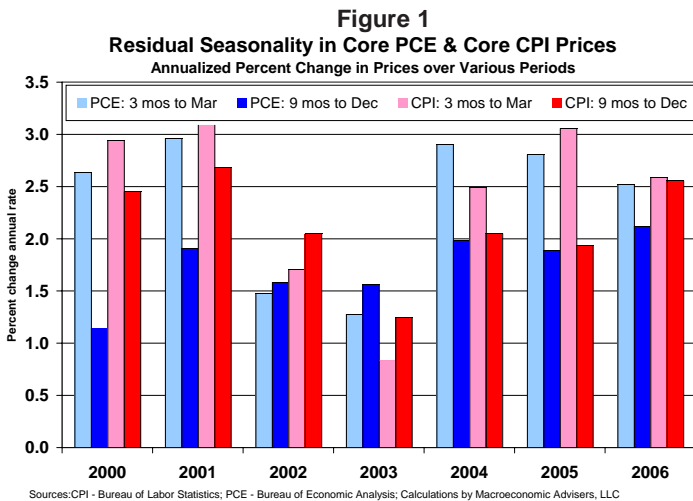
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**TABLE 1**  
**“SEASONAL DIFFERENCES” IN CONSUMER PRICE INFLATION**  
**AVERAGES OVER 2000 - 2006**  
**(PERCENTAGE POINTS, SEASONALLY ADJUSTED ANNUAL RATE)**

Total PCE			Total CPI			Core PCE			Core CPI		
1st 3 mos	Last 9 mos	Diff.	1st 3 mos	Last 9 mos	Diff.	1st 3 mos	Last 9 mos	Diff.	1st 3 mos	Last 9 mos	Diff.
3.67	1.79	1.99	3.99	2.22	1.77	2.37	1.74	0.63	2.39	2.14	0.25

Source: CPI - Bureau of Labor Statistics; PCE price - Bureau of Economic Analysis; Calculations by Macroeconomic Advisers, LLC

tion. Calculation of simple moving-average seasonal factors is consistent with a Q1 effect. Applying the Census X-12 ARIMA seasonal adjustment method had mixed results, finding seasonality over some periods and with some tests, but not convincingly. Three additional econometric tests were tried. The first estimates a significant Q1 effect in explaining inflation relative to a simple centered moving average. The second finds a significant Q1 effect in explaining inflation relative to the trend/cycle component that comes out of the X-12 ARIMA process. The third finds a statistically significant role for a Q1 dummy in a structural inflation model, namely the Price/Expectations Phillips Curve we wrote about in a recent Macro Focus. The combined weight of the results of this exploration leaves us convinced that it is more than just our imagination based on a couple of interesting charts, and that there is ample evidence of its statistical significance.



We searched for, but did not uncover, a systematic methodological cause of the residual seasonality in the core PCE. Despite considering a large number of “suspects” we were not able to point to a single systematic cause. For example, residual seasonality in the case of the core PCE is not due to a systematic tendency of the imputed price components alone to rise early in the year, although some comes from this source.<sup>3</sup> And, it is not the case that only one or two components systematically account for residual seasonality in the core PCE; many different components have contributed to residual seasonality in the core PCE at different times.

With trend (12-month) measures of the core CPI and core PCE price indexes lingering outside their respective implicit comfort zones, elevated readings of several tenths in annualized inflation measures early in 2007 could loom large in monetary policy deliberations. In addition, as has been more widely recognized, there is evidence of residual seasonality in both the overall CPI and PCE due to the motor fuels price indexes.<sup>4</sup> While this is less important for monetary policy makers, given their focus on core measures, it is very important for traders in TIPS.

<sup>3</sup> An imputed price component is a price that is inferred from information on prices other than its own, usually because the good or service is not priced separately or there is no active market in it from which to observe market prices.

In the balance of this *Macro Focus* we more fully document the magnitude of residual seasonality, provide evidence of its statistical significance, and attempt to trace it to various sources, with the more technical and detailed parts of this analysis confined to the Appendix.

