Volume Title: The Measurement of Durable Goods Prices

Volume Author/Editor: Robert J. Gordon

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-30455-8

Volume URL: http://www.nber.org/books/gord90-1

Conference Date: n/a

Publication Date: January 1990

Chapter Title: Electrical Appliances

Chapter Author: Robert J. Gordon

Chapter URL: http://www.nber.org/chapters/c8315

Chapter pages in book: (p. 241 - 320)

7 Electrical Appliances

7.1 Introduction

Next to automobiles and electronic computers, household appliances have been the most popular product for study with the hedonic regression technique. In addition to the pioneering studies by Burstein (1960, 1961), both Dhrymes (1971) and Triplett and McDonald (1977) have published hedonic regression studies of appliance prices, with a heavy emphasis on refrigerators. In addition to the presence of a previous literature, appliances are an appealing subject for inclusion in this book, with its emphasis on quality changes taking the form of changes in operating efficiency. Energy cost is a large fraction of total operating cost for several types of appliances, particularly refrigerator-freezers, room air conditioners, and clothes dryers, and the effect of adjustments for the value of changes in energy efficiency will be a central focus of the chapter. As an example, it has been estimated that electrical power accounts for 58 percent of the lifetime cost of owning a refrigerator, purchase cost 36 percent, and servicing costs the remaining 6 percent (*Consumer Appliances,* n.d., 6).

The price indexes for major appliances developed in this chapter are based on two separate sources of information. Hedonic regression equations for refrigerators, room air conditioners, and washing machines (both wringer and automatic) are estimated from the earliest feasible postwar date to 1983, using data on prices and quality characteristics transcribed from successive Sears, Roebuck catalogs. A separate source of data on prices and characteristics is provided by successive *Consumer Reports (CR)* evaluations of appliances. In this chapter, the *CR* data are not used to estimate hedonic regression equations, but are employed to develop a separate set of price indexes based on the technique of comparing "closely similar models" discussed in chapter 3. *CR* data on energy usage allow the estimation of the value of changes in energy efficiency, and these energy adjustment factors are then applied to the *CR* specification indexes of price change. This chapter develops *CR* indexes for eight products (refrigerators, room air conditioners, washing machines, clothes dryers, TV sets, under-counter dishwashers, microwave ovens, and VCRs). Additional *CR* indexes are developed that incorporate energy efficiency adjustments for four of these products (refrigerators, room air conditioners, clothes dryers, and TV sets), and an additional adjustment for reductions in the cost of repairs is developed for TV sets.

In total, this chapter develops seventeen new price indexes from thousands of price observations (both from the Sears catalog and from *CR*) that are independent of the prices collected by the BLS for the CPI and PPI. Because the *CR* indexes are developed from price quotations for all major brands and for the most popular models of each product, they are in most cases based on more information than the PPI for a given product at a given moment of time. The PPI is computed at a monthly frequency and so may be based on more total information for these products, but the informational advantage of the PPI lies in its ability to track intrayear and year-to-year price movements. When comparing price changes over periods of two or more years, the *CR* indexes probably have an informational advantage.

Of the eight products covered in this chapter, the first five (in the order listed above) are compared to both of the indexes compiled by the BLS, the CPI and PPI, for the same product. The new indexes for dishwashers and microwave ovens are compared just with the PPI, and the new index for VCRs stands alone, since there is no CPI or PPI for that product. For some products, and in some time intervals, the rate of price change in the CPI and PPI differ substantially, and some products are introduced into the two government indexes at different dates (e.g., air conditioners entered the PPI in 1952 and the CPI in 1964). The PPI is of more concern than the CPI, since a central focus of this book is the development of alternative deflators for PDE to be compared to the BEA deflators for PDE that rely entirely on the PPI and never use the CPI.[1] But the CPI is also relevant for a broader evaluation of the

1. The following PPI indexes for household appliances are used within the "service industry machinery" subcomponent of PDE. The following are the PPI indexes used and their percentage weights within the service industry machinery component in 1967 and 1981 (the source of the table is unpublished BEA worksheets):

	Weights	
	1967	1981
Household laundry equipment (124102)	8.30	5.40
Household refrigeration equipment (124103)	17.94	10.28
Household room air conditioners (12410338)	11.17	6.31
Household under-counter dishwashers (12410441)	6.00	8.42
Household canister-type vacuum cleaners (12430111)	1.17	2.97

Table 7.1 **Home Appliances and Electronic Goods, 1949 and 1983, Manufacturers Shipments in Units and Retail Value**

	Units (thousands)		Value ($million)		Mean Value ($/unit)	
	1949	1983	1949	1983	1949	1983
Air conditioners	89	2,696	31	1,054	352.37	390.95
Kitchen appliances	7,362	23,274	1,847	10,105	251.01	434.18
Refrigerators	4,450	5,255	1,134	3,607	255.00	686.39
Microwave ovens	. . .	6,006	. . .	2,586	. . .	430.57
Ranges	2,112	4,521	486	2,060	230.00	455.65
Dishwashers	160	3,054	44	1,205	275.00	394.56
Freezers	485	1,166	162	568	335.00	487.14
Other	155	3,666	21	441	135.00	120.29
Home laundry	3,866	7,426	640	3,034	165.52	408.56
Compact appliances	25	1,259	. . .	334	. . .	265.29
Video	3,000	34,190	970	10,881	323.33	318.25
Audio/hi-fi	7,805	81,274	329	4,620	42.21	56.84
Personal electronics (excluding PCs)	1,350	126,724	9	4,545	5.75	35.87
Small electrical appliances	18,942	84,330	303	3,877	16.00	45.97
Floor care	2,900	10,152	222	1,271	76.49	125.20
Personal care	1,725	60,217	37	1,273	21.50	21.14
Other	1,040	181,349	95	3,173	91.73	17.50
Total	55,441	612,891	6,330	44,167	114.18	72.06
Of which, major appliances	11,342	34,655	2,518	14,527	222.01	419.19

Sources: 1949: *Electrical Merchandising Week,* January 1959. 1983: Statistical Abstract of the United States, 1985, table 1394, p. 777, with some categories reorganized and combined.

adequacy of quality adjustments by the BLS. There are sharp differences between the CPI and the PPI for refrigerators (discussed in this chapter) and between the CPI for new cars and for used cars (discussed in the next chapter). These differences are too great to be accounted for by wholesale-to-retail markups (for refrigerators) or depreciation rates (for used cars), and may suggest the need for some internal procedure to invest extra resources in the reconciliation of such differences when they exceed some minimum value.

7.2 The Postwar Development of the Appliance Industry

A comprehensive view of the postwar development of the appliance industry is provided in table 7.1. Included are both "white goods," that is, kitchen appliances, home laundry appliances, and room air conditioners, and "brown goods," that is, video and audio/hi-fi, as well as small appliances and electronic devices.[2] The table indicates that the list of consumer appliances is a long one, and it helps provide perspective on the coverage of this chapter. Leaving aside TV sets, which are not included in the totals for major appliances at the bottom of table 7.1, the four appliances receiving the most

2. The classification of room air conditioners, which are usually brown and never white, is an anomaly, confirmed by the classification in Hunt (1975).

attention here (refrigerators, air conditioners, washers, and dryers) made up 72 percent of the value of major appliances in 1949 and 53 percent in 1983. Refrigerators alone constituted 45 percent of the value of major appliances in 1949, but only 25 percent in 1983. In the major appliance category, the only important product not covered in this chapter is the kitchen range. In turn, major appliances accounted for 39.8 percent of all products listed in 1949 and for 32.9 percent in 1983, with the decline largely due to the growing importance of "brown goods," particularly TV sets and VCRs, both of which are covered here.

The very rapidly declining price indexes for electronic computers developed in the last chapter and by other investigators suggest that quality changes may have been more pervasive in consumer electronic goods than in major appliances. This fact, and the growing importance of electronic goods evident in table 7.1, from 20.6 percent of the total in 1949 to 45.4 percent in 1983, suggests that some attention must be paid to electronic products in this chapter. This task is inherently difficult, however, since many of the dimensions over which quality has improved, for example, picture quality, are difficult to quantify within the context of the hedonic regression technique. Although most of the space in this chapter is devoted to appliances, considerable attention is devoted to the development of a *CR* index for TV sets, and a briefer treatment of VCRs is included as well.[3]

The right-hand two columns in table 7.1 exhibit unit values for each major product category in 1949 and 1983. Changes in these unit values can be compared with changes in the PPI for the same products over the same period. If both the unit value and the PPI doubled, this would imply that quality per unit remained unchanged, while if the unit value doubled and the PPI remained fixed, the quality per unit implied by the PPI would have doubled. The following are the (logarithmic) annual rates of change of unit values, the PPI for each product, and the implied PPI quality per unit over the 1949–83 interval:

	Unit Value	PPI	Quality per Unit
Refrigerators	2.95	1.36	1.59
Air conditioners (PPI used 1953–63)	0.31	0.35	−0.05
Home laundry (used PPI for washing machines)	2.69	1.73	0.96
Video (used CPI for TV sets, 1950–83)	−0.05	−1.40	1.35

These implied growth rates of quality per unit raise intriguing questions. Could video equipment really have increased in quality at a slower rate than

3. Another reason for devoting less attention to electronic goods is that they are primarily manufactured abroad, and thus, while entering the deflators for consumer and producers durable expenditures, are netted out of the GNP deflator. Thus, any bias in official price indexes for consumer electronic goods would have little effect on aggregate measures of the growth rates of output and productivity.

refrigerators? Is it reasonable to conclude that the average quality per unit of air conditioners did not improve at all, since part of the technology of air conditioners is similar to that of refrigerators?

7.3 Data Sources: The Sears Catalog and *CR*

Ideally, the data source for each product studied in this volume would be comprehensive collection of price quotations (preferably transaction prices) and quality characteristics collected for all available manufacturers and models on a consistent basis over the entire postwar period. Some studies (e.g., Triplett and McDonald 1977) come close to this ideal, but only for a particular product and for a particular subset of years (1960–72 in that study represents only thirteen years of the thirty-six-year span of this book covering 1947–83). The paucity of hedonic studies and their limited product and time coverage forces us to carry out new investigations of major products over an extended sample period. To maintain the overall research within a feasible scope, compromises must be made in the collection of data. In particular, the results in this chapter are based entirely on Sears catalogs and *CR* product evaluations.

The Sears data set has the advantage that prices have a specific meaning, that is, freight on board (f.o.b.) the Sears warehouse net of shipping expense, and these prices are not subject to discounting. Thus, we need not speculate as to the possibility that discounts from list price varied over time. Further, quality characteristics (specifications) are relatively complete and are reported in full each year, whether or not a model is changed from its counterpart in the preceding catalog.[4] This allows the Sears data base to be used for the compilation of a price index either by the specification technique, which for adjacent years compares models that are absolutely identical in their printed specifications (a technique used for clothes dryers and TV sets in this chapter and for numerous Sears products in chapter 10), or by the hedonic technique (as in this chapter for refrigerators, room air conditioners, and washing machines).

There are several obvious disadvantages of the Sears data base that apply both to the specification indexes in chapter 10 and to the hedonic indexes in this chapter, and specific disadvantages applicable to the hedonic regressions developed here. The most important disadvantage is that the Sears catalog reports prices for only a single brand name. In contrast, Triplett and McDonald (1977, table 3) estimate coefficients of "make effect" dummy variables for eleven makes, and *CR* product evaluations usually cover as many as fifteen to twenty models, most of which represent different manufacturers.[5]

4. Actually, the Sears catalog is issued twice a year. Data for this study were collected only from the spring catalog.

5. Most *CR* product reports for refrigerators cover thirteen to fifteen models, even in the late 1940s and early 1950s. Product evaluations for washing machines cover as many as twenty-four models. Numbers of models are listed explicitly for most of the *CR* price comparisons in this chapter.

Further, the range of prices across models included in the typical *CR* evaluation is quite wide, and the Sears price may not be equal to or even close to the mean price across all models.[6]

Fortunately, the Sears model is included in the *CR* evaluation often enough to allow a statement about the likely direction of bias involved in basing the hedonic regression equations only on Sears catalog price quotations. It appears that the Sears price quotation listed by *CR* was consistently at the bottom of the price spectrum in the late 1940s and 1950s, but by the 1970s and 1980s was much closer to the mean. The following are ratios (in percentages) of the Sears price to the mean price in the first two and last two *CR* evaluations covered later in the chapter:[7]

	First Two (years)	Last Two (years)
Refrigerators	76.4 (1949, 1952)	105.5 (1974, 1983)
Air conditioners	80.3 (1953, 1959)	101.4 (1976, 1982)
Washing machines	84.2 (1950, 1954)	98.2 (1982, 1984)

This consistent pattern implies that the hedonic regression indexes based solely on data from the Sears catalog are probably biased in the direction of indicating a faster price increase or a slower price decline than the appropriate universe of all models. This conclusion would be qualified to the extent that Sears models had consistently improved in quality relative to the average, or to the extent that the *CR* price quotations are misleading by shifting in the 1960s from catalog to retail store prices.[8]

Because of their more complete coverage of different manufacturers, the *CR* product evaluations would seem to be unambiguously superior to the Sears catalog quotations. Indeed, considerable emphasis is placed below on "closely similar" model comparisons based on the *CR* data. Except for automobiles, no category of consumer expenditures has received more consistent or detailed coverage by *CR* over the postwar period than major consumer appliances. Successive *CR* product evaluations not only provide information on changes in prices and quality characteristics over the entire postwar period, but also constitute our sole source of data on changes in energy usage of major appliances.

6. That is, if a Sears model is included, which does not always occur.

7. Sears prices are catalog prices until the early 1960s, when they are means of retail prices in a survey of *CR* shoppers. Catalog prices in this comparison (but not in the hedonic regressions below) include an extra $10 for shipping, an add-on factor suggested in the June 1949 *CR* evaluation of refrigerators.

8. Fortunately, sufficient data are available to rule out this last possibility. In scattered cases, *CR* lists both the catalog and the mean shopper retail price quotation for the same model, and the two are almost always within 3 percent of each other after adding an arbitrary $10 shipping cost factor to the listed catalog quotation.

However, the *CR* data have limitations of coverage that inhibit their use in a formal hedonic regression study. First, *CR* does not print a report on each product every year. Instead, an irregular span of years separates reports on a given product. For instance, refrigerator reports appeared roughly every three years between 1949 and 1970, but there was then a gap between 1970 and 1974, and again between 1974 and 1983.

A further problem is that a *CR* evaluation for a given year typically includes only a single model of each manufacturer, in contrast to the Sears catalog, which typically lists eight to ten models of each major appliance. For instance, between 1964 and 1983, *CR* reported on refrigerators without automatic freezer defrost only once, in 1974, thus precluding a hedonic estimate of the "freezer defrost" characteristic for the intervening years. Estimates of the value of other characteristics are similarly inhibited when *CR* lists only a single model of each brand, and especially when the models of each brand are selected to be as close as possible to each other in the set of included characteristics.

This aspect of the *CR* sample that makes it unsuitable for the estimation of hedonic regression equations actually facilitates the alternative technique of "comparison of closely similar models." For instance, the *CR* sample allows us to compare models with bottom-located freezers having automatic defrost in 1959, 1960, 1964, and 1968; top-located freezers having automatic defrost in 1968, 1970, 1974, and 1983; and top-located freezers without automatic defrost in 1954, 1957, 1959, 1962, 1964, and 1974. While the technique of comparing "closely similar" models is appropriate for some of these comparisons, it suffers from the defect that, in other comparisons, the size of the refrigerator compartment and/or the freezer compartment changes significantly. In these cases, a straightforward comparison cannot be made, and adjustments for changing size are made, employing hedonic coefficients from the Triplett-McDonald study and from the hedonic regression estimates for the Sears catalog sample. In other cases (e.g., dishwashers), insufficient evidence on changing size is provided, and no adjustments are made beyond direct price comparisons between models having roughly comparable features; in these cases, informal evidence on increasing size or other changes is provided to support the view that the new price indexes make insufficient allowance for quality change.

7.4 Common Features of the Hedonic Regression Equations

The data source for the hedonic regression equations estimated in this chapter is the spring Sears Roebuck catalog for every year from 1948 to 1983. When a particular product (e.g., room air conditioners) was not available in 1947, the starting date of the regression equation coincides with the first appearance of the product in the catalog (e.g., 1952 for room air conditioners). For refrigerators and washing machines, the Sears indexes begin in 1948, while the CPI and PPI are available for 1947. The Sears data for room air conditioners begin in 1952, one year before the 1953 appearance of the PPI index for this product, and twelve years before the 1964 appearance of the CPI index.

In addition to price quotations (always net of shipping costs), data were copied from the Sears catalog on all listed quality characteristics. In the case of refrigerators, these took the form of numerical magnitudes for the total cubic foot capacity and the capacity of the freezer, and dummy variables for the presence of other characteristics (e.g., refrigerator automatic defrost, freezer automatic defrost, presence of crisper, porcelain-on-steel interior, powermiser, shelves in door, etc.). Freezer capacity was sometimes listed in pounds and sometimes in cubic feet, and these were placed on a consistent basis of pounds, using the *CR* conversion factor of thirty-five pounds per cubic foot. The quantitative and dummy variables for other products are discussed below in the appropriate sections.

More variables were available than the coefficients that could be estimated, owing to the limited size of the sample, and this limitation is especially binding in the first half of the postwar period. For instance, in the case of refrigerators, sample sizes in adjacent-year regressions (i.e., the number of observations available for two successive years) ranged from six to thirteen from 1948 to 1952, from sixteen to twenty-three from 1952 to 1969, with a jump then to from thirty to forty-eight between 1969 and 1983. The criterion for inclusion of variables was to give first priority to the size and defrost dummy variables, and then to include additional dummy variables on the criterion of goodness of fit. When the list of additional dummy variables had to be shortened and two alternative lists yielded about the same goodness of fit, variables were chosen that seemed to be given more emphasis in *CR* product evaluations.[9]

All regression equations were specified in the double-log functional form, that is, with the log of price as dependent variable, and the log of quantitative variables as explanatory variables, in addition to the dummy variables. Thus, all coefficients can be interpreted as elasticities, for example, the percentage increase in price associated with a 1 percent increase in capacity, with the presence of automatic freezer defrost and other characteristics held constant. Some other studies (e.g., Triplett and McDonald 1977) use the semilog form, with the log of price regressed on the arithmetic values of quantitative variables. This has the disadvantage for expositional purposes that one cannot extract the elasticities from the tables of coefficients without knowing the means of the variables. For the portion of the refrigerator sample that overlaps Triplett-McDonald (1960–72), I estimated a semilog version of my pooled

9. Triplett and McDonald (1977, 141) report the use of *CR* to draw up a list of quality characteristics, and they note that "some characteristics mentioned by *Consumer Reports* turned out to be relatively unimportant as explanators of price variance in the sample."

regressions, and the standard error of estimate was almost the same as with the double-log version. I did not experiment with semilog versions for products other than refrigerators.[10]

Two types of hedonic regression equations were estimated from the Sears catalog data, which I call *pooled* and *adjacent-year* equations. For refrigerators, adjacent-year regressions were estimated for each year pair from 1948–49 to 1982–83, and pooled regressions were estimated for periods of five to nine years (1948–57, 1957–62, 1962–69, 1969–76, and 1976–83). Break points in the pooled regressions were generally chosen to be years when particular characteristics first appeared. Each pooled regression includes a string of dummy variables for each year except for the first year, and each adjacent-year equation includes a single time dummy variable for the second year of the pair. In each case, the price change from the beginning to the end of the sample period in the pooled regression equation is compared with the cumulative sum of the time coefficients in the adjacent-year equations covering the same period. The price indexes calculated from the time coefficients of the pooled and adjacent-year regressions are compared with *CR* indexes (with and without energy adjustments) and with both the CPI and the PPI.

