Apparel price indexes: effects of hedonic adjustment

The Bureau has adopted hedonic techniques to adjust price changes for apparel, which is subject to frequent variations in characteristics; a comparison of the new indexes with those produced using traditional methodology yields some surprising findings

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> If a poll were taken of professional economists and statisticians, in all probability they would designate (and by a wide margin) the failure of the price indexes to take full account of quality changes as the most important defect in these indexes. And by almost as large a majority, they would believe that this failure introduces a systematic upward bias in the price indexes—that quality changes have on average been quality improvements.
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> . . . Even the concept of quality change is not free of difficulty. Changes in buyers' tastes will lead to the appearance of new goods—an uncontroversial example would be fashionable apparel—which are not improvements judged by either previous or subsequent tastes, and the line separating taste changes from quality improvements will depend on the time span invoked.
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> —*The 1961 Price Statistics Review Committee*

Since January 1991, economists working on the Consumer Price Index (CPI) have been making direct adjustments for quality differences in the price observations used to calculate apparel commodity indexes.[1] These adjustments compensate for the effect of quality changes on apparel prices and are based on dollar-value estimates for product features developed through regression analysis. Previously, quality adjustments were handled implicitly when estimates of price changes were made through a procedure known as imputation.

The Bureau of Labor Statistics computes apparel indexes and other consumer price indexes from the average change in prices for a sample of consumer items in a sample of retail outlets. The price change for each sample item is the ratio of its price in the current period to its price in the previous period. A price change is valid for index use only if the item is the same or at least "comparable" between the two periods. However, measuring apparel price change is particularly difficult; these "fashion-driven" goods are subject to frequent product changes and, in some categories of apparel, items rarely remain in the outlets from one fashion season to the next.

When product changes occur, BLS determines whether price comparisons are appropriate for use in the index by carefully reviewing the prod-

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uct specifications (or "characteristics") for the changing item. Because consumer price indexes are designed to measure only price change, the quality of the items in the samples must be held constant. When an item in a sample is no longer available for consumer purchase, it is replaced—ideally, by the most similiar item in the same outlet—to provide a continuous measure of price change. BLS refers to the replacement of discontinued items with currently available items as "substitution."

BLS economists called commodity analysts determine whether substitute items are equivalent in quality by comparing data on the characteristics (such as fabric, lining, and so forth) of each item. Price change for substitute items of the same or similar quality is then measured by comparing the price of the replacement item in the current period with the price of the discontinued item in the previous period. Substitutions of this type are known as "comparable" substitutions.

Before January 1991, if the commodity analyst found that a replacement item was not of the same or similar quality, a price change was imputed (estimated) for the substitution by taking the average of all (nonimputed) price changes within the same geographic pricing area[2] that had quality characteristics similar to the replacement item.[3] Substitutions of this type are termed "noncomparable" substitutions. When the CPI uses imputed price changes for noncomparable substitutions, the effective sample size is reduced. This may increase index variance and may also reduce index accuracy.[4]

As an alternative to imputing noncomparable substitutions, commodity analysts in some cases now estimate the dollar value of the difference in quality between the original item and its replacement. This dollar value is used to "quality adjust" the price change, in essence netting out the portion of the price difference between the two items that is attributable to variations in quality. In doing so, the analyst creates a comparable substitution whose price change can be used in the CPI. The technique used in this study to estimate the dollar value of the quality difference between two items is called hedonic regression analysis.

Hedonic-based quality adjustments help to minimize the index problem associated with noncomparable substitutions. The parameter estimates developed in hedonic regression models may be viewed as the implicit prices or values (to the consumer) of a product's characteristics.[5] Commodity analysts can then adjust the prices for many noncomparable substitutions based on the value of the differences in product characteristics for the substitute items.[6] The new, quality-adjusted price changes are used for index calculation without compromising the integrity of the (constant-quality) index. This procedure permits apparel consumer price indexes to better reflect "pure" price movement in the marketplace and to provide more accurate information about inflation of apparel prices.

