Comparison between Chained CPI-U and Regular CPI-U All-US Indexes at Lower Item-Aggregate Levels (2000-2003) August 2005

Owen J. Shoemaker
U.S. Bureau of Labor Statistics, 2 Mass Ave., NE, Room 3655, Washington, DC 20212
shoemaker_o@bls.gov

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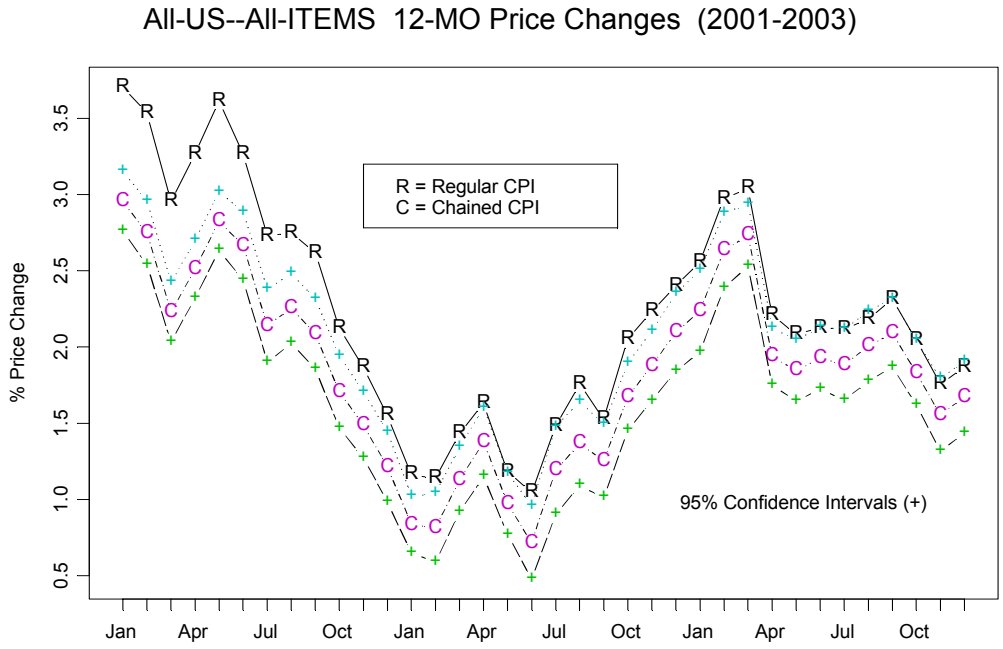
In February, 2005, the BLS calculated and published its third annual set of C-CPI-U indexes --- for the 12 months of 2003. The C-CPI-U (Chained Consumer Price Index – Urban) is calculated and published every year, with a one year lag, using a Tornqvist formula, and its set of weights are updated yearly, so that a unique set of monthly weights are available for both time *t* as well as for time *t-k*, with *k* = 1, 2, 6, or 12 months. The C-CPI-U can thus be labeled a "Superlative" index. By contrast the regular CPI-U uses weights that are, at a minimum, at least two years old, and uses a combination (Hybrid) of Geomeans and Laspeyres formulas as its final estimator. For 12-month price changes (our standard inflation measure), the All-US–All-Items chained C-CPI-U index results continue to diverge (*significantly lower*) from regular CPI-U index results, but the divergences at the lower aggregate levels (Major Group level, as well as Region level and City-Size level) are in the main *not* significantly different. We investigate the nature of these lower-level divergences, using newly calculated chained C-CPI-U standard errors to construct our confidence intervals, along with a new corroborative set of standard errors of the *differences* between Regular and Chained CPI 12-month price changes. In this paper, we will concentrate, for the most part, on the set of twelve 12-month inflation rates and inflation rate differences between the Regular and Chained indexes for the year 2003, our most current set of comparative data.