7.5 Household Refrigerators and Refrigerator-Freezers

The presentation of results begins with refrigerators and refrigerator-freezers for three reasons. This product has been the subject of substantial previous research, while relatively little has been done on other products; refrigerators account for the largest share of sales of major appliances (i.e., "white goods" excluding audio and video) in table 7.1 in both 1949 and 1983; and the product itself is more complex than air conditioners, washing machines, and the other products examined in this chapter. Also, refrigerators were introduced earlier than air conditioners or washing machines.

The first home refrigerator units went on sale in 1918, but they were of distinctly lower quality than even early postwar units: "Food kept for any length of time in them tended to dry out. Ice accumulated relentlessly around the freezing elements, demanding frequent defrosting" (Consumers' Union 1986, 150). Refrigerators began to sell in substantial numbers in the 1930s, and *CR* began rating refrigerators in its first year, 1936. In June 1938, it compared the energy efficiency of electric and gas refrigeration with the traditional icebox, and reported that an electric refrigerator could cool at one-third the cost of an icebox. This is an example of a quality improvement that is not taken into account in this book but would be relevant if this study were extended to the interwar period.

10. The Dulberger (1989) study of computers cited in chap. 6 finds the double-log functional form distinctly superior to the semilog form.

This section on refrigerators begins with the hedonic regression study of Sears catalog data and then proceeds to the comparison of "closely similar" models with *CR* data, both with and without explicit adjustments for changes in energy efficiency. The resulting indexes are then compared with the CPI and PPI. The section concludes with a discussion of omitted dimensions of quality that have improved over the postwar years and impart to the quality adjustments a downward ("conservative") bias and to the new price indexes a corresponding upward bias.

7.5.1 Hedonic Regression Results

The results of estimating hedonic regression equations from Sears catalog data are presented in a uniform format for refrigerators, room air conditioners, and washing machines. Each table is broken into parts (A, B, etc.) corresponding to the coverage of each pooled regression. The adjacent-year regressions covering the same period as the pooled regression are shown alongside. Thus, part A of table 7.2 exhibits results from estimating a pooled equation for 1948–57 and also nine adjacent-year regression equations for the year pairs 1948–49 to 1956–57. To save space, the significance of the time dummy variables is indicated by asterisks (one for significance at the 5 percent level and two at the 1 percent level).

The pooled equation contains all the available variables that are significant in the pooled regression whether or not they are significant in the adjacent-year regressions (smaller sample sizes imply that *t*-ratios would be lower in the adjacent-year results). When a variable does not appear in the adjacent-year regressions (e.g., refrigerator defrost from 1948–49 to 1951–52), either the feature was not offered on any model in the Sears catalog or the coefficient on that feature cannot be estimated owing to multicollinearity. Automatic refrigerator defrost was first offered in the Sears catalog in 1952; the first *CR* evaluation of models having that feature also appeared in 1952.

The coefficients in table 7.2, part A, do not all have the correct positive sign because of multicollinearity. Coefficients that are negative also are insignificant. Otherwise, the magnitudes seem plausible; the coefficient of 0.04 on crisper is reasonable, even though a crisper may act as a proxy for additional attributes included on "deluxe" models (e.g., shelves in door, deluxe trim). The coefficient of 0.20 on refrigerator defrost can be compared with an estimate of 0.16 that can be extracted from *CR* for 1952.[11] The standard error of estimate for the pooled regression of 0.081 improves on the standard error of 0.112 in the Triplett-McDonald 1963–65 equation, which has a much larger sample size of 303, as compared with sixty-nine in table 7.2, part A. The price decline of 44 percent between 1948 and 1957 implied

11. The January 1952 *CR* evaluation estimates that the presence of refrigerator defrost added $50 in that year. This is 16 percent of the mean price of $306.91 for the models not equipped with automatic refrigerator defrost evaluated in the October 1951 issue.

Table 7.2 **Pooled and Adjacent-Year Double-Log Regression Equations for Refrigerators, Sears Catalog Data, 1948–57, 1957–62, 1962–69, 1969–76, 1976–83 (*t*-ratios in parentheses)**

	A. 1948–57									
	Pooled 1948–57	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57
Total capacity	0.24	0.23	0.35	0.51	0.44	−0.19	−0.39	0.04	0.27	0.33
	(2.30)	(1.05)	(4.38)	(2.30)	(0.54)	(−0.26)	(−1.38)	(0.14)	(1.06)	(1.43)
Freezer capacity	0.33	0.44	0.38	0.27	0.24	0.60	0.74	0.40	0.28	0.30
	(7.04)	(2.13)	(2.60)	(2.57)	(0.50)	(1.17)	(4.98)	(3.85)	(3.03)	(3.02)
Refrigerator defrost	0.20	. . .	. . .	. . .	. . .	0.22	0.18	0.21	0.20	0.17
	(6.85)					(2.61)	(3.66)	(4.09)	(3.85)	(2.92)
Crisper	0.04	0.08	0.07	0.05	0.05	−0.06	−0.12	0.01	0.07	0.06
	(1.42)	(0.90)	(1.72)	(0.75)	(0.16)	(−0.21)	(−1.59)	(0.24)	(0.95)	(0.73)
Constant	3.33	2.97	2.54	2.16	2.53	4.22	4.69	3.90	2.94	2.60
	(9.12)	(3.64)	(4.82)	(2.61)	(0.96)	(2.24)	(5.15)	(4.38)	(3.38)	(3.41)
1949	−0.10	−0.06								
1950	−0.13*		−0.05							
1951	−0.23**			−0.08						
1952	−0.18**				0.05					
1953	−0.20**					−0.02				
1954	−0.13*						0.04			
1955	−0.41**							−0.28**		
1956	−0.42**								0.01	
1957	−0.44**									−0.02
$\bar{R}^2$	0.907	0.839	0.917	0.904	0.703	0.802	0.896	0.890	0.885	0.934
S.E.E.	0.081	0.070	0.046	0.061	0.118	0.117	0.083	0.090	0.092	0.079
Observations	69	6	9	9	7	13	18	22	23	19

(*continued*)

Table 7.2 (continued)

	B. 1957–62					
	Pooled 1957–62	1957–58	1958–59	1959–60	1960–61	1961–62
Total capacity	0.22	0.11	0.28	0.27	0.36	0.70
	(1.41)	(0.77)	(1.11)	(0.97)	(0.98)	(3.13)
Freezer capacity	0.36	0.30	0.34	0.40	0.32	0.27
	(5.00)	(3.78)	(2.82)	(2.70)	(1.94)	(2.42)
Refrigerator defrost	0.14	0.21	0.12	0.21	0.27	0.25
	(3.48)	(3.97)	(1.84)	(3.45)	(2.91)	(3.32)
Freezer defrost	0.19	−0.01	0.09	0.19	0.12	0.22
	(5.58)	(−0.16)	(1.68)	(3.01)	(1.74)	(5.60)
Door	0.10	0.07	0.18	0.12	0.04	−0.08
	(2.60)	(1.46)	(2.03)	(1.45)	(0.45)	(−1.20)
Color	0.10	0.06	0.01	0.04	0.18	0.15
	(2.68)	(1.17)	(0.17)	(0.73)	(2.63)	(3.14)
Constant	3.41	3.87	3.30	2.91	2.92	2.33
	(15.0)	(16.9)	(8.56)	(6.27)	(4.26)	(5.86)
1958	−0.04	0.01				
1959	−0.11**		−0.08			
1960	−0.21**			−0.11*		
1961	−0.28**				−0.03	
1962	−0.27**					−0.01
$\bar{R}^2$	0.938	0.970	0.932	0.960	0.954	0.968
S.E.E.	0.084	0.054	0.093	0.075	0.078	0.059
Observations	56	20	20	17	16	19

C. 1962–69

	Pooled 1962–69	1962–63	1963–64	1964–65	1965–66	1966–67	1967–68	1968–69
Total capacity	1.02	0.48	0.62	1.81	1.36	1.64	1.73	0.74
	(7.68)	(4.78)	(2.84)	(5.83)	(3.90)	(3.73)	(2.60)	(2.17)
Freezer capacity	0.23	0.38	0.48	0.12	0.35	0.04	−0.01	0.38
	(3.46)	(4.06)	(2.22)	(1.01)	(1.71)	(0.19)	(−0.04)	(2.39)
Door	−0.11	−0.12	−0.09	−0.02	−0.45	. . .	−0.16	−0.29
	(−1.41)	(−1.69)	(−0.58)	(−0.16)	(−1.28)		(−0.86)	(−1.67)
Refrigerator defrost	0.04	0.17	−0.16	−0.07	0.42	0.19	0.25	0.12
	(0.45)	(2.03)	(−0.76)	(−0.37)	(1.58)	(1.10)	(1.71)	(0.91)
Freezer defrost	0.20	0.29	0.27					
	(3.15)	(8.84)	(2.66)	. . .	. . .	. . .	. . .	. . .
Constant	1.88	2.43	1.75	0.32	0.46	0.93	0.99	1.92
	(−8.68)	(6.79)	(2.70)	(0.48)	(0.86)	(1.83)	(4.56)	(5.66)
1963	−0.06	−0.10**						
1964	−0.22**		−0.14					
1965	−0.08			0.11				
1966	−0.15*				−0.05			
1967	−0.18**					−0.06		
1968	−0.27**						−0.10	
1969	−0.25**							0.03
$\bar{R}^2$	0.851	0.959	0.788	0.802	0.879	0.908	0.897	0.892
S.E.E.	0.132	0.061	0.134	0.130	0.114	0.121	0.119	0.123
Observations	84	20	19	19	17	15	16	30

(*continued*)

Table 7.2 (continued)

	D. 1969–76							
	Pooled 1969–76	1969–70	1970–71	1971–72	1972–73	1973–74	1974–75	1975–76
Total capacity	0.68	0.65	0.66	0.54	0.51	0.69	0.65	0.45
	(9.00)	(4.96)	(5.45)	(3.00)	(2.95)	(4.08)	(4.59)	(3.04)
Freezer capacity	0.15	0.15	0.02	0.09	0.18	0.15	0.23	0.34
	(4.44)	(2.64)	(0.30)	(1.57)	(2.71)	(1.95)	(3.67)	(4.33)
Freezer defrost	0.05	0.10	0.19	0.11	0.07	0.11	0.03	−0.04
	(1.55)	(1.89)	(3.61)	(1.73)	(1.04)	(1.53)	(0.55)	(−0.72)
Icemaker	0.17	0.23	0.27	0.13	0.06	0.11	0.12	0.13
	(7.75)	(5.48)	(7.60)	(2.75)	(1.24)	(2.62)	(3.45)	(3.77)
Powermiser	0.18	0.18	0.20	0.23	. . .	. . .	. . .	0.13
	(7.51)	(4.21)	(5.46)	(4.87)				(3.73)
Cold water dispenser	0.14	. . .	0.11	0.23	0.22	0.14	0.13	0.15
	(4.83)		(1.60)	(3.82)	(3.59)	(2.62)	(2.89)	(3.64)
Constant	3.01	3.02	3.56	3.58	3.33	2.99	2.71	2.98
	(25.6)	(15.2)	(17.3)	(14.7)	(12.8)	(11.8)	(11.5)	(12.7)
1970	−0.01	−0.00						
1971	−0.00		0.00					
1972	0.04			0.05				
1973	0.03				−0.00			
1974	0.02					−0.02		
1975	0.22**						0.20**	
1976	0.10**							−0.10**
$\bar{R}^2$	0.949	0.954	0.954	0.932	0.937	0.953	0.966	0.957
S.E.E.	0.086	0.085	0.082	0.092	0.087	0.072	0.062	0.066
Observations	156	47	48	42	34	27	30	40

E. 1976–83

	Pooled 1976–83	1976–77	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83
Total capacity	0.56	−0.19	−0.05	0.30	0.78	0.97	0.88	0.82
	(5.28)	(−0.98)	(−0.26)	(1.38)	(3.84)	(7.11)	(5.98)	(3.47)
Freezer capacity	0.32	0.64	0.52	0.42	0.28	0.19	0.17	0.18
	(6.65)	(7.30)	(6.03)	(4.33)	(2.85)	(2.92)	(2.64)	(1.89)
Icemaker	0.17	0.13	0.21	0.21	0.14	0.08	0.10	0.17
	(5.79)	(2.59)	(4.46)	(4.29)	(2.73)	(1.95)	(1.71)	(1.88)
Coldwater dispenser	0.10	0.09	0.07	0.07	0.10	0.14	0.16	0.18
	(2.78)	(1.73)	(1.11)	(1.03)	(1.69)	(3.01)	(2.59)	(1.63)
Adjustable shelves	0.15	0.18	0.23	0.21	0.20	0.26	0.26	−0.00
	(6.47)	(4.96)	(6.67)	(5.37)	(4.47)	(6.21)	(3.25)	(−0.04)
Constant	2.63	3.18	3.29	2.85	2.29	2.26	2.73	3.27
	(17.6)	(12.7)	(10.9)	(8.86)	(7.89)	(11.4)	(13.5)	(9.42)
1977	−0.03	−0.06						
1978	0.03		0.05					
1979	0.11**			0.08				
1980	0.17**				0.05			
1981	0.34**					0.15**		
1982	0.47**						0.13**	
1983	0.53**							−0.01
$\bar{R}^2$	0.945	0.933	0.924	0.918	0.928	0.974	0.971	0.927
S.E.E.	0.099	0.084	0.086	0.092	0.090	0.068	0.075	0.116
Observations	131	40	37	37	35	31	26	23

*Indicates significance at the 5 percent level.

**Indicates significance at the 1 percent level.

by the coefficients on the time dummy variables in the pooled regression equation compares with a cumulative 41 percent implied by successive time dummy coefficients in the adjacent-year equations.

The next period, 1957–62, is covered in part B of table 7.2. Dummy variables for freezer defrost, ''door'' (i.e., two doors), and ''color'' (available in colors other than white) are added, while the crisper variable disappears. The coefficients in the pooled equation are all positive, significant, and reasonable in size; the coefficient on total capacity shrinks slightly and that on freezer capacity rises slightly as compared with part A of table 7.2. A few of the coefficients in the adjacent-year equations have a negative (albeit insignificant coefficient). The standard error of 0.084 in the pooled equation is almost identical to that for the 1948–57 period, and the 1957–62 price reduction of 27 percent in the pooled equation compares with the smaller cumulative reduction of 22 percent in the adjacent-year equations.

The next period, 1962–69, overlaps the Triplett-McDonald sample period. The composition of the Sears sample prevents coefficients on freezer defrost from being estimated in most of the adjacent-year regressions. The coefficients in the pooled equation are less satisfactory than before, in that the elasticity on total capacity jumps from 0.22 in part B of table 7.2 to 1.02 in part C of table 7.2, the coefficient on door is negative, and no variables are included for numerous deluxe features that one might have expected to be important. For instance, variables included by Triplett-McDonald for their 1963–65 pooled regression, but excluded here, are ''meat pan,'' ''bottom freezer location,'' and ''side freezer location.''

It is likely that the omission of these variables accounts both for the large coefficient on total capacity and for the larger standard error of estimate than in the previous tables (0.132 vs. 0.084 and 0.081). Although the Triplett-McDonald equation is estimated in a semilog form, their coefficients applied to the means of the *CR* sample for 1964 imply elasticities of 0.39 for refrigerator capacity and 0.24 for freezer capacity. Reflecting the difference in the coefficients, the 1962–69 price decline in the pooled equation of 25 percent and in the adjacent-year equations of 33 percent are not very close to the 19.7 percent decline registered by Triplett-McDonald's central index ''C'' (1977, table 5, p. 148).

For the 1969–76 period, the average sample size is larger than in previous tables, and the standard errors of estimate are lower. Dummy variables for three luxury features, ''icemaker,'' ''powermiser,'' and ''cold water dispenser,'' are included and are significant in the pooled and in almost all the adjacent-year equations. The coefficients on total capacity, freezer capacity, and the presence of freezer defrost differ again from the previous table, and the omission of several variables may account for this instability. In their pooled regression for 1970–72, Triplett-McDonald include the following dummy variables that are excluded here: meat pan, bottom or side freezer location, cantilever shelves, reversible doors, and rollers. The 1969–76 price increase in the pooled equation of 10 percent compares with a cumulative 13 percent in the adjacent-year equations.

The final table of results covers the 1976–83 interval. Once again, the sample sizes are larger than in the early years, all the estimated coefficients are highly significant in the pooled equation, and many are significant in the adjacent-year equations. The coefficients in the pooled equation for 1976–83 are quite similar to those in the 1969–76 pooled equation in the previous table. The price increase of 53 percent in the pooled equation compares with a cumulative increase of just 40 percent in the adjacent-year equations. I will turn to a comparison of these price changes with those registered by the CPI and PPI after developing the alternative price indexes based on *CR* data.

7.5.2 Comparisons from *CR* Product Evaluations

As noted above, *CR* has published detailed product evaluations of major appliances throughout the postwar years. The *CR* data base is complementary to the Sears catalog data. The catalog provides a wide variety of models under one brand name, while *CR* evaluates a single model type for a wide variety of brand names. By linking together *CR* price and quality data for "closely similar" models, a price index can be developed that is similar in principle to the specification method used to compile the CPI and PPI.

The price indexes developed in this section are based on thirteen reports on refrigerators and refrigerator-freezers that appeared between 1949 and 1983.[12] Because several reports included two model types rather than a single model type, the *CR* price indexes link together sixteen averages of *CR* price quotations, as shown in table 7.3. For each model type, simple averages of the listed price, refrigerator capacity, and freezer capacity are calculated, as well as the average monthly energy cost. The price per kilowatt hour used in computing the energy cost was also recorded, as well as any significant comments about other dimensions of quality change.