This article compares the behavior of apparel price indexes with and without hedonic quality adjustments. The research is broader in scope than previous CPI apparel studies. It involves the recomputation of more than 550 substitution price changes for the seven most important apparel component indexes (called strata) over a 6-month period. Higher level apparel indexes (called aggregates) also are simulated using the component index results. While differences are observed between published indexes (those with quality adjustments) and nonhedonic indexes (those without quality adjustments), the results reveal no consistent differences across strata or aggregate level indexes.[7]

Background of the hedonic measures

Research involving the use of hedonic regression models for apparel commodities in the CPI has been ongoing since the mid-1980's.[8] As indicated earlier, hedonic regression models attempt to determine the relationship between individual product characteristics and the price of a good. For example, the CPI hedonic model for women's dresses relates the influence of characteristics such as type (daytime or formal), number of pieces (one or two), fiber content, brand label category (store or national), size range, type of lining (bodice or full), and so forth on price. The 1991 hedonic regression model for women's dresses was estimated using more than 1,000 observations from the CPI data base, and yielded statistically significant parameter estimates for 19 product characteristics. These estimates for women's dresses (and similiar estimates for other apparel items) have proven to be very useful in the measurement of price change.

To date, CPI apparel analysts have developed about 20 hedonic regression models for apparel items. They use these models in three ways.

First, information gleaned from a hedonic model about the characteristics of a specific apparel commodity, such as a woman's coat, enhances the ability of an analyst to make decisions about the comparability of substitute items. Almost 70 percent of apparel strata display some seasonal marketing pattern, with new items introduced at the beginning of the fall/winter and spring/summer fashion seasons. Finding the same apparel items that had been priced in the previous season is a particularly difficult problem because of the frequent and widespread variation in fashions and styles. Consequently,

apparel commodities have the highest substitution rates in the CPI. Therefore, upgrading the comparability decisionmaking skills of the commodity analysts can be considered an investment that insures that only constant-quality price changes are included for index calculation.

Second, the parameter estimates developed in hedonic regressions reveal which item characteristics are most important to the price. This information is used to distinguish between "major" and "minor" price-determining characteristics when apparel data collection forms are redesigned. These revised data collection forms are intended to minimize the need for substitution, and, when substitution is necessary, they increase the likelihood that the replacement item will be the most similiar substitute and will match the "major" price-determining characteristics of the original item. Revising collection forms based on hedonic regression models increases the chance that a comparable substitute—that is, an item of the same or similar quality—will be chosen by BLS data collection staff when substitution is unavoidable.

Lastly and most relevant for this study, commodity analysts are using parameter estimates developed in hedonic regression models to adjust price based on differences in characteristics for substitute items. These hedonic-based price adjustments are applied to substitutions with major quality differences and are a valuable tool for measuring apparel price change. Quality adjustments are also applied to substitutions with minor differences in characteristics and enhance the precision of the price change used in the index. Identification of quality-adjusted price changes for major versus minor characteristic differences in substitution data permits measurement of the extent to which the use of hedonic regression models affects apparel indexes.

Table 1. **Allocation of quality adjustments in published hedonic price indexes between comparable and noncomparable substitutions in nonhedonic test indexes, June–December 1991**

Apparel items	Number of quality adjustments in published indexes	Number of substitutions for test indexes	
		Deemed comparable	Deemed noncomparable
Total	567	383	184
Men's suits	42	29	13
Men's shirts	51	41	10
Men's pants	17	12	5
Women's coats	67	44	23
Women's dresses	43	19	24
Women's separates and sportswear	310	221	89
Women's suits	37	17	20

Nonhedonic test index methods

Apparel commodity analysts compiled the substitution data used to calculate the nonhedonic test indexes. Under the assumption that hedonic quality adjustments were not at their disposal, the analysts made comparability decisions for substitutions in the second half of 1991 that had been quality adjusted in the published indexes. These decisions determined how price change would have been used in the apparel indexes had the hedonic-based quality adjustments not been used. Table 1 shows all the comparability decisions for the test (nonhedonic-based) indexes from June 1991 to December 1991 for the apparel strata included in this study.[9]

When a substitution had been deemed noncomparable, the quality-adjusted price change from the published index was replaced (in effect) with an imputed price change, and when the substitution had been deemed comparable, the prices of the substitute items were compared directly with prices of the items they had replaced. These "new" price changes excluding quality adjustment were used to compute a simulated index for each item stratum in each month included in the study.[10]

Test indexes were computed for the period June–December 1991 for three men's apparel strata (men's suits, coats, sportcoats, and jackets; men's shirts; men's pants and shorts) and four women's apparel strata (women's coats and jackets; women's dresses; women's separates and sportswear; and women's suits). In addition, aggregate (higher-than-stratum level) apparel indexes (men's apparel; women's apparel; and apparel commodities) were simulated using the results from the stratum level indexes.[11]

Tables 2, 3, and 4 show the nonhedonic test and hedonic published indexes for all apparel item strata and aggregates during the study period. Included in these tables is information about the semiannual (June to December) percent index changes.[12] Also shown are the differences between test and published indexes for 1-month index levels and semiannual percent changes.