### RESIDUAL SEASONALITY IN CORE CPI AND CORE PCE INDEXES

Because of its importance for the conduct of monetary policy, we focus first on evidence of residual seasonality in the core consumer price indexes. In a later section we discuss the large degree of residual seasonality in the energy components of the CPI and PCE price indexes, and more specifically in the motor fuels components, and explain why it persists in a seasonally-adjusted series.

Table 2 shows the annualized inflation rates in the three months ending in March and the nine months ending in December, as well as the difference in these measures, for both the core PCE and core CPI for several periods of interest. A useful summary measure of the degree of residual seasonality in any given year is the difference between the annualized pace of inflation in the three months ending in March and the annualized pace of inflation in the nine months ending in December. This difference indicates the “tilt” in inflation over the year. Subsequent quantitative references to residual seasonality in a year or span of years will refer to this difference as the “seasonal difference.” On average, the degree of residual seasonality in the core PCE has been significant since 1981, as seen in the right hand panel of Table 2. Over the period 2000 – 2006 the seasonal difference has averaged 0.63 percentage points, about the same as over the previous decade.

With respect to the core CPI, on average from 1991 through 2006, the seasonal difference has been 0.2 – 0.3 percentage points. While enough to take note of, we do not view a difference of this magnitude as particularly meaningful so we will concentrate the rest of our remarks on the core PCE price index.

To put this in perspective, consider the Federal Reserve’s latest forecast that core PCE inflation will be 2% - 2¼% in 2007, on a fourth-quarter over fourth-quarter basis. There should not be much difference between this and the December-over-December reading. Suppose this forecast turns out to be correct, and that the 12-month rise in the core PCE comes in at 2.15%, but that the pattern in inflation is 2.6% over the first three months and 2% over the last nine months. Without an understanding that residual seasonality might be at least partly to blame, the Fed and the markets would grow increasingly uncomfortable

<sup>4</sup>As explained more fully below, the seasonal adjustment procedures applied to the motor fuels component in the CPI allows apparent seasonal regularities to persist into the seasonally adjusted series. With some modification for quality improvements, the Bureau of Economic Analysis uses the CPI for motor fuels in the construction of the PCE motor fuels price indexes.

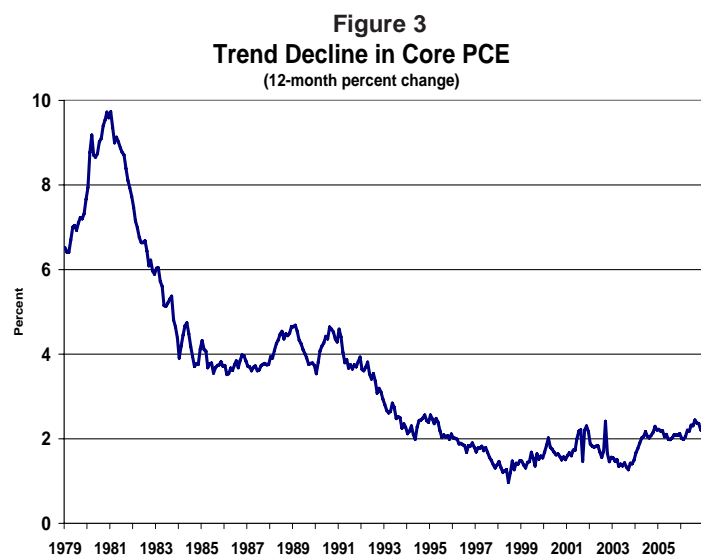
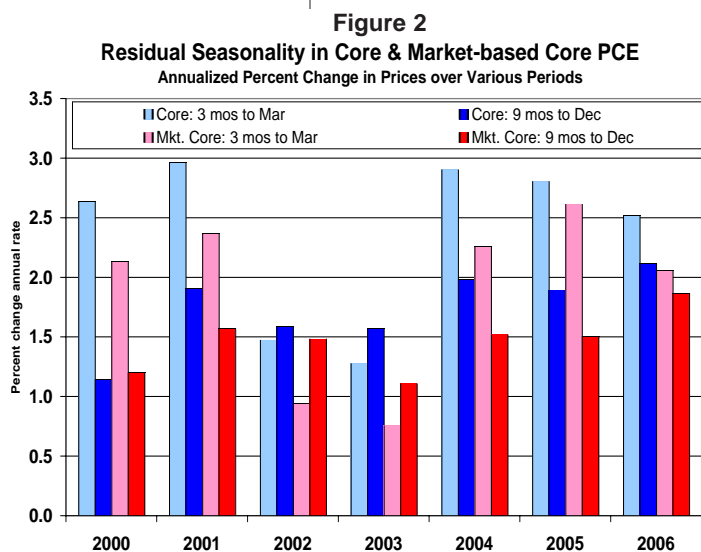
**TABLE 2**  
**ANNUALIZED PERCENT CHANGES IN CORE CPI AND CORE PCE**