Two changes in the criteria of measurement occurred over the postwar period. Starting in 1960, *CR* shifted from reporting the manufacturer's list price to an average price reported by *CR*'s own shopping survey. Fortunately, in the overlap report (September 1960), both list prices and average shopper prices are reported, and the latter are only 2.8 percent below the former ($559 vs. $575 for type E, as identified in the notes to table 7.3). While this may seem surprising, it appears from the wide range of prices in the shopping survey that in 1960 many outlets sold refrigerators at a price *above* manufacturer's list price. Because the difference in the mean list and the shoppers' prices was so small, the effect of this shift in pricing criteria is ignored in the price comparisons. A further change in criteria in the late 1950s was a shift from manufacturers' capacity measurements to *CR*'s own

12. After completing the calculations, I discovered that I had missed evaluations published in 1966, 1971, and 1979.

Table 7.3 **Comparisons of "Closely Similar" Models of Refrigerator-Freezers from *Consumer Reports*, 1949–83 (all changes are in percentages)**

		Size (cubic feet)			Adjustments to Price Change		Annual Rate of Price Change	
Dates	Type (1)	Refrigerator (2)	Freezer (3)	Price Change (dP/P) (4)	Size ($-adC/C$) (5)	Energy[a] ($dE/[P + dE]$) (6)	Without Energy Adjustment (7)	With Energy Adjustment (8)
1. 1949–51	A	8.0/ 7.1	0.42/0.68	−7.2	−6.9	−1.1[b]	−7.3	−11.7
2. 1949–51	B	7.3/ 7.5	1.50/1.21	−21.4	3.2	−8.1[c]	−9.6	−12.3
3. 1951–54	B	7.5/ 8.1	1.21/1.00	−10.4	0.6	−24.4[d]	−3.4	−12.8
4. 1951–54	D	8.5/ 9.5	1.66/1.90	1.5	−7.9	−18.1[e]	−2.2	−12.2
5. 1954–57	D	9.5/10.1	1.90/2.37	−11.1[f]	−8.0	12.2[g]	−6.8	−5.2
6. 1954–59	C	9.5/ 9.5	1.90/2.00	−22.3	−1.2	2.6[i]	−5.2	−4.9
7. 1957–59	D	7.2/ 7.2[h]	2.15/2.65[h]	−7.9	−5.1	13.1[j]	−3.3	−2.5
8. 1959–60	E	7.0/ 7.2	3.00/3.18	−20.1	−2.5	5.3[k]	−22.6	−19.8
9. 1959–62	C	7.5/ 7.0[h]	1.53/1.61[h]	−15.9	1.5	4.0[l]	−5.1	−3.1
10. 1959–62	D	7.2/ 7.5	2.65/2.73	−29.3	−2.8	−2.0[m]	−12.1	−14.2
11. 1962–64	D	7.5/ 7.6	2.73/2.73	−3.0	−0.5	−3.7[n]	−1.8	−3.9
12. 1960–64	E	7.2/ 7.3	3.18/3.24	−23.7	−1.0	6.8[o]	−6.8	−5.1
13. 1964–68	E	7.3/ 8.0	3.24/3.45	−20.7	−5.3	−7.1[p]	−7.3	−11.4
14. 1968–70	F	8.1/ 9.4	3.05/3.63	22.3	−10.6	14.3[q]	5.7	7.4
15. 1970–74	F	9.4/ 8.8	3.63/3.48	12.9	3.5	0.0[r]	3.9	3.9
16. 1974–83	F	8.8/10.3	3.48/4.65	81.3	−14.2	−4.3[s]	5.9	4.5

Note: Type A: U-type, no refrigerator or freezer defrost. Type B: Cross-top freezer, single zone, no refrigerator or freezer defrost. Type C: Same as B, but with refrigerator defrost. Type D: Same as C, but dual zone. Type E: Bottom freezer, dual zone, refrigerator and freezer defrost. Type F: Same as E, but cross-top freezer.

[a]All energy costs in the calculations in these notes are converted to a per-month basis at $.03 per kilowatt hour, except for 1949–51 ($.04 per kilowatt hour) and 1974–83 ($.0675 per kilowatt hour).

[b]From $1.81 to $1.79 per month; present value of saving = $2.75.

[c]From $2.42 to $2.17; present value of saving = $34.30.

[d]From $1.63 to $0.91; present value of saving = $98.77.

[e]From $2.36 to $1.64; present value of saving = $98.77.

[f]Deducted $35 from 1957 price to take account of additional features not present in 1954.

[g]From $1.64 to $2.00; present value of extra cost = $49.38.

[h]Starting with the 1957–59 comparison, dimensions shift from manufacturers' claims to *CR* remeasurement basis.

[i]From $1.05 to $1.11; present value of extra cost = $8.22.

[j]From $2.00 to $2.37; present value of extra cost = $50.75.

[k]From $3.42 to $3.67; present value of extra cost = $34.99.

[l]From $1.11 to $1.18; present value of extra cost = $9.60.

[m]From $2.37 to $2.31; present value of saving = $8.23.

[n]From $2.31 to $2.23; present value of saving = $10.98.

[o]From $3.67 to $3.93; present value of extra cost = $35.67.

[p]From $3.93 to $3.69; present value of saving = $3.92.

[q]From $3.07 to $3.32; present value of extra cost = $34.29.

[r]No data available for 1974; 1974–83 comparison refers to 1970–83.

[s]Change from $7.47 in 1970 to $7.29 in 1984 (at $06.75 per kwh); present value of saving = $16.07.

measurements. Since both sets of measurements are given in the 1957 and 1959 product evaluations, it is straightforward to "link out" the effect of this change. Because *CR*'s measurements in 1957 are about 25 percent smaller than manufacturer's measurements for refrigerator capacity and about 10 percent smaller for freezer capacity, columns 2 and 3 understate the overall postwar increase in capacity between 1949 and 1983.

Each of the sixteen comparisons in table 7.3 is exhibited in a uniform format. First are listed the dates of the product evaluations where the data appeared for the comparison, then the model type (identified at the bottom of the table), and then the average refrigerator and freezer capacity in the first and second years of the comparison. Column 4 lists the percentage change in price between the first and the second year, without any quality adjustments at all, except in comparison 5 for 1954–57, discussed below.

Two types of adjustments are made for changing quality. In column 5, the size changes from columns 2 and 3 are converted into value changes, using the estimated coefficients on size from the Triplett-McDonald study. Their coefficients are used in preference to mine in table 7.2 because they are based on a full range of brand names and a larger sample. Further, their implied size elasticities are smaller than mine in table 7.2 for most of the sample period, reflecting their longer list of additional characteristics included in the regression equations. As they comment in discussing their results (1977, 143), price per incremental unit of capacity fell over their 1963–72 sample period, and this is true of the implied elasticities as well. This suggests that their elasticities may be too low when extrapolated for my pre-1963 adjustments, and therefore that my size adjustments could be on the conservative side before 1963 and on the liberal side after 1972.

As an example of the calculation of the size adjustment, the implied Triplett-McDonald elasticity for refrigerator capacity is 0.397 and for freezer capacity is 0.223.[13] Thus, in the fifth comparison, where refrigerator size increased by 6.3 percent and freezer size increased by 24.7 percent, we have:

$$(6.3)(.397) + (24.7)(.223) = 8.0.$$

This increase in value is equivalent to a 8.0 percent decline in quality-adjusted price and is listed in column 5, row 5.

Thus far, this method has controlled for six quality characteristics that appear to be important determinants of cross-sectional price differences in the Triplett-McDonald study and in my Sears catalog hedonic regressions. The first two, refrigerator capacity and freezer capacity, are subject to the explicit

13. To simplify the calculations, a single elasticity was used for the entire period and was calculated as follows. The Triplett-McDonald semilog coefficients for refrigerator capacity (from table 2, p. 142) were .054 in 1963–65 and .041 in 1969–72, for a mean of .0475. Refrigerator capacity in table 7.3 for model E in 1964 of 7.3 and model F in 1970 of 9.4 average out to 8.35, implying an elasticity of 0.397 (= 8.35 × .0475). The same calculation for freezer capacity yields an elasticity of 0.223.

adjustments described in the preceding paragraph. The other four are part of the specifications of the "model types" (A, B, etc.) identified at the bottom of table 7.3, that is, refrigerator defrost, freezer defrost, freezer location, and the "dual zone" feature (which involves separate cooling coils for refrigerator and freezer).

There remains the question of adjustment for the many other features that appeared on refrigerators gradually over the postwar period, including shelves in the door, egg compartment, heated butter compartment, vegetable crispers, meat compartment, adjustable shelves, reversible doors, door stops, rollers, and heaters to prevent condensation. The addition of these features over time interacts with the shift between model types. If type A (U-type, no refrigerator or freezer defrost) lacks all the extra features, while types E and F (dual-zone, top or bottom freezer, refrigerator and freezer defrost) are equipped with all these features in all years, then the procedure of linking in a new model type would automatically incorporate the value of the extra features. However, in both my hedonic regression study and the Triplett-McDonald study, separate coefficients are estimated for features beyond the basic characteristics that define the model types. Further, note that type D (dual-zone, top freezer, refrigerator defrost, no freezer defrost) spans numerous evaluations during the main period when refrigerator prices were declining (this model appears in the 1952, 1954, 1957, 1959, 1962, and 1964 reports), yet appears to add features.

For instance, of the seven type D refrigerators in the 1952 evaluation, only four had adjustable-temperature butter compartments, only three had door shelves, and only two are listed as having "full cold-wall construction" (i.e., the dual-zone feature). By 1957, we learn that all but one of seventeen top-freezer models tested were dual zone, all models had shelves in the door, all models but one had one or more "slide-out" shelves, four models had arrangements for altering the height of some shelves, and some had freezer doors with dispenser racks and/or shelves. How can a value be established for these extra features? The 1957 report includes both a deluxe and a standard version of one brand, the Kelvinator, which differed in price by $70, and half that amount, $35, is taken as a one-time adjustment for extra features (see n. f in col. 4). I suspect that this is a substantial underestimate of the cumulative value of extra features over the full postwar period.

7.5.3 Adjustments for Improvements in Energy Efficiency

Thus far, neither the Sears hedonic regression study nor the *CR* comparisons have taken into account reductions over time in the energy consumption of refrigerators. Fortunately, in all product evaluations but one (1974), *CR* lists the monthly energy cost and the price per kilowatt hour assumed in making the calculation. The notes to column 6 of table 7.3 list the mean monthly energy cost in the first and second years of each comparison and the present discounted value of the change, calculated at a 3 percent discount rate and a fourteen-year lifetime. A 3 percent discount rate is a common choice for such comparisons, and the fourteen-year lifetime is suggested by *Consumer Appliances* (n.d.).[14] The present discounted value of the change in energy cost (dE) is then divided by the sum of that change plus the average refrigerator price in the first year of each comparison period to establish the percentage adjustment factors listed in column 6. Thus, the adjustment factor is calculated as $dE/(P_0 - dE)$. This approach treats the value of an improvement in energy efficiency as part of the price of the unit in the first year of the comparison but not in the second year of the comparison. The method also assumes static expectations regarding the future evolution of energy prices.

A difficult problem in implementing the energy adjustment is the treatment of the correlation between energy cost and other quality characteristics. Increasing refrigerator capacity adds to energy requirements, as does the addition of extra features like refrigerator and freezer defrost. By using the six separate model types A–F, I control for the extra energy consumption required by refrigerator and freezer defrost and the dual-zone feature.[15] There remains the necessity of adjusting energy consumption for refrigerator and freezer capacity. The method can be set out by decomposing the change in the energy-adjusted price index (dI^E/I^E) into four components:

$$dI^E/I^E = dP/P - adC/C + dE/(P - dE) - gdC/C. \tag{7.1}$$

The first component is the change in the average price itself (dP/P), without any adjustment for changing size or energy consumption, and appears in column 4 of table 7.3. The next component is the change in capacity (dC/C) times the hedonic coefficient (a) that translates the change in capacity into a change in value, and this component appears in column 5. The third component ($dE/[P + dE]$) is the change in the present value of energy consumption evaluated at a constant price of electricity, appearing in column 6. The final component is the effect of changing capacity on energy consumption, represented by the unknown elasticity g. The last term is included so that an increase in energy consumption solely due to larger capacity is not treated as a price increase.

14. "Based on industry information, the MIT study team established that the color TV has a life of about 10 years, the refrigerator a life of about 14" (*Consumer Appliances*, n.d., 11). *CR* in most product evaluations calculates the monthly cost of electricity use and does not indicate a lifetime, except in 1968, when it calculates the lifetime electricity cost on the assumption of a fifteen-year life (September 1968, 476, 479). The 3 percent discount rate, although appropriate for producers' purchases of appliances, may be too low for consumers. For a discussion of the evidence that consumers may "overdiscount" in making purchases of durable goods, see Hausman and Joskow (1981, 9).

15. For instance, in the *CR* report of August 1964, the average monthly energy cost of units with freezer defrost was 1.76 times that of the cost of units without freezer defrost. This compares with the comment by *CR* that freezer defrost raises energy consumption by a factor of "two-thirds," i.e., would imply a ratio of 1.67 times. The difference between 1.76 and 1.67 may be accounted for by extra features and by the fact that the 1964 freezer-defrost models had on average a 19 percent larger effective freezer capacity than the no-freezer-defrost models.

An argument could be made that the effect of larger capacity on energy consumption (g) is larger than the effect of larger capacity on manufacturing cost (a), since the former should depend on cubic area while the latter should depend on the surface area of the refrigerator "box." Applying this reasoning, the g elasticity to increased capacity should be unity and the a elasticity should be two-thirds. In contrast, the values of a used in column 5 of table 7.3, that is, the Triplett-McDonald price elasticities for refrigerator size (0.40) and freezer size (0.22), sum to a bit less than two-thirds, probably because manufacturing cost contains fixed elements as well as depending just on the surface area of the box. While a case could be made that the g elasticity should be unity, I take the more conservative approach here of assuming that $g = a$, so that year-to-year changes in my energy-adjusted price index are calculated as

$$dI^E/I^E = dP/P - 2adC/C + dE/(P - dE) \tag{7.2}$$

and the change in the price index without an energy adjustment (dI^N/I^N) is calculated as

$$dI^N/I^N = dP/P - adC/C. \tag{7.3}$$

Note that $dI^E/I^E = dI^N/I^N$ only if $dE/(P - dE) = adC/C$, that is, in the case when higher energy consumption is neither more nor less than is explained by the extra energy requirements of a larger capacity. Scanning down column 5 of table 7.3, which shows $-adC/C$, and column 6, which exhibits $dE/(P - dE)$, we note numerous comparisons (rows 5, 7, 8, 9, and 12) in which $dE/(P - dE)$ is positive and is substantially greater than $-adC/C$. This could indicate that the choice of g (as equal to a instead of equal to some higher elasticity) is too small, and/or that added features on a given model-type (C, D, etc.) raised energy consumption without increasing capacity. Either alternative would make the energy adjustments too conservative, and understate the secular rate of decline of the energy-cost-adjusted price index (I^E).

The final two columns of table 7.3 convert the price change over the multiyear comparison intervals into geometric annual rates of change. These rates of change for the non-energy-adjusted index (I^N) from (7.3) are shown in column 7, and for the energy-adjusted index (I^E) from (7.2) in column 8. The implications of the two *CR* indexes in comparison with the CPI, PPI, and Sears hedonic regression indexes are examined in the next section.

7.5.4 Alternative Price Indexes for Refrigerator-Freezers

The outcome of the investigation of refrigerator prices is presented in table 7.4. Here are contrasted the CPI and PPI with five other indexes, including the Triplett-McDonald "C" index, the two Sears catalog hedonic indexes, and the two *CR* indexes. In converting the annual rates of change of the *CR* price

Table 7.4 **Alternative Price Indexes for Refrigerator-Freezers, 1947–83 (1967 = 100)**

				Sears Hedonic		Consumer Reports	
	CPI (1)	PPI (12-41-03-35) (2)	Triplett-McDonald Index C (3)	Pooled (4)	Adjacent Year (5)	Without Energy Adjustment (6)	With Energy Adjustment (7)
1947	174.5	121.5	...	...	...	...	...
1948	192.7	130.2	...	243.5	238.7	...	...
1949	186.8	126.7	...	220.3	224.8	302.8	468.9
1950	182.7	129.1	...	213.8	213.8	278.4	415.9
1951	192.4	132.4	...	193.5	197.4	256.0	368.8
1952	185.1	131.8	...	203.4	207.5	251.4	325.5
1953	178.1	133.1	...	199.4	203.4	246.9	287.3
1954	166.0	134.1	...	213.8	211.6	240.1	253.5
1955	156.0	128.0	...	161.6	161.1	226.1	241.0
1956	134.6	123.7	...	160.0	161.6	213.0	229.3
1957	123.8	116.6	...	156.8	158.4	200.6	217.9
1958	119.6	114.3	...	150.7	160.0	192.1	209.9
1959	119.2	114.0	...	140.5	147.7	184.0	202.3
1960	116.8	108.7	137.0	127.1	132.3	161.1	178.8
1961	115.2	105.2	133.1	118.5	128.4	147.8	166.0
1962	112.5	102.0	127.4	119.7	127.1	135.7	154.0
1963	109.6	98.7	115.4	112.7	115.0	130.0	147.2
1964	107.4	98.2	107.7	96.1	100.0	124.5	140.8
1965	104.2	96.6	103.8	110.5	111.6	115.7	125.6
1966	100.2	97.6	100.4	103.0	106.2	107.6	112.1
1967	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1968	101.3	104.3	103.2	91.3	90.5	93.0	89.2
1969	103.1	105.3	102.3	93.2	93.2	98.4	96.1
1970	105.8	106.1	105.1	92.3	93.2	104.2	103.5
1971	108.1	108.1	109.4	93.2	93.2	108.3	107.6
1972	108.1	105.3	106.0	97.0	98.0	112.6	111.9
1973	108.3	105.1	...	96.1	98.0	117.1	116.3
1974	114.6	113.4	...	95.1	96.1	121.8	120.9
1975	128.7	131.6	...	116.2	117.4	129.2	126.5
1976	134.8	140.6	...	103.0	106.2	137.0	132.3
1977	139.7	147.6	...	100.0	100.0	145.4	138.4
1978	146.2	154.8	...	106.1	105.1	154.2	144.8
1979	153.2	160.2	...	115.0	113.8	163.6	151.4
1980	162.4	170.3	...	122.1	119.7	173.5	158.4
1981	173.5	184.4	...	144.7	139.1	184.0	165.7
1982	187.3	194.5	...	164.8	158.4	195.2	173.3
1983	193.3	200.8	...	175.0	156.8	207.1	181.3

changes from table 7.3 to price indexes in table 7.4, equal weights were applied to each comparison when more than one price change is available for a particular year. This procedure is symmetric with the hedonic regression studies, which give each observation an equal weight regardless of its sales.

The behavior of the various price indexes differs over alternative subperiods of the 1949–83 period. Table 7.5 summarizes for three intervals. The first is 1949–72, starting with the first year when both the Sears hedonic and the *CR*

Table 7.5 **Annual Percent Growth Rates of Alternative Price Indexes for Refrigerators, 1949–83 and Subintervals**

	1949–72	1960–72	1972–83	1949–83
CPI	−2.35	−0.64	5.42	0.10
PPI	−0.80	−0.26	6.04	1.49
Triplett-McDonald	. . .	−2.12	. . .	. . .
Sears pooled	−3.59	−2.21	5.51	−0.68
Sears adjacent year	−3.55	−2.47	4.36	−1.05
CR without energy	−4.21	−2.94	5.70	−1.11
CR with energy	−6.04	−3.83	4.55	−2.76

indexes are available. The second is 1960–72, chosen for comparability with the Triplett-McDonald hedonic regression study. The third is 1972–83. The geometric annual growth rates of the seven alternative indexes over the three intervals and the full period are presented in table 7.5.