1. Chained CPI vs. Regular CPI

BLS has been calculating and publishing a new Chained (C-CPI-U) or "Superlative" Index since January 2000 alongside the official Regular (CPI-U) Index. The new Chained Index does precisely "chain" 1-month price relatives, and so its first 12-month price relatives (and 12-month price changes) are produced a year later beginning in January 2001 and continuing. Note, the popularly publicized inflation statistic is a 12-month percentage price change, with PriceChange = (PriceRelative – 1) * 100. Moreover, it is a percentage price change which we can and do calculate variances and so standard errors for. **Fig 1** displays the three years (2001-2003) of comparative results between Regular and Chained 12-month percentage price changes, along with 95% confidence intervals around the Chained price changes, which are based on Chained-derived standard errors. When the Regular CPI's 12-month price changes fall *outside* the given 95% confidence interval, the price changes are *significantly* different at the $\alpha = .05$ level. In the first twelve months (2001) the two inflation indexes are clearly significantly different. However, in the following two years (2002-2003) the results are generally ambiguous as to whether the two inflation indexes are significantly different from each other. (To be exact, only 4 of the 36 results are *not* significantly different.)

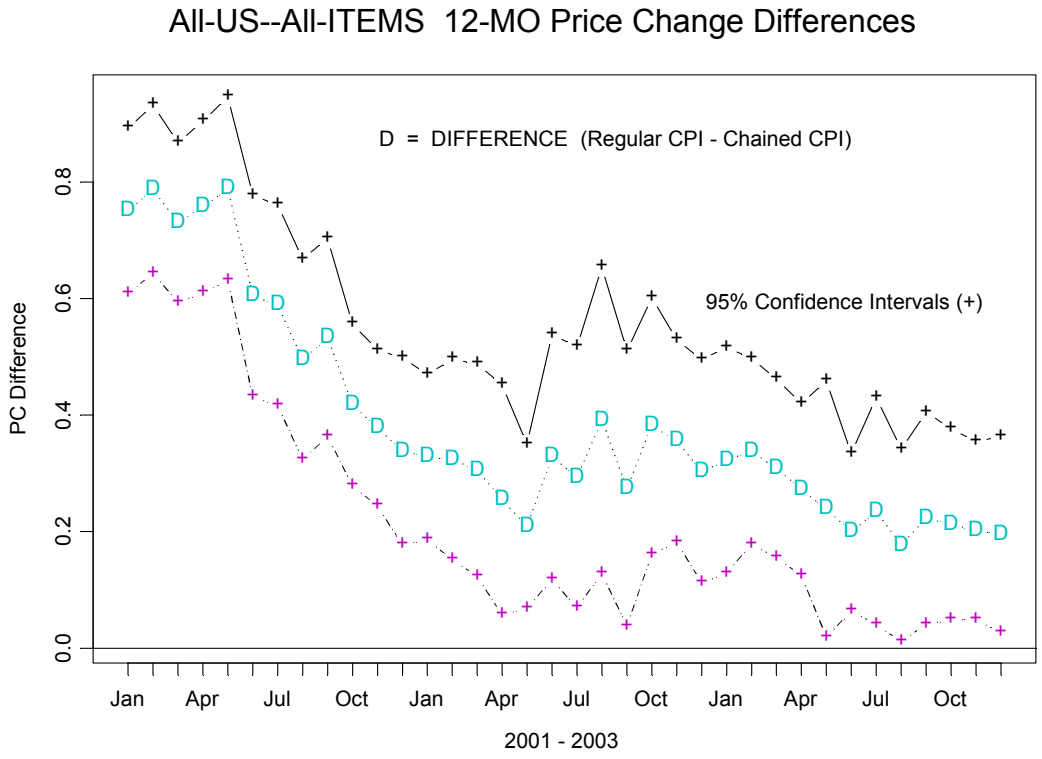
Fig 1.