Average	Core CPI			Core PCE		
	3 months to March	9 months to Dec.	Seasonal Difference	3 month to March	9 months to Dec.	Seasonal Difference
1968-1980	7.10	6.97	0.12	5.74	6.14	-0.39
1981-1990	4.83	5.11	-0.28	5.42	4.34	1.08
1991-2000	3.05	2.77	0.29	2.57	1.99	0.58
2001-2006	2.30	2.09	0.21	2.32	1.84	0.48
<b>By Year</b>						
2000	2.94	2.45	0.49	2.63	1.14	1.49
2001	3.09	2.68	0.41	2.96	1.90	1.06
2002	1.71	2.05	-0.34	1.48	1.58	-0.11
2003	0.84	1.25	-0.41	1.28	1.57	-0.29
2004	2.49	2.05	0.44	2.90	1.98	0.93
2005	3.06	1.94	1.12	2.81	1.89	0.92
2006	2.59	2.55	0.03	2.52	2.12	0.40
	2000 - 2006 Average =		0.25	2000 - 2006 Average =		0.63

Source: Bureau of Labor Statistics; calculations by Macroeconomic Advisers, LLC

with an apparent re-acceleration in consumer prices, at a time the Fed has identified a 'failure of inflation to moderate as expected' as its predominate concern.

Because of the greater degree of residual seasonality seen in the core PCE than in the core CPI, one would naturally suspect the source to be imputed prices in the core PCE that are not present in the CPI. Figure 2 at left compares the inflation rates for the core PCE and market-based core PCE, split as previously.<sup>5</sup> The same clear pattern of residual seasonality is evident in the market-based core PCE index, but it is less pronounced. On average over the last seven years, the seasonal difference in the market-based core PCE was 0.41 percentage points. This series is available starting only in January 1997, so our calculations must start with 1998. The seasonal difference over the period 1998 to 2006 falls to 0.22 percentage points because of a sharp reversal in these relative inflation rates in 1999, when core PCE inflation was 0.74% over the first three months and 1.82% over the subsequent nine months.<sup>6</sup> The comparable average seasonal difference for the core PCE price index over 1998 – 2006 is 0.36 percentage points, also due to the anomalous sharp reversal in relative inflation rates in 1999.



Given the strength of this effect since 1980 in the core PCE price index, we wondered what effect the downward trend in inflation since the early 1980s and continuing through the late 1990s might have had on residual seasonality as we have elected to define it. Since inflation started the 1980's quite high and trended downward, we might not be surprised to find that, on average, inflation was higher early in each year than later in each year. After all, if the average large positive difference between inflation early in the year and later in the year throughout the 1980s and 1990s turned out to be due solely to this declining trend in inflation, residual seasonality would be a statistical curiosity with a simple and not very important explanation. Figure 3 shows the trend in core PCE inflation since 1979.

<sup>5</sup> The market-based core PCE price index is the core PCE price index excluding items whose prices are imputed by the Bureau of Economic Analysis rather than based on surveys of market transactions.

<sup>6</sup> Much of the reversal in the pattern in 1999 is due to large negative contributions to inflation from durable goods (-0.27 percentage point), apparel (-0.30 percentage points) and "other" services (-0.38 percentage point). Durable goods and apparel prices were very weak starting in mid 1997 and were weak early in 1999, but accelerated later in 1999. It is possible that continuing fallout from the 1997 and 1998 financial crisis that gripped Eastern Asia, Russia, and South America and its impact of pushing down prices of nonpetroleum imports to the US in 1998 and 1999, played a role in this reversal. Other services prices, on the other hand looked fairly near trend early in the year but enjoyed an anomalous acceleration late in 1999.