The annual growth rates shown in table 7.5 embody striking similarities and differences among the alternative indexes. The two main similarities are the relatively narrow range of growth rates for the most recent 1972–83 period and the close similarity of the hedonic regression results for the Triplett-McDonald and Sears pooled indexes for the overlap period of 1960–72. The fact that the Sears adjacent-year price index is based on a relatively small sample in each regression and that this index deviates more than the pooled index from Triplett-McDonald in 1960–72 and from the other indexes in 1972–83 suggests that we should disregard the behavior of the adjacent-year index in the subsequent discussion.

Despite these similarities, however, the differences in the annual growth rates are remarkably large for 1949–72, ranging from −0.80 for the PPI to −6.04 for the *CR* index including the energy cost adjustment. In evaluating these differences, three main issues arise. First, why does the *CR* index without an energy adjustment decline more rapidly than the Sears pooled hedonic index from 1949 to 1972? Second, why does the *CR* index without an energy adjustment decline more rapidly than the Triplett-McDonald hedonic index from 1960 to 1972? Third, is there any explanation for the difference in timing of the time path of the CPI and of the *CR* specification index that is not adjusted for energy prices, since both are based on the specification method and cover a wide variety of brand names?

The first contrast between the Sears pooled hedonic and the *CR* no-energy indexes is largely resolved by the upward shift of the Sears Kenmore brand in the price structure. As noted above in section 7.3, the average Sears price for refrigerators (adjusted for shipping costs) was 76.4 percent of the *CR* mean for the same model type in the first two *CR* product evaluations (1949 and 1952) and 105.5 percent in the last two *CR* evaluations (1974 and 1983). Assuming that all this shift occurred before 1972, the shift in price structure would have occurred at an annual rate of 1.41 percent during

1949–72, which is greater than the 1.08 percent difference in the growth rates of the Sears pooled hedonic and *CR* no-energy indexes. While this upward shift in the relative price of the Sears brand may have been accompanied by an improvement in relative quality, this quality shift must have occurred in characteristics that are not taken into account in the hedonic or *CR* specification comparisons.[16]

The second contrast is between the Triplett-McDonald hedonic index and the *CR* no-energy index for the period of their overlap, 1960–72, with a more rapid decline in the *CR* index at an annual rate of 0.8 percent. Both indexes have in common a comprehensive coverage of all the major brand names, with between thirteen and fifteen brand names rated by *CR* in each product evaluation between 1960 and 1974. The issue of discounting is not a problem for the *CR* index during this period, since the quotation of mean shoppers' prices began in 1960; on this ground, the Triplett-McDonald PPI price quotations obtained from manufacturers may not represent true transaction prices at the retail (or even wholesale) level. Since most of the price decline in the *CR* index is accounted for by the behavior of model type E (bottom freezer, full defrost) in 1960–68, it is interesting to compare the average 1960 price of $559 to the average 1968 price of $339, for a price decline of 39 percent in comparison to the 42 percent decline in the *CR* index. This raw unadjusted price change does not take account of an 11 percent increase in refrigerator capacity between 1960 and 1968, a 8 percent increase in freezer capacity, and numerous other quality improvements.[17] Further, there is an additional aspect to the decline in price, in that full-defrost models were originally introduced in 1958–59 only in the bottom-freezer configuration, and *CR* in 1959, 1960, and 1964 tested only the bottom-freezer models. By the mid-1960s, however, top-freezer full-defrost models were available, and in 1968 *CR* stated that they outsold bottom-freezer units by a margin of five to one.[18] If one compares the 1968 top-freezer unit with the 1960 bottom-freezer unit on the ground that the

16. There is a tendency for the Sears Kenmore model to be among the lowest priced and lowest rated in the early years of the *CR* product evaluations. By the September 1968 *CR* evaluation, however, we find that the top-freezer model (type F) is second rated out of fourteen models and priced 4 percent above the mean, while the bottom-freezer model (type E) is third rated out of nine models and priced 2 percent above the mean.

17. One of the most obvious quality improvements is impossible to quantify: in 1960 only five of fourteen models were rated "acceptable-good" and the other nine models were downgraded as "good-to-fair" and "fair" because of "performance deficiencies," particularly inability to hold a zero temperature in the freezer and/or uneven temperatures. In 1968, however, there was only one "acceptable" category for all nine models rated, and the only deficiencies discussed were in the category of convenience rather than performance.

18. By 1974, *CR* called bottom-freezer units a "vanishing breed" and stated that their frequency-of-repair record is of "mainly antiquarian interest" (811). In 1983, *CR* mentions that top-freezer units had accounted for three-quarters of sales in recent years, with the remainder being side-by-side units.

top-freezer unit is preferable but was unavailable in 1960, the raw unadjusted price decline becomes 51 percent.[19]

The third and last contrast is between the CPI and the *CR* index without the energy cost adjustment. The contrast between the two indexes is highlighted by choosing 1957 and 1967 as break points for calculating annual growth rates:

	1949–57	1957–67	1967–77
CPI	−5.01	−2.11	4.21
CR (no energy adjustment)	−5.02	−6.73	4.65

The 1957 and 1967 break points highlight the similarity of the two indexes before 1957 and after 1967, and their enormous difference between 1957 and 1967. There may be two explanations for this discrepancy. First, the CPI may have placed too much weight on obsolete models. While I have been unable to locate a time series of changes in specifications, I have found the CPI specification for refrigerators in 1956, which specifically instructs field agents to exclude models with two doors and automatic defrost, yet by then automatic (refrigerator) defrost had become so dominant in the marketplace that *CR* did no further testing on no-defrost models after 1954. Second, the CPI may not have accounted adequately for discounting. Particularly striking is the contrast for the year 1960, when the CPI registers a price decline of just 2.1 percent, while the *CR* index drops by a much greater 12.4 percent. The CPI in this case seems inconsistent with the *CR* description of market conditions in 1960:

> CU's shoppers made their price survey during the last two weeks in June. Since that time retail prices for refrigerators have dropped even further; the price toboggan, which began this Spring, has been so severe this Summer that trade and financial papers like *The Journal of Commerce* and *Home Furnishings Daily* have carried headlines about how "High Stocks [Are] Causing Refrigerator Cuts." As CU goes to press, there is every indication that this downward trend in prices will reach even lower levels. [September 1960, 461]

As a final comment on the official price indexes, the PPI seems totally at variance with the new price indexes for the period before 1967 and even with the CPI for the period before 1957. Yet it is the PPI, not the CPI, that is used by the BEA for deflation of PDE.

19. This does not make any allowance for a 13 percent increase in refrigerator capacity of a 4 percent decrease in freezer capacity, nor does it include a 18 percent decline in energy consumption, having a present value of $82.30 (15 percent of the average price of the 1960 models).

7.5.5 Unmeasured Dimensions of Quality Improvement

All the quality adjustments for refrigerators discussed thus far have been quantitative in nature. In addition, there have been quality improvements in refrigerators that cannot be quantified, but that indicate that my indexes understate the total magnitude of quality improvement over the postwar period. In addition to providing the quantitative data assessed above, the successive product evaluations in *CR* include numerous comments that suggest additional dimensions of quality improvement, at least through the late 1960s.

Temperature Criteria

A primary criterion for the *CR* performance evaluation of refrigerators has always been the ability to hold a desired level of temperature in the refrigerator and freezer under normal and adverse conditions. After the early 1960s, the standard requirement was for the refrigerator compartment to be able to hold a temperature of thirty-seven degrees and the freezer compartment zero degrees. By the 1964 report, all models apparently had gained the ability to perform at this standard, and there was rarely any mention after that date of temperature-holding ability, except that the January 1983 report (23) explicitly stated that all models met the thirty-seven- and zero-degree criteria at a room temperature of seventy degrees and that only two failed at ninety degrees. But in 1949 the situation was far different. The criterion was more lenient, forty-three degrees for the refrigerator. More important, only two models were able to maintain zero degrees in the freezer, and the others ranged from five to twenty-two degrees. In 1951, *CR* continued to complain about warm spots in the freezer, with only three models out of thirteen capable of holding the freezer temperature at ten degrees, much less zero. By 1954, the refrigerator criterion (at a ninety-degree room temperature) had been tightened from forty-three to thirty-nine degrees, and by 1957 to the present thirty-seven degrees. Also by 1957, freezer performance had improved, so that all models could hold five to ten degrees. By 1964, all models had reached the zero- to five-degree range in the freezer.

Overall Quality

The tone of the *CR* product evaluations has changed over the postwar years. In the beginning, the main emphasis was on the overall range of quality, and one can link together comments into a time-series commentary on improvements in quality. The earliest postwar refrigerators seemed to be a great advance over their prewar ancestors:

> It is likely that present refrigerators will last longer without trouble than their predecessors of a decade ago. CU's consultants report that a very high percentage of service calls on prewar refrigerators were for repair of

> slipping belts, poor piping and shaft seals, trouble with expansion valves, and thermostat trouble. This year's refrigerators, with sealed motor-compressor units and capillary tubes instead of expansion valves, appear to have eliminated the first three problems almost entirely, and the likelihood of thermostat trouble appears to have been reduced. [June 1949, 248]

But early postwar refrigerators were no paragons. CU tests "revealed a very wide range of quality," with two models listed as not acceptable (October 1949, 445). By 1957, matters had improved, but "major shortcomings of performance were found among models high in 'showroom appeal.' A number of defects in design and construction showed up. . . . But from the total of the tests several good refrigerators emerged" (August 1957, 360). But by 1959, "all of these models tested by CU . . . performed considerably better than their predecessors tested two years ago, and on the average were more compact. These units are more-or-less deluxe models, so widely pictured in the ads, usually available in various colors, and boasting a variety of convenience features." Nevertheless, "although refrigerator-freezers seem to have come of age, and the conventional refrigerators can be generally trusted to perform adequately, CU encountered a number of models with some design bloopers which could irritate and infuriate the user" (September 1959, 457–58).[20] By 1964, we read, "The generally high level of performance demonstrated by the tested models is as it should be, CU believes, in an appliance on the market as long as refrigerators have been" (August 1964, 368). In 1971, a further improvement is recorded: "When we totaled our scores for all the units, we found that overall quality differences between models were generally smaller than they had been. And a notable uptrend in quality had emerged" (September 1971, 562). After 1971, there were no further comments on overall quality.

Quality Control

Manufacturing defects provoked major complaints by *CR* during the period 1960–64, in contrast to the pre-1960 period, when uneven performance was the main problem, and to the post-1964 period, when there were virtually no complaints at all. The 1960 evaluation lamented "nearly half of these high-priced 'no-frost' models were defective as received. . . . In the majority of these cases, the defects required service calls. . . . many of [these defects] could have resulted only from slipshod assembly and inadequate quality control, neither of which, in CU's view, should be present in so expensive an appliance" (September 1960, 457). The 1964 report complains of "annoying flaws" and a "deplorable lack of quality control" (August 1964, 368). The 1968 and subsequent evaluations, in contrast, make no mention of quality control problems of any kind.

20. These comments refer to the models classified as type D in table 7.3.

Frequency of Service Calls

There are no comments in *CR* to indicate any change in the frequency of service calls for refrigerators. However, the MIT report (*Consumer Appliances*, n.d., 23) reports that the incidence rate for first-year service calls for refrigerators fell steadily from 68 percent in 1958 to 32 percent in 1972. While most first-year service calls may be free, covered by warranties, they still "matter" to households who may in some cases face the possible deterioration or loss of frozen foods. No data are provided for service calls after the initial year, but one might assume that service reliability in subsequent years would improve in tandem with the first-year record. This is clearly the case for TV sets, as documented in section 7.9 below. I make no separate adjustment for this aspect of quality change, but note that it provides another reason to suspect that my indexes understate the extent of quality improvement (explicit repair cost adjustments are provided for TV sets in sec. 7.9 below).

7.6 Room Air Conditioners

In contrast to household refrigerators, which were sold widely in the 1930s, room air conditioner sales began later. The first electrical air conditioning system appeared in Grauman's Metropolitan Theater in Los Angeles in 1923, and by the mid-1930s air conditioning had been installed in the U.S. Capitol building, the White House, the Supreme Court, the Kremlin, and about 10,000 U.S. homes (Consumers' Union 1986). But as a commonly purchased major appliance, room air conditioners are a postwar phenomenon. From a modest 48,000 units in 1946, sales rose to over 450,000 in 1952 and 750,000 in 1953. The first models appeared in the Sears catalog in 1953, and the first *CR* product evaluation also appeared in 1953. Room air conditioners entered the PPI in 1953 as well, but did not enter the CPI until 1964. By 1957, when sales of room air conditioners approached 2 million units, *CR* was ready to call air conditioning a "wonderful thing," and more recently has enthused, "Without air conditioning, we wouldn't have Las Vegas. Or Miami, or Houston, or Los Angeles. At least, not in their modern metropolitan forms that, collectively, make up the Sunbelt, the fastest growing area of the United States. Nor would we have jet air travel, manned spaceflight, submarines, or computers" (Consumers' Union 1986, 2).

7.6.1 Hedonic Regression Results

The study of room air conditioner prices is considerably simpler than that of refrigerators, since air conditioners produce a much more homogenous product. Whereas refrigerators have separate capacity measurements for refrigerator and freezer, frost free or not in both compartments, alternative locations of the freezer, and a host of convenience features, room air conditioners basically provide a single "service," cooling, and have few fancy features.

The results of the hedonic regression study of Sears catalog data begins in part A of table 7.6, where the format is the same as table 7.2. A pooled regression is displayed for a particular interval, and adjacent-year regression equations alongside. The first interval, 1954–58, is chosen to reflect the shift in the catalog from quoting the overall capacity measurement as horsepower in the early years and as BTU beginning in 1958. In part A of table 7.6, the pooled equation indicates an elasticity of price to capacity of 0.53 and an insignificant coefficient on volts, which nevertheless is included to maintain uniformity with the other intervals. It is plausible that the elasticity of price to capacity should be less than unity; the estimate here of 0.53 compares to the Triplett-McDonald elasticity for refrigerator capacity of 0.40 discussed in the previous section. The standard error of estimate of 14 percent is somewhat higher than those in the hedonic regression study of refrigerator prices. The price decline of 41 percent between 1954 and 1958 implied by the coefficients on the time dummy variables compares with a cumulative 42 percent implied by the successive time dummy coefficients in the adjacent-year equations. The next interval, 1958–67, is covered in part B of table 7.6. Now the basic capacity measure is BTU rather than horsepower, and the elasticity rises from 0.59 in the earlier period to 0.74 in the pooled equation. Six of the nine capacity elasticities in the adjacent-year equations fall into the range of 0.52–0.86. Unlike the previous table, the coefficient on volts is significantly negative and indicates in the pooled equation that a doubling of volts from 115 to 230 reduces price by 15 percent. The 1958–67 price decline implied by the time dummy coefficients in the pooled equation is 9 percent, as compared to 12 percent in the adjacent-year equations.

Part C of table 7.6 continues with the period 1967–74. The explanatory variables continue to be BTU and volts, and the respective estimated elasticities of 0.70 and −0.17 are similar to those for 1958–67. The coefficients on both variables are more stable in the adjacent-year equations, and for BTU range only from 0.63 to 0.76. The standard error in this period is just 6 percent for the pooled equation and is as low as 3.6 percent for the 1971–72 equation, and the estimated 1967–74 price increase of 8 percent for the pooled equation compares to an almost identical 7 percent cumulatively for the adjacent-year equations.

The interval 1974–77 in part D of table 7.6 is presented separately, since the variable "watts" becomes available and supplants "volts." The watts variable is highly significant in each equation. The coefficients on the time dummy variables imply a price increase between 1974 and 1977 of 13 percent in the pooled equation and 12 percent in the adjacent-year equation. Since the energy efficiency ratio (EER) is BTU/watts, the inclusion of watts amounts to an energy-efficiency adjustment for this period.

Results for the final interval, 1977–83, are shown in part E of table 7.6. Now two additional explanatory variables are available, "fan speed" and "high efficiency," with highly significant coefficients for all equations.