In an earlier paper, on an analysis of the divergence between Chained CPI and Regular CPI results, the wider-than-expected divergence between the two indexes in 2000 and 2001 was investigated and somewhat resolved. (Out-of-date weights in the Regular CPI in the computer area and some out-sized price relative values in Audio Equipment in San Diego had accounted for the bulk of the excessive discrepancies.) In the last two years of comparative data (2002-2003) the difference between the two indexes has settled down to a fairly consistent 0.30 percentage price change difference in our 12-month results, and comfortably within the projected 0.40 percentage points attributed to "substitution bias" [see Boskin et al, "Final Report on the Advisory Commission to Study the CPI", December 1996] --- to the point where the question of whether there is or is not significant differences between the two indexes becomes relevant and interesting. And in particular we shall be interested in exploring the significant or non-significant differences that occur within the lower-aggregate index results, and even where the bias itself is seemingly eradicated or sometimes reversed.

We have also calculated standard errors of the *differences* between Regular CPI and Chained CPI. Having used Chained-derived standard errors as the bases for our test statistics, we may have been producing a biased or at least a one-sided choice to begin with in the construction of our confidence intervals. By producing standard errors of the *differences* themselves we hope to be able to corroborate our first significance findings as well as to produce a potentially better standard error measurement.

Fig 2.



2. Price Change Difference Variance Estimator

The BLS variance formula for Regular (CPI-U) or Superlative (C-CPI-U) price change is:

$$VAR(I,A,t,t-k)=\sum_{a\in A}\frac{1}{N_a(N_a-1)}\sum_{rep=1}^{N_a}\left(PC(I,A,t,t-k,a,rep)-PC(I,A,t,t-k,full)\right)^2$$

A natural variance estimator for the *difference* between the two price change estimates would be:

$$VAR(*)=\sum_{a\in A}\frac{1}{N_a(N_a-1)}\sum_{r=1}^{N_a}\left(\left[PC_{reg}(*,a,r)-PC_{reg}(*,f)\right]-\left[PC_{\sup}(*,a,r)-PC_{\sup}(*,f)\right]\right)^2$$

The constructions of the various replicate (*rep*) price changes (*PC*) follow the rubrics for the respective Regular and Superlative (Chained) estimates, as applied using Stratified Random Group (SRG) methods, with I = Item, A = Area, a = area random group, and N_a = number of replicates in each a. The difference estimator is, of course, estimating zero. (Standard error estimates are simply the square roots of these variance estimates.)