Core PCE inflation (3-month percent change annualized) began the 1980s at 11.2% and ended the decade at 3.8%, a 7.4 percentage point decline. If inflation had declined perfectly linearly over the decade, our summary measure of residual seasonality (the difference of annualized inflation in the three months ending in March versus inflation in the nine months ending in September) would be 0.37 percentage points. That would explain only about 1/3 of the 1.08 percentage point seasonal inflation difference we find over that period.<sup>7</sup> A similar calculation for the 1990s finds that the downward trend in inflation that decade can account for 0.2 percentage points of the 0.58 percentage point “difference” during that decade. A gradual upward trend in inflation over the last seven years works in the opposite direction. Although that upward trend would have a relatively small effect on these calculations, it makes the 0.63 percentage point average seasonal difference since 2000, look all the more startling.

### **CONCLUDING THOUGHTS**

We find a fairly consistent and statistically significant tendency for core inflation, and especially core PCE inflation, to rise temporarily in the first three months of each year, relative to the subsequent nine months. There is no smoking gun that explains this fact. Rather, a variety of factors contribute to this effect and to different degrees at different times. Given the potential for residual seasonality to impact monetary policy, a greater understanding of the underlying causes, (explored aggressively, but not fully in the Appendix) is warranted.

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<sup>7</sup> Table 1 reported an average difference of 1.08 percentage points for the period of 1981-1990, and it is also the case the average difference is 1.08 percentage points for 1980 – 1989.

## APPENDIX

### ECONOMETRIC EVIDENCE OF RESIDUAL SEASONALITY IN CORE PCE PRICES

While the seasonal difference between core PCE inflation rates early in the year and later in the year appears on its face to be significant, we can also demonstrate econometrically that residual seasonality defined this way is statistically significant using a couple of alternative methods.

**TABLE 3**  
**ESTIMATED SEASONAL FACTORS FOR CORE PCE INFLATION\***  
**FROM MOVING AVERAGE (DIFFERENCE) TECHNIQUE**  
**(PERCENTAGE POINTS)**

Sample	1985.1 - 99.4	1990.1 - 06.4	1995.1 - 06.4	2000.1 - 06.4
Q1	0.418	0.302	0.385	0.368
Q2	-0.150	-0.219	-0.206	-0.077
Q3	0.060	-0.178	-0.102	-0.450
Q4	-0.328	0.095	-0.077	0.160
Q1 Differential**	0.56	0.51	0.40	0.49

\*Inflation is defined as the 3-month annualized percent change in core PCE over the quarter.

\*\* The Q1 differential is the difference between the Q1 seasonal factor and the average of the Q2 - Q4 seasonal factors.

The first method of testing for statistical significance was the straightforward approach of applying the moving-average method to constructing quarterly seasonal factors. The dependent variable is the 3-month annualized change in core PCE inflation, selected over calendar quarters to produce a quarterly sample. Because inflation can be negative, we use the difference method rather than the ratio to moving average method. As seen in Table 3, in each sub sample, there is a large “first” quarter effect, with a differential between the Q1 seasonal and the average of the last three quarters’ seasonal that ranges between 0.40 and 0.56.

The second method was to apply the Census X-12 ARIMA seasonal adjustment procedure. Again we used quarterly data with core PCE inflation defined as the 3-month annualized percent change over the quarter. Somewhat surprisingly, the X-12 tests did not uniformly find seasonality, with the exception of the 1980 to 2006 sample. This was true whether we subjected the level of the core PCE price or core PCE inflation to the seasonal adjustment tests. The tests would often confirm stationary seasonal factors at a the 1% level, but then not confirm moving seasonals, and suggest failure to find seasonality in the “combined” X-12 test. We suspect that this is due to the relatively small effects typically found in Q2 through Q4 as seen in the seasonals derived from the moving average method. As such, it is difficult for the F test to prove significance on the power of the Q1 effect alone.

However, given the strong “visual” evidence from the seasonal difference calculations, we did not stop with the X-12 tests. We employed two additional econometric techniques to isolate a statistically significant effect.