Table 7.6 **Pooled and Adjacent-Year Double-Log Regression Equations for Air Conditioners, Sears Catalog Data, 1954–58, 1958–67, 1967–74, 1974–77, 1977–83 (*t*-ratios in parentheses)**

A. 1954–58

	Pooled 1954–58	1954–55	1955–56	1956–57	1957–58
Horsepower	0.53	0.75	0.63	0.26	0.37
	(5.77)	(3.54)	(3.25)	(1.37)	(1.54)
Volts	−0.01	−0.17	−0.13	0.11	0.13
	(−0.12)	(−0.72)	(−0.86)	(0.81)	(0.82)
Constant	5.77	5.85	5.73	5.53	5.43
	(67.34)	(55.5)	(64.3)	(101.)	(89.7)
1955	−0.08	−0.08			
1956	−0.22*		−0.15*		
1957	−0.29**			−0.07	
1958	−0.41**				−0.12
$\bar{R}^2$	0.584	0.655	0.619	0.546	0.603
S.E.E.	0.143	0.149	0.135	0.132	0.141
Observations	40	9	17	24	19

B. 1958–67

	Pooled 1958–67	1958–59	1959–60	1960–61	1961–62	1962–63	1963–64	1964–65	1965–66	1966–67
BTU	0.74	1.17	0.52	0.55	0.57	0.57	0.86	0.42	0.69	0.37
	(10.4)	(14.0)	(3.57)	(4.74)	(5.59)	(7.27)	(5.26)	(5.63)	(10.4)	(3.94)
Volts	−0.15	−0.10	−0.12	−0.10	−0.06	−0.07	−0.29	−0.33	−0.15	. . .
	(3.53)	(−2.62)	(1.92)	(−1.77)	(−1.16)	(−1.50)	(−2.49)	(−2.74)	(3.21)	
Constant	3.83	2.74	4.43	4.25	4.17	4.19	3.58	3.32	3.84	4.57
	(23.6)	(14.7)	(12.9)	(16.7)	(18.2)	(24.4)	(9.71)	(9.07)	(25.9)	(18.3)
1959	0.07	0.04								
1960	0.01		−0.08							
1961	−0.01			−0.01						
1962	−0.01				−0.00					
1963	−0.04					−0.02				
1964	−0.17**						−0.13			
1965	−0.11							0.05		
1966	−0.16*								−0.04	

1967	−0.09									0.07
$\bar{R}^2$	0.674	0.971	0.659	0.609	0.707	0.803	0.634	0.662	0.935	0.749
S.E.E.	0.123	0.038	0.073	0.081	0.079	0.077	0.183	0.182	0.051	0.085
Observations	70	12	12	16	18	19	19	17	12	6

C. 1967–74

	Pooled 1967–74	1967–68	1968–69	1969–70	1970–71	1971–72	1972–73	1973–74
BTU	0.70	0.67	0.70	0.65	0.63	0.76	0.72	0.73
	(32.8)	(10.1)	(18.4)	(15.5)	(11.6)	(26.1)	(23.7)	(18.3)
Volt	−0.17	−0.15	−0.16	−0.11	−0.11	−0.24	−0.19	−0.21
	(−6.84)	(−2.12)	(−3.70)	(−1.97)	(−1.54)	(−6.65)	(−5.39)	(−4.76)
Constant	3.85	3.92	3.82	3.87	4.01	3.69	3.80	3.81
	(60.8)	(24.9)	(47.1)	(41.2)	(34.5)	(61.5)	(59.7)	(43.1)
1968	−0.03	−0.03						
1969	−0.06		−0.04					
1970	0.02			0.07*				
1971	−0.02				−0.04			
1972	−0.01					0.01		
1973	0.02						0.03	
1974	0.08							0.07*
$\bar{R}^2$	0.970	0.942	0.966	0.966	0.962	0.991	0.988	0.965
S.E.E.	0.060	0.079	0.066	0.066	0.069	0.036	0.039	0.062
Observations	79	14	23	16	15	19	21	30

D. 1974–77

	Pooled 1974–77	1974–75	1975–76	1976–77
BTU	1.15	1.05	1.12	1.27
	(17.0)	(12.3)	(12.3)	(11.8)
Watts	−0.59	−0.50	−0.60	−0.69
	(−6.69)	(−4.34)	(−5.01)	(−5.20)
Volts	0.04	0.06	0.07	−0.00
	(0.09)	(0.82)	(0.94)	(−0.11)
Constant	7.09	6.70	7.36	7.68
	(14.4)	(10.2)	(10.9)	(10.24)

(continued)

Table 7.6 (continued)

	D. 1974–77			
	Pooled 1974–77	1974–75	1975–76	1976–77
1975	0.15**	0.14**		
1976	0.12**		−0.02	
1977	0.13**			−0.00
$\bar{R}^2$	0.944	0.953	0.936	0.937
S.E.E.	0.088	0.079	0.093	0.096
Observations	69	39	44	30

	E. 1977–83						
	Pooled 1977–83	1977–78	1978–79	1979–80	1980–81	1981–82	198
BTU	0.95	0.87	0.50	0.57	0.72	0.93	1
	(15.8)	(4.93)	(2.19)	(2.65)	(7.29)	(11.7)	(13
Watts	−0.41	−0.31	0.26	0.08	−0.18	−0.40	−(
	(−6.28)	(−1.42)	(0.99)	(0.32)	(−1.69)	(−4.75)	(−6
Fan speed	0.23	0.29	0.32	0.28	0.24	0.20	(
	(11.0)	(6.74)	(6.33)	(6.55)	(8.84)	(5.92)	(4
High efficiency	0.03	0.09	0.23	0.17	0.12	0.04	−(
	(1.31)	(1.41)	(2.88)	(2.25)	(3.66)	(7.39)	(−(
Volts	−0.05	. . .	. . .	−0.00	−0.09	−0.02	(
	(−1.56)			(−2.61)	(−2.43)	(−0.59)	((
Constant	6.21	5.64	2.39	3.62	5.18	6.54	7
	(17.6)	(4.63)	(1.66)	(2.86)	(9.15)	(14.8)	(16
1978	0.08*	0.07**					
1979	0.14**		0.05				
1980	0.18**			0.04			
1981	0.30**				0.12**		
1982	0.38**					0.09**	
1983	0.44**						(
$\bar{R}^2$	0.977	0.966	0.917	0.941	0.984	0.976	(
S.E.E.	0.070	0.055	0.083	0.079	0.052	0.064	(
Observations	121	21	25	29	39	49	47

Note: Volts is defined as 0 for 110, 1 for 220. *High efficiency* is 1 for high efficiency, 0 otherwise.

Perhaps because of the data on the additional variables, the elasticity on capacity drops from 1.18 in the previous table to 0.95 here. For all years, the standard errors of estimate in all the equations are well below 10 percent. The price change for 1977–83 of 44 percent in the pooled equation is identical to the 43 percent cumulative change implied by the time dummy coefficients in the adjacent-year equations.

By and large, these hedonic regression results are straightforward and do not indicate any obvious problems. It is worth noting that the sample size in the adjacent-year equations increases markedly from the first three equations for 1954–57 containing an average of seventeen observations, to the last three equations for 1980–83 containing an average of forty-five observations. The large number of models sold under a single brand name in a single year reinforces the reality of product heterogeneity even for so simple a product as a room air conditioner.

7.6.2 Comparisons from *CR* Product Evaluations

Although the room air conditioner was introduced later than the refrigerator, nevertheless it is possible to develop even more comparisons of "closely similar" models (eighteen for room air conditioners vs. sixteen for refrigerators) owing to the greater frequency of product evaluations of air conditioners after 1970. All seventeen *CR* product evaluations of room air conditioners that appeared between 1953 and 1986 were consulted in the preparation of this section. In contrast to the refrigerator analysis, which used six classifications of "model types," this section uses the straightforward criterion of comparing machines of similar size. Thus, for instance, in rows 14–16, we have three overlapping comparisons of air conditioners of, respectively, 6,000, 8,000, and 5,000 BTU. The interval for each comparison depends on the appearance of models of a particular size class in the *CR* evaluations, since (as in the case of refrigerators) each evaluation tends to cover just one size class.

The criterion of capacity measurement in the *CR* evaluations changed from horsepower to BTU in 1959, about the same time that the same change occurred in the Sears catalog.[21] Fortunately, data are provided by *CR* to translate horsepower to BTU in both 1953 and 1959, and these translation factors are consistent with those given in the Sears catalog in 1958. Another minor complication that can be handled in a straightforward way results from a technological change that altered the relation of both BTU and energy consumption to horsepower, and details on the shift in this relation are provided by *CR* in the 1957 evaluation (see table 7.7, nn. c and e). The format of the comparisons in table 7.7 is the same as for refrigerators in table 7.3. Column 1 lists capacity in BTU in the first and second year of each comparison, and column 2 lists the percentage change in the average price of all models rated by *CR*.

21. This transition is described by *CR*, June 1959, 283.

Three adjustments are made to the raw price change calculated from the average unadjusted price for the models listed in each *CR* evaluation. First, as indicated by equation (7.3) above, the change in value attributable to changing size is calculated using an estimated elasticity of price on capacity. The coefficient a in (7.3) is set at 0.74, which is the coefficient on BTU in the pooled Sears catalog equation for 1958–67 in part B of table 7.6 and not far from the 0.72 coefficient for 1967–74 in part C. Two other adjustments are made that do not relate directly to energy efficiency. The second involves the transition from 230 to 115 volts in 1957, and this is taken into account using the coefficient of -0.15 on volts in part B of table 7.6. Third, an adjustment is made for the convenience value of reduced installation cost. Initially, room air conditioners were extremely heavy, with an average weight in 1957 for 6,400 BTU units of 180 pounds (May 1957, 302), and were bulky, with an average projection inside the room of ten to twenty inches (July 1953, 286). As a result, an extra installation expense was required, estimated at $35 by *CR* in 1953 (July, 280) and $25–$35, excluding the possible need for house rewiring, in 1959 (June, 286). Gradually, weight declined, reaching seventy pounds in 1970 for 6,000 BTU units, and brackets for self-installation were provided with each unit, making possible installation by the purchaser. Further, the bulk of the units also declined, with a projection into the room of three inches or less for eleven of seventeen models tested in 1970. To allow for this improvement in the price-change calculations of column 2, I include $30 in the price for installation cost before 1961, $15 in 1961, and nothing thereafter. While it could be argued that self-installation at zero pecuniary cost is not actually costless in time or effort, there is the offsetting fact that lower weight allows purchasers to remove the unit each fall and reinstall each spring, as recommended by *CR* in cold climates (e.g., July 1986, 444), thus providing savings in heating expense and an improvement in comfort and aesthetics during the winter that are not taken into account.[22] Implicitly, this approach assumes that there is an exact offset between the inconvenience of self-installation and the benefits of lower weight that makes possible winter removal. Of the adjustments discussed in the preceding paragraph, the first two are combined and listed in column 3 of table 7.7. The third (the installation cost adjustment) is taken into account in the basic calculation of

22. In the transition year of 1961 (June, 336), *CR* contains an explicit discussion of the installation issue: "In the past, all window installations were of the 'permanent' type, often done by a skilled serviceman, at a cost which could range from $10 on up. . . . once the installation is completed, the conditioner remains in place the year-round, and is an obstruction to light and air. . . . In contrast, some of the recently introduced, simplified 'do-it-yourself' mountings (see Ratings) are relatively simple to install, even for a layman. . . . The flexibility of such an arrangement is obvious. You can remove the conditioner for storage during the winter months, and then have full use of the window. You can readily move the unit to another location . . . should you later decide to do so. The disadvantage of this type of installation lies principally in the fact that the unit is not likely to be so securely mounted as it should be, and may not be well sealed against outside air."

price change in column 2. There are other aspects of quality change for which I do not adjust, and these are discussed below.

7.6.3 Adjustments for Improvements in Energy Efficiency

The adjustments for changes in energy efficiency are based on similar information as that for refrigerators, with the minor inconvenience that data on energy consumption are not provided in the evaluations between 1957 and 1965. As for refrigerators, the listed monthly energy cost data are averaged across all models of a given size in a given year, and the average monthly energy cost is standardized to an electricity price of $0.03 until 1974 and $0.0675 after 1974. Then the present discounted value of the change in energy cost from one product evaluation to the next was calculated, using the same discount rate as for refrigerators (0.03) and a shorter ten-year average lifetime. Monthly cost was converted to annual cost assuming 4.2 months of use per year (taken from *CR*'s own 1973 translation of $3.55 per month to $15.00 per year).[23]

Over the postwar period, energy cost savings in the operation of room air conditioners have been very significant, as indicated by the large negative adjustment factors in column 4 of table 7.7. Also, in contrast to refrigerators, where the energy savings were concentrated at the beginning and end of the 1949–83 postwar period, energy efficiency improvements for air conditioners were virtually continuous. I discuss the plausibility of these large adjustments in the next section, where alternative price indexes for air conditioners are compared.

7.6.4 Alternative Price Indexes for Room Air Conditioners

The alternative price indexes for room air conditioners are listed in table 7.8. The CPI and PPI are contrasted with four new indexes, including the pooled and adjacent-year indexes using Sears catalog data, and the *CR* indexes without and with an energy efficiency adjustment.[24] As for refrigerators, equal weights were applied when more than one *CR* price comparison in table 7.7 applied to a particular year. For instance, the price change between 1975 and 1976 for the *CR* price index without the energy adjustment (table 7.8, col. 5) is the average of the annual rates in rows 13, 14, and 15 of table 7.7 (12.7, 9.4, and 5.2 percent).

Since the behavior of the various price indexes differs over alternative subperiods of the 1953–83 interval, the differences are displayed for three subintervals. The first is 1953–72, starting with the earliest possible date. The second is

23. The monthly cost of a particular GE model is given in July 1973, 450, and the yearly cost of the same model at the same assumed electricity price, BTU capacity, and EER rating is given in July 1974, 520.

24. While the Sears hedonic regression equations in table 7.6 begin in 1954, we have two Sears observations for 1953 that allow the index to be extended back one year. Both these two models were also sold in identical form in 1954 at an average price 8.2 percent lower than in 1953.

Table 7.7 **Comparisons of "Closely Similar" Models of Room Air Conditioners from *Consumer Reports*, 1953–86**

Dates	Capacity (BTU) (1)	Price Change (%) (2)	Adjustments to Price Change: Capacity and Volts (3)	Adjustments to Price Change: Energy[a] (4)	Annual Rate of Price Change: Without Energy Adjustment (5)	Annual Rate of Price Change: With Energy Adjustment (6)
1. 1953–57	7,500/6,375[c]	−13.4[b]	1.0[c,f]	−13.8[c]	−3.3	−7.0
2. 1953–57	7,500/8,625[c]	−5.2[b,d]	−21.8[e,f]	0.0[e]	−7.6	−11.4
3. 1957–61	6,375/6,875	−35.0[b]	−5.8	−3.2[h]	−12.3	−15.8
4. 1957–59	8,625/8,575	−39.3[b]	0.6	−10.0[i]	−21.7	−28.0
5. 1957–60	8,626/10,246	−26.1[b]	−4.0[f]	0.0[i]	−11.3	−13.0
6. 1959–71	8,575/8,000	−2.6[b]	6.8	−43.6[j]	0.3	−3.2
7. 1961–65	6,875/5,117	−36.0[b]	18.9	−8.5[h]	−4.6	−1.7
8. 1965–67	5,117/6,320	14.9	−17.4	−9.7[k]	−1.3	−16.1
9. 1967–70	6,320/6,000	−1.7	3.7	−0.4[l]	0.7	2.0
10. 1970–72	6,000/6,000	2.8	0.0	−5.8[m]	1.4	−1.5
11. 1971–75	8,000/7,916	26.0	0.8	−11.3[n]	6.1	3.8
12. 1972–74	6,000/6,000	7.6	0.0	−13.3[o]	3.7	−2.9
13. 1973–76	5,000/5,150	45.4	−2.2	−22.7[p]	12.7	5.8
14. 1974–79	6,000/6,120	57.9	−1.5	−18.8[q]	9.4	6.4
15. 1975–79	7,916/8,130	24.5	−2.0	7.1[r]	5.2	6.3
16. 1976–80	5,150/5,070	23.6	1.1	−8.9[s]	5.7	4.0
17. 1979–82	8,130/8,085	18.9	0.4	0.3[t]	6.1	6.3
18. 1980–86	5,070/5,565	28.0	−7.2	−2.2[u]	3.2	1.8

[a]All energy calculations prior to 1974 use $0.03 per kilowatt hour. After 1974, $0.0675 is used. Notes below give monthly figures. These are converted to present values assuming 4.2 months of use and a real interest rate of 0.03 percent.

[b]Prices before 1961 include $30 for installation, 1961 models include $15 for installation, while nothing is included for installation after 1961.

[c]1957 *CR* states (212) that three-quarter-horsepower models produce 0.85 times as much cooling for 0.60 as much energy as "their predecessors." Energy cost in 1957 of $5.00 per month at $.02 per kWh ($7.50 at $0.03 per kWh) implies 1953 energy cost of $12.50 per month. However, this contradicts the explicit listing of energy costs in 1953 that average out to $9.34. By choosing the latter figure for 1953, I take the lower of the two energy cost adjustments that could be made for this comparison. The decline from $9.34 to $7.50 yields a present value of energy saving of $66.69.

[d]Comparison of price of the three-quarter-horsepower model in 1953 with the one-horsepower model in 1957, both including $30 for installation.

[e]1957 *CR* states (212) that one-horsepower models produce 1.15 times as much cooling for the same energy as previous three-quarter-horsepower models. Energy cost in 1957 listed as $8.00 per month at $0.02 per kWh, or $12.00 per month at $0.03 per kWh.

[f]Adjustment includes allowance for charge in volts, using hedonic coefficient of −0.15.

[g]Using equation (7.2), but applying the capacity adjustment ($-gdC/C$) only to the charge in BTU, not the charge in volts. The geometric annual rate of energy adjustments in col. 6 are computed by calculating the annual rate of charge of the monthly energy cost converting that to a present value for the first year of the comparison, including the price in the first year of the comparison, and then combining that annual rate with the annual rates of charge in cols. 2 and 3 as in eq. (7.2).

[h]No energy consumption data are given for 1959 and 1961. Energy cost was linearly interpolated between the three-quarter-horsepower figure for 1957 (see n. c) and the 1965 average figure of $6.25 per month. This implies the following first- and second-year per-month cost and implied present value of saving: 1957–59: $7.50, $7.17, $11.96; 1959–61: $7.17, $6.85, $11.18; 1961–65: $6.85, $6.25, $21.75.

[i]No information given for 1960; no energy adjustment attempted in view of change in size and volts.

Table 7.7 (continued)

[j]The annual rate of change of the monthly energy cost between 1957 and 1971 is −5.2 percent per annum. This implies a present value of savings for 1957–59 of $4.08 and for 1959–71 of $184.94.

[k]From $6.25 to $5.81; present value of saving = $15.95. Temporary change in size from 1961 to 1965 and then back again in 1967 is ignored.

[l]From $5.81 to $5.79 (midpoint of range of p. 351); present value of saving = $0.72.

[m]From $5.79 to $5.50 (single figure given, p. 433); present value of saving = $10.51.

[n]Shifted from monthly cost to EER. EER conversion as follows. July 1973 states special GE model used 625 watts of power (p. 443), for monthly cost of $3.55 (p. 450) at $0.03 per kWh. This implies a conversion factor for other units of:

$$\text{Monthly cost} = (\text{BTU/EER}) \times (\$3.55/625).$$

For models rated in 1975, this comes out at $4.88. Saving from 1971 figure of $5.70 has a present value of saving = $29.72.

[o]From $5.50 to $4.77, calculated from EER = $7.15 as in n. n; present value of saving = $26.46.

[p]From $5.20 to $3.99, calculated from EER = $8.33 as in n. n; present value of saving = $43.86.

[q]Now using $0.0675 per kWh, from $10.73 to $9.54, calculated from EER = $8.20; present value of saving = $43.13.

[r]From $10.98 to $11.52, calculated from EER = $9.02; present value of extra cost = $19.53.

[s]From $8.98 to $8.39, calculated from EER = $7.72, present value of saving = $21.38.

[t]From $11.52 to $11.53, calculated from EER = $8.96; present value of extra cost = $0.36.

[u]From $8.39 to $8.23, calculated from EER = $8.64; present value of saving = $5.80.

1964–72, reflecting the earliest date when a comparison can include the CPI. The third is 1972–83. The geometric annual growth rates of the six alternative indexes over the three intervals and the full period are given in table 7.9.

The relation among the indexes in table 7.9 differs in the three subperiods and the full 1953–83 interval. In the first period, the two Sears indexes agree almost exactly with the non-energy-adjusted *CR* index, but all three indicate a rate of price decline at double the rate of the PPI, or an absolute difference of 1.69 percentage points below the PPI and the *CR* no-energy. For the 1953–64 segment of the first subinterval, the absolute difference is an even larger 2.74 points, with a rate of decline for the PPI of 3.39 percent compared with an average for the other three of 6.13 percent. In the second subinterval, there is a close correspondence among the indexes that are not explicitly adjusted for energy efficiency; the CPI, PPI, Sears adjacent-year, and *CR* indexes grow at almost exactly the same rate, and the Sears pooled index grows at a slightly faster rate. In the final subinterval, the two Sears indexes and the non-energy-adjusted *CR* index increase much more rapidly than do the CPI and PPI, and the latter two indexes even increased at a slightly slower rate than the energy-adjusted *CR* index.