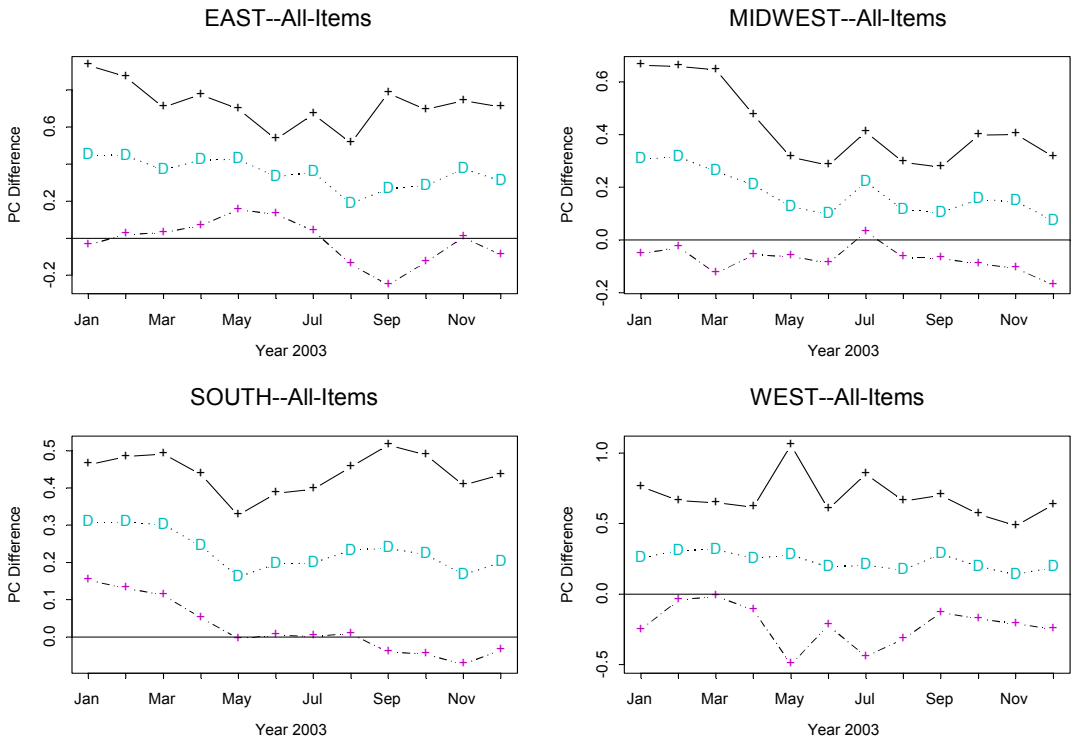
As can be seen by comparing the confidence intervals in **Fig 1** and **Fig 2**, this new difference variance estimator achieves remarkably similar *significance* results. This similarity was hoped for and anticipated but nonetheless a welcomed corroboration of the first set of *significance* results. The difference variance estimator seems to be producing more conservative confidence intervals than the original confidence intervals, but only marginally so. Moreover the similarities continue as we will see when we look at the lower item-aggregate differences at the end of this paper.

3. Region Level Differences between Regular CPI and Chained CPI

A leading question of this paper is whether the observed *significant* differences between the two indexes at the All-US–All-Items level continues down through the lower aggregate levels, along with whether the expected upward bias of the Regular CPI remains consistently at all these lower levels.

We look first at the Region Level breakdown (East, Midwest, South, and West for All-Items), using only 2003 data:

Fig 3. **Region-Level 12-Month Price Change Differences**
Difference (D) = Reg CPI – Sup CPI
95% Confidence Intervals (+)