Since we are less interested in statistically identifying seasonal factors for each quarter, but rather we aim to pin down the first-quarter effect relative to the rest of the year, we can design an econometric test for seasonality (as we have defined it) that is less restrictive than X-12. We found several specifications in which we could identify statistically significant Q1 effects, so we report just a few of these in Table 4. The regressions reported in Table 4 employ as the dependent variable the 3-month annualized percent change in core PCE over the quarter less a 4-year or 2-year centered moving average. We used both lengths of centered moving average (CMA) because we wanted to be able to use as much of the available data as possible, especially in the more recent period and the 4-year CMA required dropping the last 7 quarters of the sample. The 2-year CMA required dropping only the last 3

**TABLE 4**  
**ISOLATING A Q1 EFFECT IN REGRESSIONS OF CORE PCE INFLATION**  
**RELATIVE TO A CENTERED-MOVING-AVERAGE OF INFLATION**

Sample	(1) 82.1-05.4	(2) 90.1-05.4	(3) 81.1-06.1	(4) 90.1-06.1	(5) 00.1-06.1	(6) 00.1-06.4
Dependent Variable	Core PCE Inf. less 4-yr CMA	Core PCE Inf. less 4-yr CMA	Core PCE Inf. less 2-yr CMA	Core PCE Inf. less 2-yr CMA	Core PCE Inf. less 2-yr CMA	Core PCE Inf. less Trend/Cycle From X-12
Constant	-0.236 (-2.54)	-0.144 (-1.35)	-0.205 (-2.43)	-0.144 (-1.45)		-0.193 (-1.04)
DumQ1	0.631 (3.44)	0.577 (2.77)	0.626 (3.75)	0.578 (2.97)	0.492 (1.79)	0.591 (2.18)
AR (1)					-0.460 (-2.13)	
DW	2.56	2.47	2.73	2.56	2.19	3.24
R <sup>2</sup>	0.12	0.12	0.13	0.12	0.28	0.10

Note: Values in parentheses are t-values calculated using White heteroskedasticity-consistent standard errors.

quarters of data. We used a third variant of this approach that replaces the centered moving average with the estimated trend-cycle component from the X-12 ARIMA seasonal estimation described above. The results of one of these tests are shown in column (6). (The results from this series of regressions are very similar to those using the CMA method.) The Q1 dummy variable is in the range you might expect based on the foregoing descriptive analysis and significant at the 1% level in all regressions shown except equations (5) and (6), where it is significant at the 5% level. In that case, the very small sample raises the standard error and lowers the t-value so that the dummy is significant only at the 10% level. The 2-year CMA also was borderline on producing white-noise residuals as we shrunk the sample, so in regression (5) we add an AR(1) term and also dropped the insignificant constant. Regression (6), which uses as the dependent variable the 3-month annualized percent change in core PCE over the quarter less the trend-cycle component from the X-12 process, also finds a significant Q1 effect, and, because the ARIMA component of X-12 extends the sample, we are able to use the full seven years through 2006.4.

Estimating seasonal dummies in simple linear models may still be subject to specification error and so we did not want to rely on this type of statistical test alone. A more telling test is whether the Q1 dummy would show up significantly in a structural model of inflation. For this we turned to the Price/Expectations Phillips Curve we wrote about in our January 18, 2007 Macro Focus, "The Gravitational Pull of Inflation Expectations." That model explained core PCE inflation as a function of a forward-looking survey-based measure of core PCE inflation, an unemployment gap term, a short distributed lag of past inflation, energy price changes, and non-petroleum import price changes. We revised slightly the definition of the dependent variable by replacing the annualized percent change in quarterly averages of core PCE with the annualized percent change over the three months of the quarter, and we added the Q1 quarterly dummy. Using a sample that begins in 1980, the Q1

dummy is again found to be significant (at the 1 percent level) with a coefficient of 0.36 (percentage point) and a standard error of 0.13.

This estimate of the Q1 effect on inflation found in this Phillips Curve estimation is broadly consistent with the average seasonal difference in the 1981-2006 period, after adjusting for the downward inflation trend in the 1980s and 1990s. The “trend-adjusted” difference is 0.71 (=1.08-0.37) in the 1980s, and 0.38 (= 0.58-0.2) and 0.48 in 2001 – 2006, assuming no trend adjustment. The weighted average over the full 26 years is 0.53 percentage points. If we adjust this difference to be relative to the average inflation for the year (the effect the Q1 dummy is capturing in the regression), rather than relative to inflation in the last nine months, it would fall to 0.40 (= 0.53 - .25\*.53), very close to the regression coefficient on the Q1 dummy in the structural inflation equation.