Overall, the results seem consistent with the view that the CPI and PPI have gradually improved their corrections for quality change, and the divergences for 1972–83 imply that both the CPI and the PPI must have taken considerable care to treat improvements in energy efficiency as a quality improvement. There remains the question as to whether the greater rate of price decline in the new indexes before 1972 is credible. Starting with the

Table 7.8 **Alternative Price Indexes for Room Air Conditioners, 1953–83 (1967 = 100)**

Year	CPI (1)	PPI (12-41-03-38) (2)	Sears Hedonic: Pooled (3)	Sears Hedonic: Adjacent Year (4)	Consumer Reports: Without Energy Adjustment (5)	Consumer Reports: With Energy Adjustment (6)
1953		153.6	178.7	185.6	207.8	345.3
1954		153.5	165.2	171.6	196.7	315.0
1955		144.6	152.1	158.4	186.3	287.3
1956		137.7	132.4	136.3	176.4	262.0
1957		132.7	123.6	127.1	167.1	239.0
1958		127.8	109.4	112.7	145.4	197.8
1959		119.2	117.4	115.0	126.6	163.6
1960		115.5	110.5	108.3	117.1	147.1
1961		109.0	108.3	107.3	110.2	133.8
1962		107.8	108.3	107.3	107.9	130.5
1963		106.4	105.1	104.1	105.5	127.4
1964	105.5	105.1	89.6	92.4	103.3	124.3
1965	97.8	99.7	98.0	97.0	101.0	121.3
1966	98.0	98.7	93.2	93.2	100.5	110.1
1967	100.0	100.0	100.0	100.0	100.0	100.0
1968	102.3	101.6	97.0	97.0	100.5	99.4
1969	105.0	101.3	94.2	93.2	101.0	98.8
1970	107.1	104.2	102.0	100.0	101.5	98.2
1971	110.2	108.4	98.0	96.1	102.4	95.9
1972	110.7	109.4	99.0	97.0	106.3	97.0
1973	110.1	107.7	102.0	101.0	111.6	97.5
1974	113.4	114.8	108.3	108.4	120.3	99.7
1975	123.8	126.5	125.9	124.7	132.1	105.1
1976	129.5	125.3	122.1	122.2	144.8	111.8
1977	135.1	126.2	123.4	122.2	154.9	118.2
1978	138.3	131.3	133.6	131.1	165.7	124.9
1979	147.4	138.3	141.9	137.8	177.3	132.1
1980	154.0	150.1	147.7	143.4	188.1	137.5
1981	160.1	158.0	166.5	161.7	197.1	143.2
1982	167.7	164.2	180.4	176.9	206.4	145.7
1983	170.7	174.5	191.6	187.9	213.1	148.4

non-energy-adjusted *CR* index, which in 1972 has an index value equal to 0.512 times its 1953 value, we find confirming evidence in comparing the average 1972 price of a 6,000 BTU unit of $173.75 with the $415.63 price of a 7,500 BTU unit in 1953.[25] Raising the price of the 1972 unit by 18 percent (25 percent greater capacity times the hedonic coefficient of 0.74), we have a 1972 price of $205.03, which is 0.493 of the 1953 price. The same exercise with the average price of a 8,000 BTU unit in 1971 yields a price ratio of 0.535. Both are quite close to the ratio for the *CR* index and differ markedly from the implied 1972/1953 PPI price ratio of 0.712.

The non-energy-adjusted *CR* index implies that the price ratio between the beginning and end of the entire period, 1982/1953, was 0.993. We can take the

25. The 1953 price includes $30 for installation, as discussed above.

Table 7.9 **Annual Percent Growth Rates of Alternative Price Indexes for Room Air Conditioners, 1953–83 and Subintervals**

	1953–72	1964–72	1972–83	1953–83
CPI	. . .	0.60	4.02	. . .
PPI	−1.77	0.50	4.34	0.43
Sears pooled	−3.06	1.26	6.18	0.23
Sears adjacent year	−3.36	0.61	6.19	0.04
CR without energy	−3.46	0.40	6.53	0.08
CR with energy	−6.46	−3.05	4.43	−2.61

average price for 8,000 BTU units in 1982 of $435.31, and adjust this down to $408.78 to compare with the 7,500 BTU capacity of 1953 units; this yields a 1982/1953 price ratio of 0.984, which corresponds almost exactly to the *CR* index ratio of 0.993.

There remains the question of the extremely rapid rate of decline of the energy-adjusted *CR* index. Using the explicit cost per month figures in *CR* for 1957, we can develop a comparison with 1971. The $12.00 monthly cost in 1957 for the average unit of 8,625 BTU compares with the average $5.71 cost in 1971 for 8,000 BTU. Using the same method as in table 7.7, the present value of the difference between $12 and $5.71 per month is $227.99, or 58 percent of the price (including installation) of the 1957 model. If one takes the ratio of the actual 1971 price adjusted to 8,625 BTU ($246.66) to the price of the 1957 model plus the present value of the extra energy consumption ($622.14), one has a ratio for 1971/1957 of 0.396, compared to a ratio of 0.401 for the index in column 6 of table 7.8, indicating a very close correspondence.

As for the more recent period of 1973–86, the average EER rating of models in the 5,000 BTU range improved from 6.0 to 8.64, for a saving having a present value at the post-1974 electricity price of $125.77, or 84 percent of the average 1973 price for 5,000 BTU units. Adding this to the 1973 price, one obtains a price ratio for 1986/1973 of 1.248, considerably less than the 1983/1973 ratio for the energy-adjusted *CR* index of 1.511. A similar exercise for 8,000 BTU units between 1971 and 1982 yields a ratio of only 1.166 for the 1982 price ($435.31) to the 1971 price ($233.18) plus the present value of energy saving on the 1982 model compared to the 1971 model ($140.09). Both these comparisons suggest that the *CR* index may overstate the increase in prices in the post-1972 subinterval.

7.6.5 Unmeasured Dimensions of Quality Improvement

In the previous study of quality changes for refrigerators, we found aspects of quality improvement that could not be taken into account in price indexes, either by the hedonic or by the specification method. These included a tightening of the *CR* criteria for temperatures in the refrigerator and freezer, a greatly improved ability of the average unit to hold the required temperatures, improvements in design to eliminate previous inconvenience, improvements in quality control, and a reduced frequency of service calls. In the case of air conditioners, dimensions of unmeasured quality improvement are fewer, partly because the air conditioner is a simpler product to begin with. In particular, there seems to have been no improvement at all in the ability of a unit to maintain a fixed temperature, unlike refrigerators in which temperature control ability improved markedly.

Nevertheless, there are a few aspects of quality improvement that deserve note. I have already remarked on the weight and bulk of the early units, and the impossibility of taking them in for the winter or of moving them from room to room. A rough adjustment for this change is made by including installation cost in the price of models before 1961. In that adjustment, I made no allowance for the requirement that air conditioners of the 1950s required their own fifteen-ampere electric circuit, requiring extra wiring in homes without extra circuits, but by the 1960s and 1970s drew as little as 7.5 amps, allowing an existing circuit to be shared with lighting or other electrical requirements. A second issue is that the 1953 models were not equipped with some features that became common later. Of the sixteen models rated in 1953, nine lacked thermostats, although all could be equipped with thermostats for an average extra cost of $14.61, and allowance for this would add another 2 percent to the average 1953 price. Also, eleven of the sixteen models had only one fan speed. By 1967, all models had at least two fan speeds and most had three. Another difference is noise. *CR* commented in 1953 that "all are noisy," but by 1965 that the "top-rated models are very quiet" (June, 276). Overall, however, these improvements seem minor, and there is little reason to suspect that the new indexes miss major dimensions of quality change.

7.7 Washing Machines

The first electric washing machine was introduced in 1911, when Maytag added electricity to a wringer model known as the "Hired Girl." The first automatic model was introduced by Bendix in 1940, but sales of automatic washers did not pass those of wringer-style models until 1952.[26] In the subsequent decade, automatic washing machines added a host of features, including wash-and-wear cycles, and multiple temperature and water-level choices. The main issue in developing price indexes for washing machines is to make adequate corrections for the steady increase in features and options. As in the two previous sections, I begin with the results of estimating hedonic regression equations from Sears catalog data on prices and specifications and then turn to a comparison of "closely similar" models from successive *CR* product evaluations.

26. Historical details are from Consumers Union (1986, 232).

7.7.1 Hedonic Regression Results

The regression results for 1948–54 are presented in part A of table 7.10 and cover wringer models until 1952 and automatic models for 1952–54.[27] The equations for wringer models include as explanatory variables capacity and dummy variables for the presence of automatic drains and timers. The coefficients on capacity are relatively large, ranging from 0.87 to 1.47, and are highly significant, as are most of the coefficients on the dummy variables. The 1952–53 equation for automatic models includes only a capacity variable, because the small number of observations for that equation precludes adding additional variables. A greater range of models is available in 1953–54, and so variables are entered for the number of machine cycles and the number of speed settings. The cumulative price change between 1948 and 1954 implied by the six adjacent-year equations is −17 percent.

The next table (7.10, pt. B) covers the full decade from 1954 to 1964, with the pooled regression equation displayed in the first column, followed by the ten adjacent-year equations. The capacity variable is joined by the number of cycles and the level 1 variable, which is a dummy variable indicating the presence of more than one water-level setting.[28] The large semielasticity on the level variable, 19 percent in the pooled equation, suggests that this variable may partly be standing as a proxy for other "deluxe" features. The standard error on the pooled equation is about 10 percent, similar in magnitude to the equations for refrigerators and air conditioners estimated in previous sections. The standard errors in the adjacent-year equations are less after 1961, and it is interesting to note that the elasticity of price to capacity fell sharply after 1961 as well. The cumulative price change of −44 percent in the pooled equation compares with −33 percent in the adjacent-year equations.

Part C of table 7.10 for 1964–71 contains the same variables as the previous table. The elasticity of price to capacity is markedly lower than in the period before 1961. In the pooled regression for 1964–71, the coefficient on the cycles variable is somewhat higher than for 1954–64, and the coefficient on level 1 is considerably lower. The standard error in the pooled equation is also lower than in the previous table. The cumulative price change in the pooled equation of 8 percent is identical to that implied by the adjacent-year equations.

Part D of table 7.10, covering the 1971–76 period, introduces a new definition of the level variable (indicating the presence of a continuous level

27. Part A of table 7.10 is arranged in a slightly different format than the other tables presenting hedonic regression results in this chapter, since these results are taken from the 1974 draft of this book.

28. The "cycle" variable is the number of cycles, entered linearly. The coefficient of 0.03 in the pooled regression indicates that the addition of one more cycle adds 3 percent to price. Since the average number of cycles on the machines in my sample for 1960 was almost six, the coefficient on the cycles variable implies that a machine with an average number of cycles would have a price 15 percent higher than a machine with a single cycle.

Table 7.10 **Pooled and Adjacent-Year Double-Log Regression Equation for Washers, Sears Catalog Data, 1948–54, 1954–64, 1964–71, 1971–76, 1976–80, 1980–83 (*t*-ratios in parentheses)**

A. 1948–54

	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54
Type	Wringer	Wringer	Wringer	Wringer	Auto	Auto
Capacity	0.87	1.085	1.28	1.47	2.03	1.34
	(10.4)	(21.2)	(19.3)	(8.7)	(6.48)	(1.99)
Automatic drain	0.06	0.08	0.07	0.05	. . .	. . .
	(2.32)	(5.10)	(4.29)	(1.11)		
Automatic timer	. . .	0.21	0.16	0.12	. . .	. . .
Cycles	. . .	(8.78)	(9.73)	(3.09)		0.13
Temperatures	. . .	. . .	. . .	. . .	. . .	(1.10)
1949	−0.16**					0.13
1950		0.02				(2.00)
1951			0.07			
1952				0.01		
1953					0.02	
1954						−0.13
$\bar{R}^2$	0.974	0.997	0.998	0.993	0.978	0.955
S.E.E.	0.039	0.019	0.017	0.034	0.030	0.061
Observations	8	8	8	7	4	8

B. 1954–64

	Pooled 1954–64	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61	1961–62	1962–63	1963–64
Capacity	0.62	2.33	2.07	1.11	0.86	0.68	1.09	1.02	0.37	0.34	0.36
	(4.33)	(3.73)	(2.94)	(2.70)	(2.70)	(1.53)	(2.69)	(2.41)	(1.46)	(3.18)	(3.88)
Cycles	0.03	0.04	−0.04	. . .	0.09	0.17	0.03	0.03	0.04	0.04	0.03
	(4.20)	(0.64)	(−0.28)		(0.63)	(2.05)	(2.69)	(2.96)	(7.68)	(8.25)	(5.84)
Level 1	0.19	−0.01	0.17	0.28	0.20	0.00	−0.02	0.05	0.18	0.19	0.20
	(5.22)	(−0.08)	(0.80)	(3.87)	(0.80)	(0.00)	(−0.13)	(0.45)	(4.01)	(5.64)	(6.48)
Constant	3.95	2.58	0.79	3.71	3.06	3.47	2.72	2.85	4.15	4.18	4.13
	(12.7)	(3.07)	(0.53)	(3.10)	(3.40)	(3.58)	(3.18)	(3.07)	(7.48)	(17.9)	(19.3)

1955	−0.11	−0.10									
1956	−0.20**		−0.06								
1957	−0.28**			−0.09							
1958	−0.20**				0.06						
1959	−0.28**					−0.08					
1960	−0.26**						−0.04				
1961	−0.33**							−0.04			
1962	−0.37**								0.03		
1963	−0.44**									−0.01	
1964	−0.44**										−0.00
$\bar{R}^2$	0.782	0.808	0.709	0.773	0.673	0.687	0.808	0.826	0.969	0.967	0.958
S.E.E.	0.099	0.082	0.098	0.107	0.146	0.121	0.097	0.094	0.034	0.039	0.042
Observations	63	9	10	10	12	13	13	12	10	12	14

C. 1964–71

	Pooled 1964–71	1964–65	1965–66	1966–67	1967–68	1968–69	1969–70	1970–71
Capacity	0.25	0.39	0.36	0.34	0.21	0.19	0.17	0.06
	(4.20)	(4.77)	(8.08)	(10.2)	(3.12)	(2.55)	(1.52)	(10.5)
Cycles	0.05	0.04	0.04	0.04	0.05	0.06	0.06	0.42
	(14.3)	(6.92)	(13.0)	(14.6)	(8.62)	(9.68)	9.86	(3.32)
Level 1	0.08	0.16	0.14	0.20	0.14	0.08	0.09	−0.17
	(2.70)	(5.10)	(7.64)	(14.1)	(3.97)	(1.82)	(1.23)	(−2.26)
Constant	4.39	4.06	4.07	4.11	4.47	4.47	4.50	4.50
	(31.6)	(21.3)	(38.5)	(57.9)	(27.0)	(25.4)	(18.7)	(19.2)
1965	−0.05	−0.04						
1966	−0.05		−0.00					
1967	−0.04			0.01				
1968	−0.03				0.00			
1969	−0.04					−0.01		
1970	−0.03						0.01	
1971	0.08*							0.11*
$\bar{R}^2$	0.908	0.969	0.991	0.995	0.964	0.944	0.923	0.888
S.E.E.	0.067	0.038	0.021	0.015	0.041	0.047	0.057	0.075
Observations	60	13	12	12	15	17	17	18

(continued)

Table 7.10 (continued)

	D. 1971–76[a]					
	Pooled 1971–76	1971–72	1972–73	1973–74	1974–75	1975–76
Capacity	0.06	0.17	0.22	−0.04	−0.00	0.02
	(1.80)	(2.44)	(3.54)	(−0.51)	(−0.03)	(0.64)
Cycles	0.02	0.04	0.04	−0.00	0.00	0.04
	(3.11)	(3.06)	(4.28)	(−0.12)	(0.08)	(4.70)
Level 2	0.14	0.10	0.12	0.23	0.19	0.04
	(3.35)	(1.42)	(2.41)	(3.08)	(2.42)	(4.70)
Filter	0.16	0.08	0.14	0.22	0.17	0.15
	(4.19)	(1.23)	(3.26)	(2.96)	(2.33)	(3.80)
Constant	5.13	5.10	5.04	5.15	5.19	5.22
	(126.)	(107.)	(126.)	(75.0)	(72.1)	(135.)
1972	0.00	0.00				
1973	−0.04		−0.03			
1974	−0.04**			0.02		
1975	0.10**				0.15**	
1976	0.10**					−0.02
$\bar{R}^2$	0.776	0.838	0.938	0.755	0.679	0.865
S.E.E.	0.095	0.082	0.054	0.108	0.115	0.062
Observations	51	17	16	16	16	18

	E. 1976–80				
	Pooled 1976–80	1976–77	1977–78	1978–79	1979–80
Capacity	0.07	0.09	0.12	0.08	0.04
	(3.57)	(3.36)	(2.76)	(2.14)	(1.75)
Cycles	0.03	0.02	0.03	0.03	0.04
	(6.90)	(2.67)	(4.02)	(4.30)	(1.27)
Filter	0.08	0.08	0.09	0.07	0.08
	(2.95)	(1.83)	(1.68)	(1.24)	(2.29)
Saver	0.10	. . .	0.02	0.10	0.12
	(4.28)		(0.54)	(2.79)	(5.33)

Speed	0.10	0.14	0.14	0.08	0.02
	(3.64)	(3.20)	(2.65)	(1.37)	(5.20)
Constant	5.10	5.05	5.08	5.19	5.26
	(125.)	(103.)	(76.9)	(78.2)	(116.)
1977	0.06	0.05**			
1978	0.08**		0.04		
1979	0.19**			0.10	
1980	0.20**				0.04
$\bar{R}^2$	0.899	0.910	0.904	0.814	0.904
S.E.E.	0.070	0.078	0.070	0.070	0.057
Observations	70	19	25	25	35

F. 1980–83

	Pooled 1980–83	1980–81	1981–82	1982–83
Capacity	0.06	0.05	0.05	0.14
	(2.04)	(1.74)	(1.23)	(1.72)
Cycle	0.03	0.03	0.03	0.03
	(7.60)	(6.66)	(5.34)	(4.39)
Speed	0.18	0.17	0.21	0.24
	(4.67)	(4.25)	(4.50)	(2.77)
Constant	5.22	5.26	5.29	5.20
	(76.1)	(7.89)	(67.8)	(29.8)
1981	0.09**	0.09**		
1982	0.18**		0.09**	
1983	0.26**			0.08*
$\bar{R}^2$	0.817	0.832	0.804	0.669
S.E.E.	0.090	0.077	0.082	0.105
Observations	61	34	30	27

[a]From 1971 on, "capacity" becomes a dummy variable (0, 1), where 1 represents "large capacity."

adjustment) and a new variable indicating the presence of a lint filter. Another change is that the capacity variable is now a dummy variable rather than an actual measurement. Reflecting the fact that now all the variables in the equation are dummy variables, the title of the table indicates that the equations should be interpreted as having a semilog specification. The coefficient on capacity is smaller than before, while the coefficients on the cycles and level variables are similar to those in the previous table. The coefficient on filter seems implausibly large, suggesting that this variable has now taken on the role of acting as a proxy for other deluxe features. The cumulative price change indicated by the pooled equation is 10 percent, somewhat less than the 12 percent implied by the successive coefficients on the time dummy variables in the adjacent-year equations. There are problems with the signs and significance of the adjacent-year coefficients of capacity.