Comparing hedonic/nonhedonic indexes

Test indexes are compared with published indexes to determine both the direction and magnitude of discrepancy for each of the seven item strata and three aggregate apparel indexes. As indicated earlier, the published indexes are assumed to be better proxies for price movement in the (apparel) marketplace because they incorporate less imputed price change. The semiannual percent index changes are considered the primary indicators of test index discrepancy because they provide trend measures of index behavior.

Table 2. **Test (nonhedonic) and published (hedonic) price indexes[1] for men's apparel, 1991**

Month	Men's suits			Men's shirts			Men's pants		
	Test	Published	Difference	Test	Published	Difference	Test	Published	Difference
June	131.6	131.7	-0.1	133.3	[2]133.3	0.0	123.2	123.3	–0.1
July	128.4	128.3	+ .1	129.3	129.0	+ .3	121.9	121.8	+ .1
August	132.7	132.8	–.1	132.5	132.4	+ .1	123.8	123.6	+ .2
September	134.2	134.5	–.3	135.0	134.8	+ .2	125.0	124.8	+ .2
October	134.2	134.4	–.2	136.4	136.1	+ .3	125.8	125.6	+ .2
November	133.2	133.8	–.6	136.2	135.4	+ .8	129.0	128.8	+ .2
December	130.8	131.4	–.5	133.4	133.1	+ .3	126.3	126.1	+ .2
June–December percent change[3]	–.6	–.2	–.4 (Down)	+ .1	–.2	+ .3 (Up)	+2.5	+2.3	+ .2 (Up)

[1] The indexes correspond to the not seasonally adjusted Consumer Price Index for All Urban Consumers.

[2] No quality adjustments that month for the published index.

[3] Down (Up) indicates an overall downward (upward) discrepancy in the test indexes (without quality adjustments) for the June–December study period. See text for further explanation.

How different would the apparel indexes have been without the hedonic quality adjustments? The difference between test and published indexes, if any, may be positive (upward) or negative (downward). In this study, "upward discrepancy" means that the test index *rises more than* the published, quality-adjusted price index if prices are rising, or that the test index *falls less than* the published index if prices are falling. Conversely, "downward discrepancy" means that the test index *rises less than* the published, quality-adjusted price index if prices are rising, or that the test index *falls more than* the published index if prices are falling.[13] *Generally speaking, subtracting the published semiannual percent index change from the test semiannual change will indicate the direction of the discrepancy*—that is, a negative difference implies a downward discrepancy and vice versa. The magnitude of the test index discrepancy is represented by the absolute value of the difference in semiannual percent changes between published and test indexes.

The test and published semiannual percent index changes for men's suits are –0.6 and –0.2, respectively, as shown in table 2. Because the test index fell more than the published index during a period of falling prices, the published men's suits index would have been lower had the CPI staff not made its hedonic quality adjustments. The magnitude of this test index discrepancy is 0.4 percent—calculated as $|-0.6 - (-0.2)| = |-0.4| = 0.4$. The direction and magnitude of test index discrepancies are shown in tables 2, 3, and 4 for the men's strata, women's strata, and aggregate indexes, respectively.

Of the 10 apparel test indexes produced in this study, 3 reflect upward discrepancies, 5 reflect downward discrepancies, and 2 reflect no discrepancy due to the removal of quality adjustments. For test indexes found to be different from the published figures, the magnitude of the discrepancies ranges from 0.2 to 3.2 percent.

Factors in the differences

There are three factors suspected of contributing to the differences between hedonic and nonhedonic indexes in this study. The first may be described using the information in table 1. For each apparel stratum, a certain percentage of the substitutions that were quality adjusted for the published indexes were deemed comparable for the test indexes, and the remaining percentage were deemed noncomparable. The ratio of these two percentages provides an indication of how price change was treated in the test indexes—whether by using direct comparison or by imputing change from the average for the stratum—for substitutions that were quality adjusted in the published indexes. The second and third rows in table 5 reflect the percentages of substitutions deemed comparable and noncomparable for each apparel item in the study.