### RESIDUAL SEASONALITY IN OVERALL CPI AND PCE PRICE INDEXES

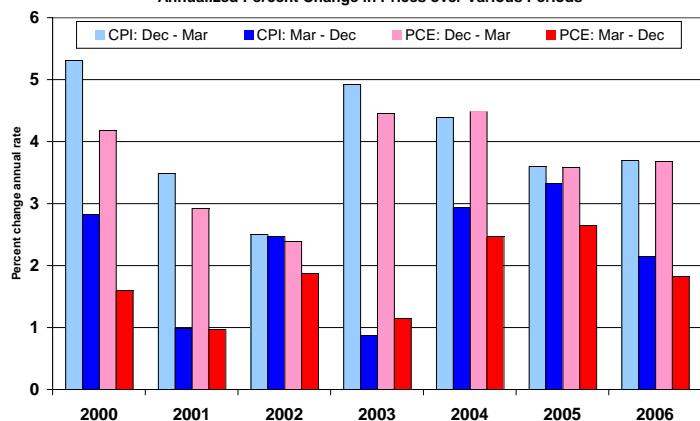
The occurrence of residual seasonality in the overall CPI and PCE price indexes over the last several years is documented in Figure 4, and Table 5 summarize these measures back to 1968. Figure 4 shows the annualized percent change in the seasonally-adjusted total CPI and PCE price indexes over the three months ending March and the nine months ending

December, from 2000 through 2006. Over the period 2000-2006 the average seasonal difference is 1.77 percentage points for the CPI and 1.88 percentage points for the PCE price index.

As noted above, most of the residual seasonality in the total CPI and much of the residual seasonality in the total PCE price index, as suggested by the seasonal difference, is due to the energy components, and more specifically the motor fuels components. Over the past seven years, we estimate that that roughly 1.5 percentage points of the seasonal difference in the CPI comes from a strong seasonal pattern in the motor fuels component, while in the PCE price index, roughly 1.2 percentage points is from this source.

Figure 4

Residual Seasonality in Overall CPI & PCE Indexes  
Annualized Percent Change in Prices over Various Periods



### WHAT'S THE STORY ON MOTOR FUELS PRICES?

Motor fuels price components in both the CPI and PCE exhibit hugely significant residual seasonality, especially over the last several years. These series are seasonally adjusted, yet they have a pronounced tendency to grow significantly faster over the first three months of the year than over the subsequent nine months. Since the BLS employs five-year seasonal adjustment windows, even a recent emergence of such a seasonal pattern might be expected to be washed from the not-seasonally-adjusted data by the seasonal adjustment process and thus not appear in the final seasonally-adjusted series. Table 6 shows recent decade averages and the last seven years annualized growth rates for the motor fuels prices in both the CPI and PCE price indexes.

How can a seasonally adjusted component exhibit such a strong seasonal pattern? Residual seasonality in this instance results entirely from the so-called “intervention process” whereby unusual price movements deemed to be non-seasonal in nature are excluded prior to the calculation of the seasonal factors. Indeed, this is the only way that independently seasonally adjusted series can show a significant seasonal pattern.<sup>8</sup> Analyst interventions have been applied by the BLS to motor fuels only since 1990, and the Bureau of Economic Analysis has recently adjusted these prices for quality changes related to the introduction of reformulated gasoline in the May – September period each year to reflect environmental mandates, but these latter adjustments are small and do not contribute to the seasonal pattern under discussion here.<sup>9</sup>