The next period, 1976–80, is covered in part E of table 7.10. Here, a linear variable for the number of speed settings replaces the dummy variable for water level. A new variable for the presence of a water-saving feature (which reduces the amount of hot water needed, thus saving energy) is added. All the explanatory variables are significant in the pooled equation and most in the adjacent-year equations. The standard error in the pooled equation is lower than before, and the number of observations per year is much higher. The 1976–80 price increase of 20 percent in the pooled equation compares with a larger 23 percent increase in the adjacent-year equations.

The final table (7.10, pt. F) covers the 1980–83 period. The number of explanatory variables is smaller than before, and the standard error of the pooled equation is also higher. The price increase in the pooled equation is 26 percent, and the indicated price increases for 1980–81, 1981–82, and 1982–83 are identical in the pooled and adjacent-year equations.

7.7.2 Comparisons from *CR* Product Evaluations

The *CR* price index developed in this section is based on nineteen reports on automatic washing machines that appeared in *CR* between 1948 and 1983.[29] The procedure for converting the *CR* price listings into a price index is simpler than for refrigerators and room air conditioners, because no adjustment is made for changes in energy efficiency. Washing machines have very small direct energy requirements in comparison with the indirect energy used in heating the water that they use. Thus, the main way in which manufacturers could have accomplished a reduction in the total energy cost involved in washing a load of dirty clothes would have been to devise methods of saving hot water. Consumption of hot water averaged eighteen gallons in 1950 and twenty-three gallons in 1980, but the capacity of washers increased by about 50 percent in the meantime, probably more than accounting for this

29. The report that I use for 1983 prices was actually published in January 1984.

Table 7.11 **Comparisons of "Closely Similar" Models of Automatic Washing Machines from *Consumer Reports*, 1948–83**

Dates	Price Range (1)	Price Change[a] (2)	Quality Adjustment (3)	Annual Rate of Price Change with Quality Adjustment (4)
1. 1948–50	Low	−4.3[b]	0.0	−2.2
2. 1950–54	Low	−0.5[b]	−13.0[c]	−3.6
3. 1954–60	Low	−22.5	0.0	−4.2
4. 1959–60	Top	−5.7	0.0	−5.7
5. 1960–62	Middle	−21.8[d]	0.0	−11.6
6. 1962–64	Middle	−3.4	−2.0[e]	−2.7
7. 1964–66	Middle	2.7	−2.0[e]	0.3
8. 1966–69	Middle	−1.4	−2.0[e]	−1.1
9. 1969–70	Middle	3.7	−1.0[e]	2.7
10. 1970–71	Middle	2.6	−1.0[e]	1.6
11. 1971–73	Middle	1.7	−2.0[e]	−0.2
12. 1973–74	Middle	−3.3	−1.0[e]	−4.3
13. 1974–75	Middle	22.5	−1.0[e]	21.5
14. 1975–78	Middle	18.5	−3.0[e]	4.9
15. 1978–79	Middle	5.8	−1.0[e]	4.8
16. 1979–80	Middle	9.5	−1.0[e]	8.5
17. 1980–81	Middle	7.8	−1.0[e]	6.8
18. 1981–82	Middle	3.7	−1.0[e]	2.7
19. 1982–83	Middle	1.7	0.0	1.7

[a]Unless otherwise noted, price change is between the unweighted average of *CR* price listings in each year excluding Tumbler-type models. Also excluded are deluxe models when two models are included for the same brand name.

[b]Excludes bolt-down models in 1948 and 1950.

[c]Adjusts for increase from one to two temperatures, using 1953–54 hedonic coefficient of 0.13.

[d]Comparison of top-range 1960 models with mid-range 1962 models assumes that mid-range models in 1960 would have been priced midway between average price of top-range and economy models.

[e]One percent per annum quality improvement applied from 1962 to 1982. See text.

difference.[30] The most important energy-saving innovation in the postwar period was the development of cold-water detergents, allowing some types of loads to be washed with no hot water at all, but any credit for this development should go to the soap industry rather than the appliance industry.

The year-by-year price comparisons for the *CR* price index are listed in table 7.11. Only a few decisions need to be made in compiling the index. The first is the linking of models in different price classes. In the 1950s, *CR* was not consistent in its choice of models to be tested. The 1948, 1950, and 1954 evaluations are based on very simple machines by present standards. In contrast, "top-of-the-line" super deluxe models were tested in 1959 and

30. The 1950 figures are a simple average of the hot water consumption figures given in the detailed ratings. The 1980 figure is an in-text remark (November, 680) that does not specify the size of the load used in the test.

1960. Beginning in 1962, *CR* consistently rated only mid-range models that had certain minimum features but not all the bells and whistles of the super deluxe models. The difficulties caused by this shift in the model-selection criterion are greatly eased by the fact that *CR* rated both deluxe and economy models in 1960. The inclusion of simple models for 1960 establishes a price link between 1954 and 1960 (row 2), and the presence of both top- and bottom-grade models in 1960 allows us to estimate a midpoint for comparison with the mid-range models tested in 1962 and thereafter.

The second issue is the adjustment for improvements in quality over the years. The first adjustment is made in row 1 for the 1950–54 comparison. The 1950 models had no optional settings at all for speed, temperature, or water level. But 1954 machines could be set to wash with either hot or warm (but not cold) water. The value of the extra temperature setting is taken from the coefficient on temperature settings in the Sears hedonic regression equation for 1953–54. Another improvement, for which no explicit adjustment is made, is that three of the ten non-bolt-down machines in 1950 required that the water first be turned on manually and that the user wait until the machine was full before switching on the wash cycle (for two of these three models, "the water may flood over onto the floor if you aren't there to turn it off" [November 1950, 503]). Also, five of the ten models lacked an automatic cut-off in the case of excessive vibration.

The other quality adjustment made is to take account of the gradual improvement in capacity and other features on the mid-range models between 1962 and 1982. Unfortunately, *CR* does not provide explicit and consistent measures of capacity in each report, yet enough information is provided to allow a guess that capacity must have increased by at least 50 percent after 1962. In the 1962 report (380), four models claimed twelve-pound capacities, "while six others are rated at 9 to 10 pounds."[31] And *CR* found that even these claims were exaggerated: "Most of the machines tested simply did not have the physical capacity to take a 12-pound mixed load, and many could not handle 10 pounds without the obvious signs of overloading—clothes becoming tightly packed, items of clothing escaping into the outer tub, or the machine stopping frequently. In general, even where machines could handle large loads, washing ability and uniformity fell off as the load increased" (August 1962, 380). In contrast, in 1981 (October, 558), *CR* wrote that "Nearly half of the machines sold last year were identified as 'large' models. (Some manufacturers define 'large' as an 18- to 20-pound capacity; others don't define it.) The 12 machines we tested are in that class." Further, there are no comments in the 1981 report disputing the capacity claims of manufacturers. I surmise that this increase in capacity must have occurred

31. "Most of the remaining models do not, to CU's knowledge, claim specific load weights" (August 1962, 380).

gradually, because comments on capacity in 1971 indicate an in-between status. Some but not all models claimed eighteen-pound capacities, and these were described by *CR* as "very large" and "capacious." But other tubs were described as "medium" and "small." Further, in contrast to the quote from 1962, "all the machines with medium or larger tubs accepted our 11-pound load easily; we had to cram the smaller tubs."

Overall, these quotes suggest an increase in average capacity from ten pounds in 1962 to eighteen pounds in 1981. To be conservative, I estimate the increase as 50 percent and multiply it by the Sears hedonic coefficient for 1964–71 (0.25) to arrive at an upward quality adjustment of 12.5 percent for capacity over the 1962–82 period. Further adjustments must be made, however, for the numerous features on 1982 models that were not present in 1962. The selection criterion in 1962 was "the least expensive model in each line that offered two agitator and spin speeds." There was no criterion for number of water levels, temperature combinations, or number of automatic cycles. The detailed model-by-model ratings indicate that some models could be preset to three alternative water levels, while in other cases "user must be present to push button when water has reached desired level." Most machines offered three wash temperatures and two rinse temperatures, but there is no mention for any of the brands of multiple cycles. Further, no dispensers were included for liquid bleach or fabric softener.[32]

By 1971, quality had improved. All machines offered at least one cycle in addition to the regular cycle, and all offered bleach dispensers. And, by 1984, further improvements had been introduced. In a detailed chart listing features of machines rated by *CR* and other models of the same brands, we learn that all rated machines provided three cycles, two separate automatic dispensers (for bleach and softener), and continuous rather than discrete control of water level (which *CR* considered preferable). To adjust for these improvements, I raise the estimate of 1962–82 quality improvement from the 12.5 percent warranted by the capacity increase to 20 percent. Since the hedonic regression equations estimate that two extra cycles raise price by 6–10 percent, depending on the sample period, this adjustment would seem to be conservative in that it makes no explicit allowance for the improved control of water level and the addition of automatic dispensers. As shown in column 3, the estimated 20 percent quality improvement is introduced at the rate of 1.0 percent per year over the twenty years from 1962 to 1982.

7.7.3 Alternative Price Indexes for Automatic Washing Machines

The alternative price indexes for automatic washing machines are compared in table 7.12. The CPI and PPI are compared with the pooled and

32. The exception is the Blackstone, which is listed in 1966 (431) as a top-of-the-line model. To maintain consistency, all Blackstone models are excluded in calculating the price comparisons of table 7.11.

Table 7.12 **Alternative Price Indexes for Automatic Washing Machines, 1947–83 (1967 = 100)**

Year	CPI (1)	PPI (12-41-02-01) (2)	Sears Hedonic: Pooled (3)	Sears Hedonic: Adjacent Year (4)	*Consumer Reports* (5)
1947	112.7	111.5	...	...	...
1948	121.2	117.7	191.5	169.0	208.3
1949	119.6	113.6	163.2	144.8	203.7
1950	118.1	112.9	166.5	147.7	199.3
1951	126.2	122.9	178.6	158.4	192.2
1952	126.7	122.4	180.4	160.0	185.4
1953	124.8	122.0	184.0	163.2	178.8
1954	121.8	121.8	161.6	143.3	172.5
1955	118.5	118.5	144.8	129.6	165.4
1956	115.7	115.7	132.3	122.1	158.6
1957	117.1	117.1	122.1	111.6	152.1
1958	115.8	115.8	132.3	118.5	145.8
1959	113.6	113.6	122.1	109.4	139.9
1960	110.7	110.7	124.6	105.1	133.7
1961	107.4	107.4	116.2	101.0	119.1
1962	104.5	104.5	111.6	104.1	106.1
1963	103.0	103.0	104.1	103.0	103.3
1964	101.6	101.6	104.1	103.0	100.5
1965	100.2	100.2	99.0	99.0	100.8
1966	99.7	99.7	99.0	99.0	101.1
1967	100.0	100.0	100.0	100.0	100.0
1968	102.5	102.5	101.0	100.0	98.9
1969	104.6	103.8	100.0	99.0	97.8
1970	107.3	105.9	101.0	100.0	100.5
1971	109.4	105.7	112.8	111.6	102.1
1972	110.5	106.9	112.8	111.6	101.9
1973	111.0	107.2	108.4	108.3	101.7
1974	117.1	117.7	108.4	110.5	97.4
1975	131.9	132.5	124.6	128.4	120.8
1976	141.0	143.9	124.6	125.9	126.9
1977	145.5	148.9	132.4	132.3	133.2
1978	154.0	155.0	135.0	137.7	139.9
1979	164.1	162.9	150.7	152.2	146.8
1980	177.1	173.0	152.2	158.4	159.8
1981	189.8	184.8	166.5	173.3	171.1
1982	203.6	196.8	182.2	189.6	175.7
1983	212.7	203.5	197.4	205.4	178.8

adjacent-year Sears hedonic indexes and with the *CR* index.[33] The geometric annual growth rates of the five alternative indexes over three intervals and the full period are given in table 7.13. The first interval is 1950–60, starting with the first year when both the Sears hedonic and the *CR* indexes are available.

33. I extrapolate the pooled Sears hedonic index prior to 1954 with the Sears adjacent-year index and replace the implausible 1980–81 price change in the adjacent-year index with that in the pooled index.

Table 7.13 **Annual Percent Growth Rates of Alternative Price Indexes for Automatic Washing Machines, 1950–83 and Subintervals**

	1950–60	1960–72	1972–83	1950–83
CPI	−0.66	−0.02	6.13	1.80
PPI	−0.20	−0.29	6.03	1.80
Sears pooled	−2.86	−0.83	5.22	0.52
Sears adjacent year	−3.35	0.50	5.70	1.01
CR	−3.91	−2.24	5.24	−0.33

The second is 1960–72, chosen for comparability with the presentation of results in the refrigerator section. The third is 1972–83.

These annual growth rates indicate a relatively close correspondence between the CPI and PPI and the Sears hedonic indexes after 1960, but with an average absolute difference of 2.7 percentage points in the first decade between 1950 and 1960. The growth rate of the *CR* index is lower than that of the CPI and PPI in every period, with the difference narrowing from an average 3.48 points for 1950–60, to 2.09 points for 1960–72, to a mere 0.84 points in 1972–83. The discrepancy between the *CR* and the Sears hedonic indexes can be partly explained by the fact (introduced above in sec. 7.3) that Sears models were at the low end of the price spectrum in the 1950s but close to the mean price in the 1980s. For washing machines, the Sears price rose from 84.2 percent of the mean in the 1950 and 1954 reports to 98.2 percent of the mean in the 1982 and 1984 evaluations. The growth rate of this ratio is 0.5 percent per year, accounting for most of the 0.85-point difference between the growth rates of the Sears pooled and *CR* indexes.

7.7.4 Unmeasured Dimensions of Quality Change

A contrast between the 1950 and the 1982 product evaluations reveals relatively few unmeasured aspects of quality improvement. In 1982, *CR* comments explicitly on how much automatic washers had changed since their introduction in 1937, but "the most conspicuous difference is that the 1982 machines are very versatile—they can give you a great deal of control over the way the laundry is handled." These convenience features, including continuous water level control, temperature control, and automatic cycles, are taken into account explicitly in my quality adjustments.

However, one does note several remarks in the 1950 evaluation that suggest improvements. One 1950 machine was rated "not acceptable" because "it tangled clothes so badly and so consistently." In contrast, the only other strongly negative evaluations were for two models rated "not acceptable" in 1962 and three rated "conditionally acceptable" in 1966. We note in 1960 that, with three exceptions, "most of the remaining washers were unable to get rid of large quantities of sand, or tended occasionally to reposit some of the sand they removed onto subsequent loads" (August, 414), whereas in

1982 ''most machines do a fairly good job of getting rid of any sand that's collected in beach towels and clothing'' (October, 509). Further, lint was a problem even on the deluxe models tested in 1960: ''Many housewives complain that their washers deposit too much lint on clothes. . . . The problem of deposition is something else again; CU can offer no complete solution. The fact is that all of the machines tested . . . left some lint on the items washed'' (August, 414). In contrast, we read in 1982 that ''all the machines are designed to prevent lint from resettling on clothing during the wash.''

As for quality control, the only comment is in 1964: ''Now, as in the past, the odds are unfortunately in favor of your having some trouble with a new washer'' (September, 419). In contrast, a 1979 chart (November, 684) lists the percentage of washers needing repair as ranging from 11 percent on one-year-old models to 28 percent on ten-year-old models. Unfortunately, there is no quantitative information in *CR* to allow a comparison over time of frequency of repair records.

7.8 Clothes Dryers

The indoor clothes dryer is a comparative latecomer in the world of household appliances. It was apparently invented in 1930 by J. Ross Moore of North Dakota, who ''deplored the fact that his mother had to hang out wash in 40-below temperatures. . . . [he] designed a series of proper drying machines that could be brought into the house, although one prototype weighed 700 pounds. They didn't sell'' (Consumers' Union 1986, 234). Although clothes dryers began to sell in quantity in the early 1950s, and warranted a report by *CR* in 1951, they did not appear in the PPI until 1954 or in the CPI until 1963.

This section provides a briefer evaluation than the previous sections, mainly because there are too few models in the Sears catalog to warrant estimating hedonic regression equations. The main information consists of a comparison of ''closely similar'' models from successive *CR* product evaluations. The end of this section compares the resulting *CR* price index with an index of matched models from the Sears catalog.

7.8.1 Comparisons from *CR* Product Evaluations

The comparisons of gas and electric dryers are presented in table 7.14, which is arranged like the previous *CR* comparisons of refrigerators, room air conditioners, and automatic washing machines. Since product evaluations appeared less frequently for clothes dryers than the other products, the resulting price index extends over longer spans of years and thus may miss some year-to-year price variations. But this should not alter the accuracy of the trend rate of price change over long periods, which is the main orientation of this study.

Table 7.14 **Comparisons of "Closely Similar" Models of Clothes Dryers from *Consumer Reports*, 1951–84**

Years	Price Range (1)	Number of Models (2)	Price Change: Gas (3)	Price Change: Electric (4)	Annual Rate of Price Change: Gas (5)	Annual Rate of Price Change: Electric (6)
1. 1951–54	Low	6/6	1.6[a]	0.0[b]	0.5	0.0
2. 1954–57	Low	8/8	0.0[a]	−1.4[c]	0.0	−0.5
3. 1957–61	Low	8/8	−20.1[d]	−19.2[d]	−5.5	−5.2
4. 1961–66	High	27/20	−18.7[e]	−27.5[e]	−4.1	−6.2
5. 1961–72	Low	9/20	−20.1[f]	−20.5	−2.0	−2.1
6. 1966–74	High	20/21	−5.8[f]	−4.8	−0.7	−0.6
7. 1974–75	High	21/23	20.9[g]	15.4[g]	20.9	15.4
8. 1975–82	Medium	23/11	46.4[h]	46.2[h]	5.6	5.6
9. 1982–84	High	11/11	6.8[i]	5.2[i]	3.3	2.6

[a]1951–54 and 1954–57 price changes calculated for two matched models of the same brand both having automatic ignition, timer control, and temperature control.

[b]1951–54 price change calculated for four matched models of the same brand all having timer control and temperature control, but not having a "dryness" control.

[c]1954–57 price change calculated for six matched models of the same brand, all having timer control and temperature control, but not having high speed, automatic control, or other special features.

[d]Excludes models having automatic dryness control. No comparison for gas models is possible; gas price is estimated as $32.50 above the electric model price, based on two otherwise identical models.

[e]Excludes Easy brand, which does not have automatic dryness control.

[f]Excludes models not having automatic ignition.

[g]1975 prices are for mid-range models lacking automatic dryness control. $30 added to 1975 price to incorporate automatic dryness control, using the figure in *CR* (November 1975, 686).