The data in this table indicate that, as the percentage of substitutions deemed noncomparable increases (that is, as the use of imputed price change for test index calculation increases), so does the magnitude of discrepancy between the test and published indexes. The test indexes for men's suits, women's dresses, and women's suits, as well as the aggregate index for women's apparel, all reflect the greatest use of imputed price change because they have the highest percentages of substitutions deemed noncomparable within their own groups. They also have the largest magnitudes of test index discrepancies in table 5. This result is expected because imputed price change is an inadequate proxy for inflation of apparel prices, as noted earlier. The relationship between the use of imputed price change and the

direction of test index discrepancies is not as evident, although apparel items with relatively high percentages of substitutions deemed noncomparable are negative.

The second factor contributing to differences in test index discrepancies is apparel item complexity. In this study, apparel item complexity is determined by the number of characteristics collected for an item. Item complexity relates the degree of difficulty involved in holding quality constant between an original item and its substitute, at both the collection and review stages of substitution. Complexity is assumed to increase with the number of item characteristics collected. Information about the number of characteristics collected for an apparel item in the CPI is provided by the apparel data collection forms, as described earlier. The fourth row of table 5 shows the number of characteristics collected for each of the seven apparel item strata in this study.

These data indicate that item complexity varies directly with the magnitude of test index discrepancies and, to a lesser extent, inversely with the direction of these discrepancies: as the number of item characteristics for which data are collected increases, the magnitude of test index discrepancy increases while the direction tends to become negative. The table reveals that the women's apparel item with the greatest number of characteristics (women's suits) has the highest index discrepancy (3.2 percent), while the least complex item (women's separates and sportswear) shows no index discrepancy (0.0 percent).

The findings for men's apparel are less conclusive but show that the most complex item within that group (men's suits) reflects the greatest index discrepancy (0.4 percent). The direction of test index discrepancies for strata with the greatest complexity in each of the men's and women's groups (men's and women's suits) indicates that these indexes would be lower without quality adjustments.

The third and final factor suspected of contributing to differences in test index discrepancies is the relative importances of the indexes for individual apparel item strata.[14] Relative importances of stratum-level indexes are based on consumer expenditure data for goods and services in the CPI base period, adjusted through time for relative price change. Aggregate-level relative importances are merely the sum of their components; for example, the sum of the relative importances for all men's item strata indexes equals the relative importance of the men's apparel index. The relative importances for each of the men's and women's strata and aggregate groups are presented in the fifth row of table 5. Percentage values are included in the last row to indicate the degree of influence a component index has on its aggregate index.

There was no test index discrepancy reported in table 5 for men's apparel, which is to be ex-

Table 3. **Test (nonhedonic) and published (hedonic) price indexes[1] for women's apparel, 1991**

	Women's coats			Women's dresses		
	Test	Published	Difference	Test	Published	Difference
June	113.9	113.9	0.0	127.3	129.0	−1.7
July	114.9	114.9	.0	122.3	124.9	−2.6
August	122.4	122.7	−.3	126.9	131.8	−4.9
September	130.2	130.2	.0	133.7	138.9	−5.2
October	127.3	126.5	+.8	135.3	139.4	−4.1
November	125.5	124.7	+.8	134.7	138.2	−3.5
December	121.9	121.1	+.8	125.3	128.0	−2.7
June–December percent change[2]	+7.0	+6.3	+.7 (Up)	−1.6	− .8	−.8 (Down)
	Women's separates			Women's suits		
June	128.1	128.0	+.1	129.6	129.2	+ .4
July	123.5	123.2	+.3	129.4	128.9	+ .5
August	125.7	125.3	+.4	138.5	136.8	+1.7
September	132.4	131.9	+.5	145.9	149.5	−3.6
October	135.0	134.8	+.2	150.0	153.5	−3.5
November	135.5	135.7	−.2	144.6	151.0	−6.4
December	131.3	131.2	+.1	140.7	144.5	−3.8
June–December percent change[2]	+2.5	+2.5	.0	+8.6	+11.8	−3.2 (Down)
	(No discrepancy)					

[1] The indexes correspond to the not seasonally adjusted Consumer Price Index for All Urban Consumers.