One rationale for interventions is to prevent a coincidence of moves that are clearly not seasonal in nature from distorting the seasonal factors within the five-year window over which the seasonal factors are calculated by the BLS. This makes intuitive sense, but raises the issue of how much of any observed movement in the not-seasonally adjusted series is seasonal in nature and how much is not. These judgments may be particularly difficult in the energy area as we are constantly reminded that for much of the last half dozen years or so, reduced crude and product inventories, as well as a much tighter supply/demand balance, has made prices vulnerable to upside spikes for relatively minor supply disruptions or demand increases. What if this greater sensitivity to supply and demand shifts is greatly amplifying the seasonal variation in energy prices generally and motor fuels prices specifically. If the nature of the market has changed, should the analyst “expect” only normal seasonal movements and conduct interventions to allow so much vari-

<sup>8</sup> The Census X-12 seasonal adjustment procedure allows the analyst calculating the seasonal adjustment factors to exclude economic phenomena that is determined to be non-seasonal in nature before the calculation of seasonal factors for the individual series.

<sup>9</sup> Interventions are also employed in the seasonal adjustment of retail sales to capture the impact of the calendar shift that occurs for some seasonal holidays, such as Easter and Thanksgiving.

**TABLE 5**  
**ANNUALIZED PERCENT CHANGES IN TOTAL CPI AND TOTAL PCE**

Average	CPI			PCE			
	3 months to March	9 months to Dec.	Seasonal Difference	3 months to March	9 months to Dec.	Seasonal Difference	
1968-1980	7.61	7.45	0.16	6.71	6.65	0.06	
1981-1990	4.53	4.52	0.01	5.17	3.92	1.25	
1991-2000	2.52	2.72	-0.20	2.20	2.04	0.16	
2001-2006	3.78	2.22	1.56	3.57	1.79	1.78	
<b>By Year</b>							
2000	5.32	2.82	2.50	4.18	1.60	2.58	
2001	3.48	0.99	2.50	2.93	0.97	1.96	
2002	2.50	2.47	0.03	2.39	1.86	0.53	
2003	4.93	0.87	4.06	4.45	1.14	3.31	
2004	4.39	2.93	1.46	4.49	2.46	2.03	
2005	3.60	3.33	0.27	3.59	2.65	0.93	
2006	3.69	2.14	1.55	3.68	1.83	1.85	
2000 - 2006 Average =			1.77	2000 - 2006 Average =			1.88

Source: Bureau of Labor Statistics and Bureau of Economic Analysis; calculations by Macroeconomic Advisers, LLC

**TABLE 6**  
**ANNUALIZED PERCENT CHANGE IN MOTOR FUELS PRICES OVER VARIOUS PERIODS**

Average	CPI Motor Fuels			PCE Motor Fuels			
	3 months to March	9 months to Dec.	Seasonal Difference	3 months to March	9 months to Dec.	Seasonal Difference	
1968-1980	18.8	10.5	8.3	18.6	10.4	8.3	
1981-1990	10.5	1.9	8.7	9.9	1.9	8.0	
1991-2000	0.0	4.3	-4.3	-1.5	4.6	-6.0	
2001-2006	42.8	0.8	41.9	55.0	-1.7	56.6	
<b>By Year</b>							
2000	86.3	-2.8	89.1	77.9	-2.1	80.0	
2001	13.9	-26.9	13.1	-13.1	-27.5	14.4	
2002	38.6	21.2	17.4	55.4	15.8	39.6	
2003	100.6	-13.5	114.1	128.1	-16.1	144.2	
2004	64.9	14.9	50.0	82.4	11.0	71.4	
2005	23.5	13.4	10.1	36.1	9.9	26.2	
2006	28.8	-0.5	29.3	40.8	-3.1	43.9	
2000 - 2006 Average =			46.2	2000 - 2006 Average =			60.0

Source: Bureau of Labor Statistics and Bureau of Economic Analysis; calculations by Macroeconomic Advisers, LLC

ation through to the seasonally adjusted series. This is certainly a question to be asked by those performing the seasonal adjustment.

While the tendency for the motor fuels components to rise significantly more rapidly early in the year is evident since 1968, this tendency was particularly acute in the last seven years.

Given recent discussion and concern about the potential for sharp energy price changes (especially increases) to be passed through into core inflation measures, we wondered whether the sharp energy price increases that coincidentally seem to have occurred early in the year (as suggested in Table 6) might have also been the source of energy price pass-through to core inflation that could help to explain the high degree of residual seasonality in core inflation. To test for this we added energy-price pass-through terms to the regressions reported in Table 4 and found that these terms were insignificant and had no effect on the Q1 dummy; this provided fairly conclusive evidence the Q1 dummy was not simply proxying for coincidental early-in-the-year energy price shocks. This conclusion was further supported by our finding that the Q1 dummy entered significantly in the estimation of the structural inflation model, which included energy prices and allowed for energy price pass-through to core.