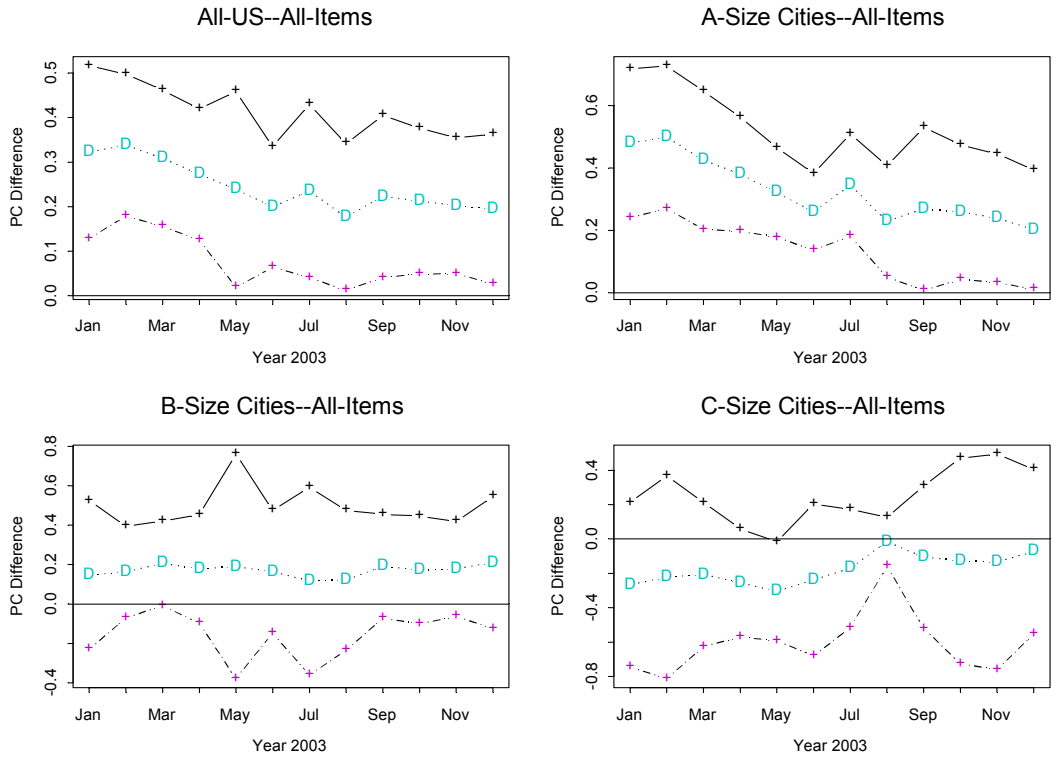


In the East and South roughly half of all differences are *not* significantly different, while in the Midwest and West practically none of the twelve 12-month differences is significantly different. Thus, *significance* appears to be weakening as we begin to move down the aggregate ladder. However, with these Region differences the patterns are more similar than dissimilar, and not particularly distinct from their All-US–All-Items counterparts (see the first graph in **Fig 4).**

4. City-Size Level Differences between Regular CPI and Chained CPI

When we break out the CPI indexes by Metropolitan City-Size (A = Large, B = Medium, C = Small), we observe some sharper distinctions. The A-Size Cities are in near mirror conformity with the All-US–All-Items results, but then the A-Size Cities represent a full 57.5% of all CPI expenditures. (The B-Size Cities constitute 36.5% of the total, and the C-Size Cities makeup the remaining 6.0%.) In the C-Size Cities not only are the differences all *not* significantly different from zero but the Superlative 12-month price changes themselves are all *greater* than their Regular counterparts. These differences represent only 6% of the whole CPI but this anomaly may need further investigation (unstable superlative weights perhaps?). In the B-Size Cities the differences themselves retain the expected upward bias (i.e., Reg > Sup), but none of the differences are significant at an $\alpha = 0.05$ level, even though these B-Size Cities represent a full 36.5% of the entire CPI. Again, as we move down to lower aggregate levels the significant levels diminish.

Fig 4. **City-Size Level 12-Month Price Change Differences**
(D = RegCPI – SupCPI ----- 95% Conf Intervals)



5. Major Group Level Price Change Differences

Finally, we turn to Lower Item-Aggregate levels, to observe and test the differences between Regular CPI and Superlative CPI indexes at the Major Group level. At BLS we break down All-Items into 8 Major Groups (with their relative importances measured by expenditure level): Apparel (4%), Education & Communication (6%), Food & Beverages (16%), Housing (41%), Medical (6%), Recreation (6%), Transportation (17%) and Other Goods & Services (4%). We continue to observe the relative differences between our two indexes for the twelve 12-month price changes in 2003. **Fig 5** displays the results using the new difference variance estimator and **Fig 6** displays the results using a test statistic based on Superlative-derived standard errors. Overall, using either variance methodology, the number of times the difference between the two indexes is *significantly* different drops dramatically. At the All-US–All-Items level, using Superlative-derived standard errors, 8 of the 12 12-month price change differences are *significantly* different, where only 22 of the 96 (12 MOs x 8 MGs) are *significantly* different at the Major Group level. A drop from 67% to 23%. Using the new difference standard errors, we find all 12 of the 12-month price change differences at the All-US–All-Items level *significantly* different, but that at the Major Group level only 30 out of 96 *significant*. A drop from 100% to 31%. Comparing the results of the two variance methodologies at the individual Major Group levels, moreover, shows a strong similarity of the *significant* results across each Major Group pair. Again, the confidence intervals generated by the new difference variance estimator are more conservative across the board, but not in any appreciably different sense.