[2] Down (Up) indicates an overall downward (upward) discrepancy in the test indexes (without quality adjustments) for the June–December study period. See text for further explanation.

Table 4. **Test (nonhedonic) and published (hedonic) price indexes[1] for aggregate apparel, 1991**

Month	Men's apparel			Women's apparel			Apparel commodities		
	Test	Published	Difference	Test	Published	Difference	Test	Published	Difference
June	127.1	127.1	0.0	124.2	124.4	−0.2	124.4	124.5	−0.1
July	124.0	123.9	+.1	121.1	121.4	− .3	122.5	122.6	−.1
August	126.3	126.3	.0	124.5	125.0	− .5	125.0	125.2	−.2
September	128.7	128.7	.0	130.4	131.3	− .9	128.8	129.1	−.3
October	129.7	129.7	.0	131.9	132.7	− .8	130.4	130.7	−.3
November	130.5	130.4	+.1	131.7	132.8	−1.1	130.5	130.9	−.4
December	128.2	128.3	−.1	127.3	128.0	− .7	126.9	127.2	−.3
June–December percent change[2]	+.9	+.9 (No discrepancy)	.0	+2.5	+2.9	− .4 (Down)	+2.0	+2.2	−.2 (Down)

[1] The indexes correspond to the not seasonally adjusted Consumer Price Index for All Urban Consumers.

[2] Down (Up) indicates an overall downward (upward) discrepancy in the test indexes (without quality adjustments) for the June–December study period. See text for further explanation.

Table 5. **Factors related to differences in test index discrepancies**

Factor	Men's apparel				Women's apparel					Apparel aggregates		
	Total	Men's suits	Men's shirts	Men's pants	Total	Women's coats	Women's dresses	Women's separates	Women's suits	Apparel commodities	Men's apparel	Women's apparel
Test index difference	0.0	−0.4	+0.3	+0.2	−0.4	+0.7	−0.8	0.0	−3.2	−0.2	0.0	−0.4
Percentage of quality-adjusted substitutions deemed comparable	74.5	69.0	80.4	70.6	65.9	65.7	44.2	71.3	45.9	67.5	74.5	65.9
Percentage of quality-adjusted substitutions deemed noncomparable	25.5	31.0	19.6	29.4	34.1	34.3	55.8	28.7	54.1	32.5	25.5	34.1
Number of apparel item characteristics[1]	—	*16.3	14.0	12.0	—	16.0	21.0	*13.5	30.0	—	—	—
Apparel item relative importances[2]	1.173	.347	.299	.242	2.082	.205	.356	.972	.180	5.440	1.173	2.082
(As a percent of aggregate)	—	(29.6)	(25.5)	(20.6)	—	(9.8)	(17.1)	(46.7)	(8.6)	—	(21.6)	(38.3)

[1] The numbers in the row labeled apparel item characteristics were obtained from the CPI data collection forms for these items. An asterisk indicates that more than one collection form is used to collect data for this item and the number shown represents an average. See text for further discussion.

[2] The relative importance row relates the value weight of the apparel items with respect to the total (aggregate). The relative importances for men's furnishings and unpriced men's uniforms and other clothing are 0.269 (22.9 percent) and 0.015 (1.3 percent). Those for women's underwear, nightwear, and accessories and unpriced women's uniforms and other clothing are 0.339 (16.3 percent) and 0.031 (1.5 percent). These apparel items were excluded from the study because no quality adjustments were performed during the test period. The relative importances for boys' apparel, girls' apparel, footwear, infants' and toddlers' apparel, sewing materials and luggage, and jewelry are 0.249 (4.6 percent), 0.376 (6.9 percent), 0.798 (14.7 percent), 0.215 (4.0 percent), 0.094 (1.7 percent), and 0.453 (8.3 percent), respectively. These apparel groups were excluded from the study because relatively few quality adjustments were performed, and because the objective was to study the impact for men's and women's apparel.

pected, because this result is about equal to a weighted average of the aggregate index components. Men's suits is the most influential stratum, with a test discrepancy of −0.4 percent, but is offset by men's shirts and men's pants with test discrepancies of +0.3 and +0.2, respectively. The test discrepancy reported in table 5 for women's apparel, −0.4, also is consistent, because the direction and magnitude of this discrepancy is about equal to a weighted sum of the aggregate components: the +0.7 and 0.0 discrepancies for women's coats and women's separates dampen the influence of the −0.8 and −3.2 discrepancies associated with women's dresses and women's suits. Finally, the test discrepancy reported for apparel commodities, −0.2, also is reasonable, because the women's apparel index has a greater weight (or relative importance), with a test discrepancy of −0.4, but is offset by the 0.0 result for men's apparel.