#### **IS THERE A READILY IDENTIFIABLE SOURCE?**

Having satisfied ourselves that residual seasonality in the core PCE price index is real, persistent, and significant, we set out to find its source. We have already identified and considered several possible causes which either had an only modest effect or no effect at all. For example, the downward trend in overall and core inflation since 1980 has only a small effect on our assessment of the degree of residual seasonality. Residual seasonality in the imputed components in the core PCE also plays some role, specifically helping to account for the larger residual seasonality in core PCE relative to the core CPI. On the other hand, pass-through from sharp changes in energy prices that coincidentally have tended to come in the early part of the year do not appear to play a significant role in explaining residual seasonality in core inflation rates. Finally, the decision to intervene in the seasonal-adjustment process, which permits seasonality to persist into the aggregated price components, was identified as the central factor for overall consumer price inflation, specifically related to the treatment of motor -fuel prices

We now turn our attention to other possible sources of residual seasonality. The first additional source might be the fact that not all price indexes that go into the CPI and which are used in the PCE price index are seasonally adjusted. The all-items CPI is an aggregation of seventy-three subcomponent indexes, but only forty-three of these are independently seasonally-adjusted using the X-12 ARIMA method. Currently thirty of the seventy-three subcomponents do not meet the criteria for seasonal adjustment and thus feed in directly to the total without first being seasonally adjusted. According to BLS, in 2006 about 20% of the expenditure weight of the CPI was not seasonally adjusted. Since the core CPI and CPI excluding energy exhibit almost no residual seasonality, the failure to apply seasonal adjustment to these series appears to be of little consequence.

One area that we examined closely as a possible source of residual seasonality and as a potential reason for the large difference in residual seasonality between the CPI and PCE price indexes was medical services. Recently, the weight of medical services in the core PCE is over 20%, while the relative importance in the CPI is less than 5%, although the weight has been growing in both. In addition to the greater weight, the fact that Physicians services fees in the core PCE is a large part of the difference in the two indexes, and because these often move based on Medicare and Medicaid reimbursement rates, suggested this could play a role. These rates are set by the government, often changing early in the year. Moreover, it is the policy of the BEA not to seasonally adjust out of the data movements that are due explicitly to government policy. However, we found this not to be the case. Medical services over the last seven years contributed only 0.06 percentage points to residual seasonality in the core PCE and the Physicians Services subcomponent contributed negatively.

Another way to determine if failure to seasonally adjust some consumer prices that are aggregated to the core CPI and core PCE is responsible for the presence of residual seasonality in the aggregate is to consider every major subcomponent of these prices to see if it is a consistent contributor. More specifically, in the years when core PCE inflation is significantly higher in the first 3 months than over the subsequent nine months, are the same underlying components responsible? The answer to this is no. We examined every major PCE component, drilled deeply into those that appeared to contribute to residual seasonality, and identified those subcomponents that historically have contributed the most to residual seasonality. In general, it seems to be a different component or set of components each year that account for the residual seasonality. As such it is probably not the case that failure to seasonally adjust some component series is the cause. If it were, we should observe a more systematic relationship between residual seasonality in the aggregate and the contributions from specific components.

That the average degree of residual seasonality (again measured by the seasonal difference) from 1991 through 2006 in the core CPI (+0.26 percentage points) is roughly half that in the core PCE (+0.52 percentage points) is intriguing. Since the Bureau of Economic Analysis employs seasonally-adjusted price indexes from the CPI, why does the core PCE exhibit more residual seasonality? The answer has to be: partly imputations, partly different weighting. It might also be related to quality adjustments performed by the BEA, and it might be related to seasonality in the quantity indexes that are used to chain-weight the prices in the construction of the PCE price aggregates. A thorough examination of these issues is beyond the scope of this effort, but we would encourage the BEA to examine them carefully.

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**Figure 5**