The graphs in **Fig 6** provide the additional information for tracking the actual annual inflation rates for each of the eight Major Groups through 2003 and provide similar significant difference results as the graphs in **Fig 5**. But we will concentrate our attentions primarily on the graphic results obtained from using the new difference variance estimator.

We look first at the three Major Groups that seem to be producing consistently *significant* differences: Food & Beverages, Education & Communication and Transportation. Roughly a third of the differences in

these three sectors are skirting zero or are actually below zero (and thus officially *significant* at the $\alpha = .05$ level). So these groups, which account for about 40% of the entire CPI, seem to be in line with the All-US–All-Items results. Recreation and Other Goods & Services (10%) display a mixed bag of results.

But Apparel, Medical and especially Housing produce *non-significant* difference results all but every time. Apparel, which runs notoriously high variances, no matter what the estimator or methodology used, is showing not only clearly *non-significant* results but nearly identical indexes, particularly in the last four months of 2003. Medical also produces consistently *non-significant* differences in 2003. But these two Major Groups together constitute just 10% of the CPI. Housing, which alone represents over 40% of the CPI, is far and away the largest contrarian situation.

Housing includes fuels and furnishings and lodging away from home, but its two main components are Rent (7%) and REQ (22%), or Owners' Rental Equivalency, whose separate index is, in the main, moved by the Rent index. Largely, then, due to the behavior of the Rent Index in relationship to the two index estimators (i.e., Regular versus Superlative), we find a near consistent *reversal* of the difference between the two indexes. In the Housing Major Group in 2003, particularly as the year progresses, the Regular CPI is actually tracking *lower* than the Chained (Superlative) CPI. The "reverse" differences are not large, but they clearly establish *non-significant* difference results across all twelve months of observation. And whatever expected bias, substitution or otherwise, is not longer present in the Housing comparisons.

What, indeed, may be going on is a counter-intuitive mathematical phenomenon related to the Geometric mean estimator versus a Laspeyres estimator. Superlative estimates use a Tornqvist formula, which, while formally constituting a superlative formula, is still mathematically a purely geometric mean. In a 1999 ASA paper, on the performance comparisons of Laspeyres indexes versus Geometric Mean indexes in the CPI, it was demonstrated that, for a certain important range of Rent Levels where "low" rents corresponds to higher rent changes and "higher" rents to correspondingly lower rent changes, that a geometric mean estimator will perforce produce a *higher* price relative than its Laspeyres counterpart which uses a variation of an arithmetic mean. Thus, whatever natural "substitution bias" is at work throughout the rest of the CPI, within Rent and REQ (i.e., within Housing) this bias is not operable and these "reverse" results reflect that.

6. Summary

- At the All-US–All-Items level, the 12-month price change differences between Regular CPI and Chained (Superlative) CPI remain significantly different at an $\alpha = .05$ level, with the difference between the two indexes leveling off at ≈ 0.30, with Chained CPI the lower index.
- We have calculated new standard errors both for Superlative 12-month price changes and for the *differences* between Superlative CPI and Regular CPI, using adaptation of the Stratified Random Group (SRG) method.
- As we move down to lower aggregate levels, we find that the differences between the two indexes become less and not more significantly different.
- At the Region Level, the difference patterns similarly match the All-US–All-Items differences, but with fewer significant differences, particularly in the West Region.
- At the City-Size Level, the differences between All-US–All-Items become more and more pronounced as the City-Size diminishes.
- At the Major Group Level, some differences remain significant but most all now are non-significant, with a particularly strong non-significance pattern in the Housing group

Fig 5. **All-US 12-Month Price Change Differences by Major Group**
Difference (D) = Regular CPI – Chained CPI
95% Confidence Intervals (+)