Other factors, such as the degree of product knowledge exhibited by the commodity analyst and the capacity of the data collection document to capture the quality of an item being priced, also may account for test index discrepancies. Unfortunately, the effects of these factors are more difficult to quantify, but they should be considered as potential sources of test index discrepancy.

Conclusion

The quotation from the 1961 study of price statistics that opens this article indicates that many professional economists and statisticians believe

the CPI has failed to account for considerable quality increase and is therefore too high. There is little evidence for that conclusion in this study. In fact, the traditional CPI procedure of imputing prices for items with quality change may have caused the index to miss price change as well as quality change. Therefore, when new techniques are introduced, the new, improved indexes do not differ from the old indexes in the way expected. An example is the final effect of quality-adjustment procedures on the apparel commodities index, which exhibited a test discrepancy of –0.2 percent.

The development of reliable hedonic regression models for use in making quality adjustment in (consumer) price indexes requires knowledge of the market and sophisticated statistical models. The information provided by hedonic regression models assists the commodity analyst in determining which product characteristics have the most impact on price, devising data collection forms that increase the chance of choosing a substitute item of the same quality, and adjusting price differences for their quality component when substitute items are not similar.

In this study, measuring the effect of using hedonic regression models when producing price indexes for apparel—items particularly subject to changes in characteristics due to seasonality and style preferences—is achieved by comparing indexes with and without quality adjustments, other things equal. The empirical results indicate that test indexes not utilizing hedonic quality adjustments exhibit upward as well as downward discrepancies from published hedonic-based indexes. In addition, the magnitude of these discrepancies is not uniform. Factors that seem to account for differences are the percentage of item substitutions deemed noncomparable, the complexity of an apparel item, and the influence that a component index has on its aggregate.

Footnotes

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[1] An announcement about this improvement in CPI procedures was reported in *CPI Detailed Report* (Bureau of Labor Statistics, September 1990), pp. 6–7.

[2] The term "pricing area" refers to one of the 44 geographic areas that represent the United States in the CPI. In each pricing area, there are 207 groups of goods and services (called item strata), which represent all consumer expenditures. Thus, there are 9,108 (44 times 207) basic item-area indexes from which the CPI is constructed. Imputed price changes for substitutions of dissimilar quality are computed at the basic item-area index level.

[3] In December 1992, a new methodology for estimating imputed price change was adopted for the CPI. Because the data used in this study are from 1991, imputed price changes for noncomparable substitutions in the nonhedonic indexes were estimated based on the old methodology. Therefore, conclusions cannot be made about the differences between hedonic-adjusted indexes and the new imputation methodology. Future work comparing the current imputation method with hedonic adjustment may prove interesting. More information about this improvement in CPI imputation procedures can be found in *CPI Detailed Report* (Bureau of Labor Statistics, August 1992), pp. 3–4.

[4] Many of the price changes used for imputation prior to December 1992 were for items sold year round (over 30 percent of the index sample) that showed little or no price change from month to month. In addition, price changes for seasonal items that were used for imputation and still were available in the current season (such as in-season items that do not require substitution) reflected discounted "sale" prices because these items were left over from the previous fashion year. Substitution price changes, however, usually represent seasonal items entering the marketplace at the beginning of the selling season, a time when manufacturers and retailers are passing along price increases that raise prices above those from the previous selling seasons. Therefore, using the average of zero and negative price changes to impute price changes for substitutions that typically reflect price increases may introduce an index inaccuracy.

[5] The reader is referred to Mokoto Ohta and Zvi Griliches, "Automobile Prices Revisited: Extensions of the Hedonic Hypothesis," *Household Production and Consumption*, National Bureau of Economic Research Studies in Income and Wealth, no. 40 (New York, Columbia University Press, 1975), pp. 325–90, for theoretical interpretations on the use of hedonic methods.

[6] For a detailed discussion of the way in which parameter estimates developed in hedonic regression models are used to adjust substitution prices for characteristic differences see Paul R. Liegey, Jr., "Adjusting Apparel Indexes in the CPI for Quality Differences," in M. Foss, M. Manser, and A. Young, eds., *Price Measurements and Their Uses*, National Bureau of Economic Research Studies in Income and Wealth, no. 57 (The University of Chicago Press, 1993), pp. 209–26.

[7] Findings which support the conclusion that indexes unadjusted for quality change may result in both upward and downward errors are not new to the price index literature. In a May 1971 *Monthly Labor Review* article entitled "Determining the effects of quality change on the CPI," Jack Triplett surveys a number of different studies that attempt to gauge the magnitude and direction of index discrepancy due to quality change for various components of the CPI. While conceding that the studies in his survey are not exhaustive over the literature, Triplett states that, "the (consumer price) index may have negative as well as positive errors due to quality changes." He concludes that "these errors will be determined, not solely by the extent and rapidity of quality change in the marketplace, but also by the particular marketing arrangements for different products and by the interaction of these factors with the mechanisms set up by BLS (Bureau of Labor Statistics) to try to control the size of quality errors permitted in index comparisons."

[8] See Paul A. Armknecht, "Quality Adjustment in the CPI and Methods to Improve It," *Proceedings of the Business and Economic Statistics Section* (American Statistical Association, 1984), pp. 57–63; Efthemia V. Georges and Paul

R. Liegey, "An Examination Using Hedonic Regression Techniques to Measure the Effects of Quality Adjustment on CPI Apparel Indexes, *Quality Quarterly*, Internal Newsletter no. 28 (Bureau of Labor Statistics, 1988), pp. 4–7; Paul A. Armknecht and Donald E. Weyback, "Adjustments for Quality Change in the U.S. Consumer Price Index," *Journal of Official Statistics*, vol. 5, 1989, pp. 107–23; Paul R. Liegey, "Implementation of Hedonic Regression Techniques to Adjust for Quality Differences in the CPI," *Quality Quarterly*, Internal Newsletter no. 34 (Bureau of Labor Statistics, 1990), pp. 5–9; and Liegey, "Adjusting Apparel Indexes."

[9] Ideally, a longer period would have been desirable for this study, but resources at the time the data were compiled were extremely limited. Because the substitution data in this study represent predominantly the fall/winter fashion season, one might naturally ask if we would expect similiar test results if spring/summer substitution data are used. There is no reason not to expect similiar results, especially because the data used to calculate the hedonic models for making the quality adjustments are fully and equally represented by both fall/winter and spring/summer items. See Armknecht and Weyback, "Adjustments for Quality Change," p. 115; and Liegey, "Adjusting Apparel Indexes," footnote 7.

[10] The computer program that simulates index computation was devised by Kenneth J. Stewart, Information and Analysis Section Chief of the Consumer Price Index, Office of Prices and Living Conditions, Bureau of Labor Statistics.

[11] The author thanks Claire McAnaw Gallagher for providing the computer software that simulates aggregate consumer price indexes. Ms. Gallagher is an economist with the Production and Control Section of the Consumer Price Index, Office of Prices and Living Conditions, Bureau of Labor Statistics.

[12] The semiannual percent index changes were calculated in the following manner: [(Index number, Dec. 1991)/(Index number, June 1991) – 1]*100. For example, the test semiannual percent index change for men's suits (table 2) is equal to [(130.8)/(131.6) – 1]*100 = –0.607. Each semiannual percent change was rounded to the nearest tenth.

[13] The wording used to describe upward and downward discrepancies in this section is similiar to that used by Triplett, "Determining the Effects," in the note to table 4, p. 30.

[14] The relative importance of a component in the CPI is its expenditure or value weight expressed as a percentage of the All-items CPI. These values indicate how the index population distributes expenditures among all the components that make up the All-items CPI. The U.S. All-items CPI is the highest aggregate measure of consumer price inflation, and generally the measure of most interest to the public. Apparel and upkeep is one of the seven major groups that make up the All-items CPI. Relative importance values are derived from data collected from the 1982–84 Consumer Expenditure Survey, updated by price changes from the CPI sample of items. For a more detailed discussion, see *BLS Handbook of Methods*, Bulletin 2414 (Bureau of Labor Statistics, 1989), chs. 18 and 19.