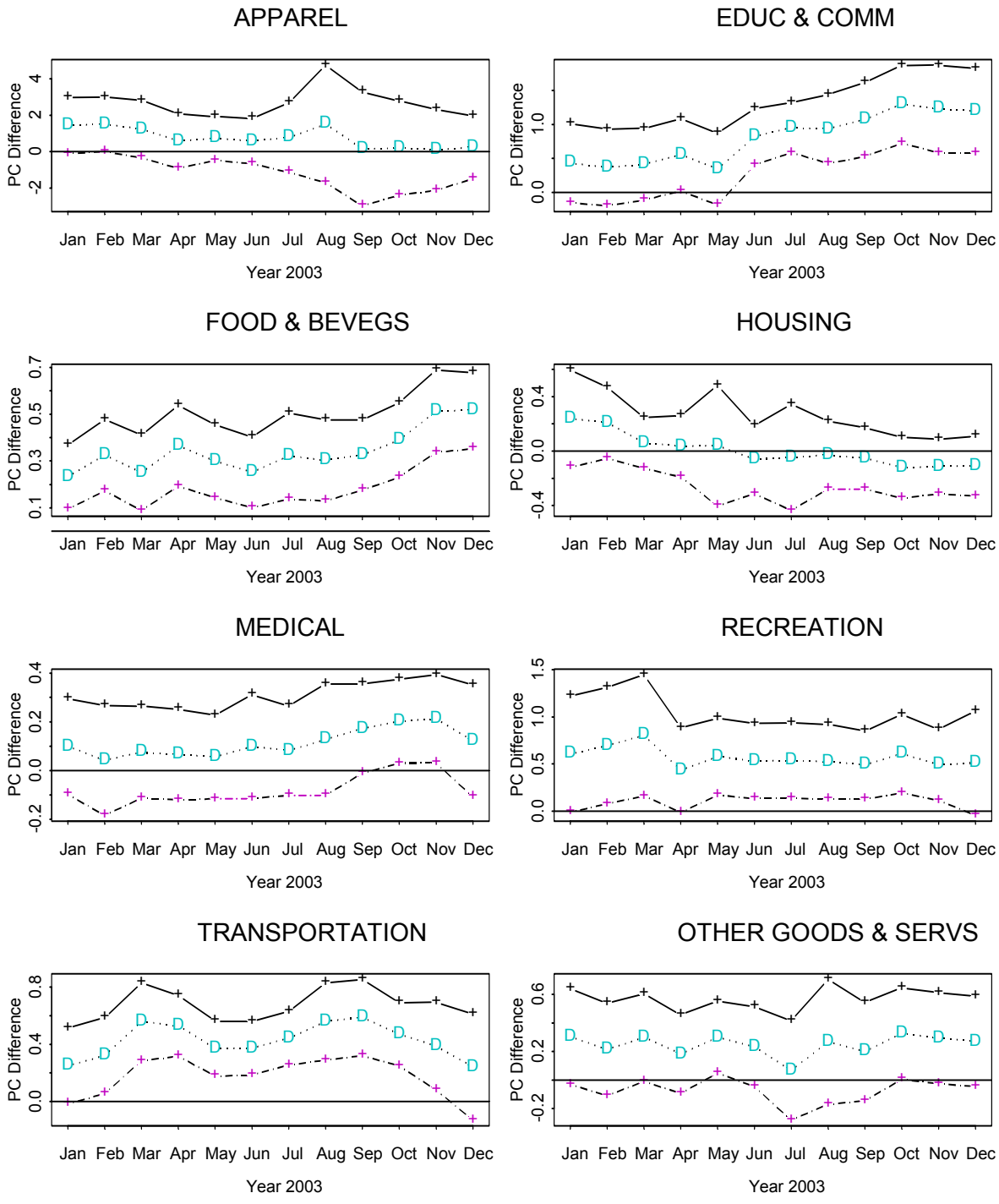


Fig 6. **All-US 12-Month Price Changes by Major Group**
Regular (R) CPI vs. Chained (C) CPI
95% Confidence Intervals (+)