[h]Medium-range models chosen rather than high-priced models since the latter contain permanent press (cool-down) cycles, "added tumble," electronic touch switches, and other features not available in 1975.

[i]1982–84 comparison based on models matched by model number (seven electric and four gas).

Like washing machines, the evolution of clothes dryers mainly involved the addition of more and more complex controls. In the first *CR* product evaluation (1951), most dryers had a simple timer or a simple temperature control, and in a few cases both. Some gas dryers had automatic ignition, but some had a pilot light that required lighting by hand each time the dryer was used. By the last report in 1984, controls had become much more complex. The top-of-the-line models rated in 1984 had not only automatic sensors that turned off the dryer when clothes were dry, but permanent press cycles and in some cases electronic switches.

Particularly in the 1950s and 1980s, the rated dryers were sufficiently heterogeneous that it was necessary to match them model by model to allow a legitimate price comparison. For instance, the 1951, 1954, and 1957 comparisons include matched models having both time and temperature controls (not "either-or") and lacking automatic dryness control, "high-speed drying," and other features. The 1951–54 and 1954–57 comparisons link prices of identical brand names. An invaluable aid was the presentation by *CR* of prices and ratings of both deluxe and economy models in 1961. This allowed the linking of the economy-model prices with the simple models of earlier years, as well as with a single further rating of economy models in 1972, and the linking of the deluxe-model prices with the more complex models of later years.

By the 1980s, the models that incorporated the same features as the deluxe models of the 1960s and 1970s had slipped to the mid-range of the price spectrum, and new features had been added to the most expensive models that had not been previously available, including permanent-press and delicate-fabric cycles, and "added tumble time" (an extended period of cool tumbling to keep clothes from wrinkling until the user has time to empty the machine). Thus, 1975 mid-range models, with their prices adjusted to incorporate automatic dryness control, are compared with 1982 mid-range models. The 1982–84 comparison is for deluxe models matched by brand and model number to have similar features.

7.8.2 Adjustments for Improvements in Energy Efficiency

CR does not present detailed model-by-model data on energy usage, but the text of each product evaluation report contains a statement regarding the energy consumption or energy cost of a load of a specified weight. The remarks are mainly included as an attempt to advise readers on the length of time needed for the lower energy usage of gas dryers than electric dryers to compensate for their higher purchase price. But the listed monthly energy cost can be used to calculate an energy-efficiency adjustment. Until 1974, the monthly electricity cost of electric dryers does not show any clear trend, as it is reported to be $3.29 in 1954, $2.93 in 1954, $2.73 in 1961, $3.61 in 1966, and $2.73 in 1974.[34] The 1966 figure seems to be inconsistent with a trend that otherwise would be slightly downward; however, there can be no misreading the text of the evaluation, which states clearly in 1966 that "it would cost you $3.38 to dry 26 loads a month with the least power-hungry dryer tested" (September, 443).

However, there is no ambiguity about the improvement in energy efficiency after 1974. Using *CR*'s own figure of $0.0775 per kWh, and noting that it had increased the dry weight of its test load from 8 to 10.5 pounds, we have monthly electricity costs of $8.65 in 1974, $8.86 in 1975, $5.17 in 1982, and $5.53 in 1984. The 1984 figure is 63.9 percent of the 1974 figure. Another consistent way of calculating the energy saving is to note (October 1984, 583) that 1984 electric dryers drew 5.4 kilowatts and required thirty minutes to dry a 10.5 pound load, for a consumption of 2.7 kWh. This implies a

34. Sometimes *CR* provides the cost per load, sometimes the cost per month, and sometimes both, using a translation factor of twenty-six loads per month. In 1957 and 1961, the electricity consumption in kWh is given per load. All figures given in the text are on an equivalent energy price basis of $0.03 per kWh.

consumption of 2.18 kWh for a load of eight pounds, or just 58 percent of the 3.75 kWh requirement explicitly stated in *CR* for 1957 (July, 308).[35]

Similar calculations for gas dryers produce a consumption in cubic feet of 13.5 in 1957, 13.0 in 1961, and 11.8 in 1974 for an eight-pound load, and 15.8 in 1974, 14.6 in 1975, 7.9 in 1982, and 7.8 in 1984 for an eleven-pound load. The 1984/1974 ratio is just 49.4 percent, an even greater proportional saving than for electric dryers.[36] To convert these figures into a quality adjustment for the improvement in energy efficiency, I make one calculation for 1954–74 using pre-1974 energy prices and an eight-pound load, and a second calculation for 1974–82 using post-1974 energy prices and a 10.5 pound load. For electricity, the present value of the saving from the 1954 monthly electricity cost of $3.29 to the 1974 monthly cost of $2.73, assuming a ten-year lifetime, comes to $58.05. Using the same method as for refrigerators and air conditioners (adding the energy saving to the base-year price), we have an adjustment factor of − 1.07 percent per year for 1954–74. The present value of the saving from the monthly electricity cost of $8.65 to the 1982 electricity cost of $5.35 is $342.12, implying an adjustment factor of − 12.93 percent per year from 1974 to 1982.[37] The present value of the saving from the 1954 monthly gas cost of $0.33 to the 1974 monthly gas cost of $0.29 is $4.31, implying an adjustment factor of a minuscule −0.08 percent per year in the twenty years before 1974. But there was a more sizable drop from the monthly gas cost of $2.42 in 1974 (calculated at post-1974 gas prices and a larger 10.5 pound load) to $1.21 in 1982, implying a present value of energy saving of $125.45 and a yearly adjustment factor of −5.73 percent.[38]

7.8.3 Alternative Price Indexes for Clothes Dryers

As with the other products, the behavior of the various price indexes displayed in table 7.15 differs over alternative subperiods of the 1951–84 period. Table 7.16 summarizes over three subintervals the CPI, PPI, Sears matched model index, and four *CR* indexes for gas and electric dryers, without and with an energy adjustment. The Sears index is calculated by the

35. In 1974, *CR* states that the cost of drying a load of eleven pounds is 1.289 times the cost of drying a load of eight pounds, for an elasticity of cost to weight of 0.77.

36. None of these figures are reported directly in *CR*. But the text of the evaluations provides enough information to make the necessary calculations. For instance, in 1975 we read that with gas at $0.25 per 100,000 BTU and electricity at $0.09 per kWh, 300 eleven-pound loads would cost $11.58 for gas and another $6.75 for electricity to run the dryer's motor. At 1,055 BTU per cubic foot, the price becomes $0.2637 per 100 cubic feet. A cost of $11.58 per 300 loads implies a cost per load of $0.0386, or 14.64 cubic feet of gas (and 0.25 kWh of electricity) per load.

37. I choose the period 1974–82 rather than 1974–84, since the transition to lower energy usage had already occurred by 1982. To make the adjustment slightly more conservative, I take the average of the 1982 and 1984 monthly electricity cost figures rather than the lower 1982 figure.

38. I use the gas price in the 1984 *CR* evaluation of $0.617 per therm, which is less than the 1982 price of $0.7 per therm.

Table 7.15 Alternative Price Indexes for Clothes Dryers, 1951–83 (1967 = 100)

				Consumer Reports			
				Without Energy Adjustment		With Energy Adjustment	
Year	CPI (1)	PPI (12-41-02-32) (2)	Sears Matched Models (3)	Gas (4)	Electric (5)	Gas (6)	Electric (7)
1951	...	...	...	144.8	155.1	146.1	179.2
1952	...	...	...	145.5	155.1	146.8	179.2
1953	...	...	...	146.4	155.1	147.6	179.2
1954	...	103.4	144.6	147.1	155.1	148.4	179.2
1955	...	100.5	118.0	147.1	154.3	148.3	176.3
1956	...	102.5	113.3	147.1	153.6	148.3	173.6
1957	...	106.5	108.4	147.1	152.8	148.2	170.9
1958	...	106.5	108.4	139.2	145.1	140.2	160.5
1959	...	108.7	116.9	131.8	137.7	132.6	150.8
1960	...	105.2	116.9	124.7	130.7	125.4	141.6
1961	...	103.5	100.6	118.0	124.1	118.6	133.0
1962	...	102.3	110.8	114.5	119.2	115.0	126.3
1963	105.8	102.3	112.0	110.1	114.5	110.4	119.8
1964	105.5	101.0	112.0	107.7	109.9	108.0	113.7
1965	103.0	97.8	108.4	104.5	105.5	104.7	107.9
1966	100.0	98.1	93.9	101.4	101.4	101.4	102.4
1967	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1968	103.1	102.6	100.0	98.6	98.6	98.5	97.6
1969	105.2	104.9	104.8	97.3	97.3	97.2	95.3
1970	108.4	108.4	113.3	96.0	96.0	95.8	93.0
1971	112.4	110.1	120.5	94.7	94.7	94.4	90.8
1972	114.2	108.8	120.5	93.4	93.5	93.1	88.6
1973	114.4	110.8	120.5	92.8	92.9	92.4	87.2
1974	121.4	120.7	130.1	92.2	92.3	91.7	85.7
1975	136.7	134.8	156.6	113.6	107.8	106.7	87.8
1976	148.6	148.8	169.8	120.1	113.9	106.6	81.6
1977	155.1	154.0	175.9	127.1	120.5	106.4	75.9
1978	163.7	161.2	162.6	134.4	127.4	106.3	70.5
1979	174.5	172.3	206.0	142.1	134.8	106.1	65.5
1980	188.3	191.4	215.7	150.3	142.5	106.0	60.9
1981	201.8	207.0	236.1	158.9	150.8	105.8	56.6
1982	216.5	223.6	260.2	168.1	159.4	105.7	52.6
1983	226.2	232.5	283.1	173.8	163.6	109.3	54.0
1984	231.8	238.7	...	179.6	168.0	112.9	55.4

methods described in detail in chapter 10. The subintervals are 1954–63, 1963–74, and 1974–83, and the full 1954–83 period (1954 is the first year of the PPI; the 1963 break point corresponds to the first year of the CPI; and the 1974 break point corresponds to the year that divides the two subintervals of our energy adjustment).

These annual growth rates indicate a relatively close correspondence of the Sears and *CR* no-energy indexes in the first subinterval, and between the PPI and the Sears indexes in the second subinterval. The CPI, PPI, and *CR* no-energy indexes are also quite close together in the final subinterval. The greater rate of price decline in the *CR* no-energy indexes than in the Sears

Table 7.16 **Annual Percent Growth Rates of Alternative Price Indexes for Clothes Dryers, 1954–83 and Subintervals**

	1954–63	1963–74	1974–83	1954–83
CPI	. . .	1.26	7.16	. . .
PPI	−0.11	0.73	7.55	2.83
Sears matched model	−2.80	0.67	9.02	2.34
CR gas no energy	−3.17	−1.60	7.30	0.57
CR electric no energy	−3.31	−1.94	6.57	0.18
CR gas with energy	−3.23	−1.67	1.97	−1.05
CR electric with energy	−4.38	−3.00	−5.00	−4.05

index between 1963 and 1974 may be the counterpart of the gradual shift in Sears's location in the price structure from well below average to average. The rapid rate of increase in the Sears index after 1974 is something of a puzzle that should be resolved.[39] As for the *CR* indexes incorporating the energy adjustments, these are dependent on the validity of the same assumptions used to calculate the energy adjustments for refrigerators and room air conditioners, namely the use of a 3 percent discount rate and the evaluation of post-1974 energy savings at the energy prices of the early 1980s.

7.8.4 Unmeasured Dimensions of Quality Improvement

Like washers, dryers have mainly improved over the years through the addition of extra controls and convenience features. Because models with comparable features are linked in table 7.14, there are few additional dimensions of quality change to discuss. By far the most important is the remarkable improvement in energy efficiency achieved in an appliance that (at least for electric dryers, which account for about two-thirds of sales) over its lifetime consumes electricity worth more than double its purchase price (125 percent more at 1972 prices and 100 percent more at 1982 prices).

The only evidence of quality improvement along other dimensions appears in 1957, when *CR* (July, 308) wrote that "you can buy a better dryer today than you could three years ago," and cited two major improvements (lower temperatures and faster drying speed) and several minor additions that are not taken into account in the explicit quality adjustments (shut-off switch when door is opened, foot-pedal door openers, and magnetic door closers). Another area of improvement may have been larger capacity, although no explicit comments are made on this issue. The chief hint that capacity increased is that *CR*'s "standard load" for testing and the calculation of energy costs was eight pounds until 1974, both eight and eleven pounds in 1974 and 1975, and 10.5 pounds thereafter. In 1966, but not before, *CR* mentions testing dryers with a twelve-pound load on which "they still performed quite well." Since it seems

39. As of this writing, I have not had the opportunity to attempt to match Sears models in the catalog to those rated by *CR*.

clear from the previous section that the capacity of automatic washing machines increased significantly, it makes sense to infer that dryer capacities must have increased as well. However, I have no basis on which to make a quantitative adjustment for increased capacity, and so I leave this as one dimension of improvement that suggests that my *CR* index may not adjust sufficiently for quality change.

7.9 TV Sets

No consumer product has improved more over the postwar era taken as a whole than TV sets. It is startling to look back and discover that, in September 1946, RCA introduced the first black-and-white (B&W) table model with a 10-inch diagonal screen for a selling price of $375, plus $50 for installation and the first year's service.[40] A Rip Van Winkle who had gone to sleep in 1946 and woken up in 1986 would have been dazzled by the incredibly sharp and bright picture on a 19-inch color TV set that sold for just $168.[41] In contrast to this history, the price decline registered by the CPI price index for TV sets from its inception in 1950 to 1984 is just 40 percent. It seems likely that a careful attempt to link the prices of "closely similar" models over the postwar period would yield a price index that declines by substantially more than this.

The first half of the postwar era was dominated by B&W receivers. Although TV was invented before World War II and demonstrated at the New York World's Fair of 1939, mass production of TV sets did not become feasible until 1946–47, when the first stations went on the air on a full-time basis. Even as large a city as San Francisco did not have a single TV station until 1948. Yet by 1949 the production and sales of TV sets had taken off, with 3 million sets sold in that year (see table 7.1 above). Quality changes for B&W sets over the postwar period have included increases in picture size, improvements in picture quality, reductions in weight that made possible portable sets, and a decreased incidence of service calls.

The current broadcast system for color TV was adopted in 1953, but the first color sets produced to meet this standard were unsuccessful in the marketplace. RCA managed to sell only thirty of its $1,000 set in its first month on the market in 1955. Only in the 1965–66 season did all three networks begin to broadcast most of their evening programs in color, after years when RCA's NBC division had run scattered programming in a feeble

40. "The RCA TS630, c. 1946, had a 10-inch picture tube and weighed 85 pounds. . . . The first mass-produced model, the TS630 made television ownership practical and possible for many, opening the way for the age of television" (*CR*, January 1954).

41. This was a 19-inch set with remote control advertised by a chain store in the *Chicago Tribune* on 23 October 1986. It is an extreme example, but there were many different chains advertising 19-inch sets with quartz tuning, automatic fine tuning, and remote control in the price range of $279–$298 during the same week.

attempt to sell color sets. Not until 1973 were half of U.S. homes equipped with color sets. Color sets did not outsell black and white sets in numbers until 1972, but in value they became dominant several years earlier. And the improvement in quality of color sets from the 1960s to the 1980s has been phenomenal: "Those venturesome consumers who bought color sets in the 1960s were plagued by the difficulty of tuning them and by inordinately frequent, lengthy, and expensive repairs. 'Of all types of products, only autos generate more complaints,' *CR* wrote in its May 1968 issue" (Consumers' Union 1986, 34).

The goal of this section is to quantify improvements in quality along as many dimensions as possible, while admitting in advance that some dimensions, particularly picture quality and portability, are inherently unquantifiable. The year-by-year comparisons are set out in table 7.17, which exhibits thirty-nine different pairwise comparisons of particular types of TV sets. In some years, *CR* published as many as two or three evaluations of TV sets of different sizes and types. Only two or three of these comparisons are excluded, and so table 7.17 summarizes essentially *all* the information of prices of TV sets in *CR* over the four decades between 1947 and 1986.[42] A total of 384 models is included in the comparisons, a figure taken as the sum of the number of models listed for the first year of each comparison in column 2 of table 7.17.

Just as refrigerators are separated into separate categories by type of defrost and location of freezer for the comparisons of "closely similar models," here TV sets are subdivided by B&W or color, size of screen, and type of cabinet (console, table model, or portable). As the string of zeros in column 4 demonstrates, it is possible to make most pairwise comparisons of a given type of TV set without any explicit adjustment for quality change. This section describes the major adjustments that were made. The comparison in row 12 includes an allowance for the introduction of a bonded picture tube, using a *CR* statement about the difference in cost, and an arbitrary $10 allowance for increased ease of servicing from the introduction of pull-out chassis units. The 1965–67 comparison in row 19 involves an allowance for the introduction of UHF tuners, using the price difference between VHF-only and VHF-UHF tuners listed in 1965.

Several other adjustments are made, sometimes involving arbitrary but plausible estimation of the value of particular features, including $20 for a cart when included for a portable set, $20 for the addition of quick warmup and automatic or one-button fine tuning, and $5 for a cable connection.

42. The exceptions are a 1957 evaluation of 14-inch B&W sets, which could not be directly compared with the same size of set for either earlier or later years; a 1960 evaluation of "minor-brand" B&W consoles, which I felt might not be fully comparable to the major brand sets; and a 1981 evaluation of 19-inch color sets loaded with all conceivable "bells and whistles" and sold at very high prices, with no information provided on less-complex models that would be comparable to the 19-inch sets included for earlier years.

Table 7.17 **Comparisons of "Closely Similar" Models of Television Sets from *Consumer Reports*, 1947–84**

Years	Type (1)	Number of Models (2)	Price Change (3)	Quality Adjustment (4)	Annual Rate of Price Change (5)
1. 1947–48	10" table B&W	1/1	−13.3[a]	0.0	−13.3
2. 1948–49	10" table B&W	4/10	−21.9	0.0	−21.9
3. 1949–50	12" table B&W	5/8	−38.1	0.0	−38.1
4. 1949–51	16" table B&W	1/7	−33.2[b]	0.0	−18.3
5. 1951–52	17" table B&W	7/7	−21.9	0.0	−21.9
6. 1952–53	21" table B&W	9/10	−12.9[c]	0.0	−12.9
7. 1953–55	21" table B&W	10/10	−21.9	0.0	−11.6
8. 1955–57	21" table B&W	10/7	12.8	0.0	6.2
9. 1957–58	21" table B&W	7/10	−1.9	0.0	−1.9
10. 1958–59	17" portable B&W	7/17	−0.6	0.0	−0.6
11. 1959–61	17/19" portable B&W	17/13	13.0	−16.6[d]	−1.8
12. 1961–62	19" portable B&W	13/14	−5.2	0.0	−5.2
13. 1961–62	23" console B&W	14/14	−2.7	0.0	−2.7
14. 1962–63	19" portable B&W	14/15	−17.9	0.0	−17.9
15. 1962–64	23" console B&W	14/15	−3.5	0.0	−1.8
16. 1963–65	19" portable B&W	15/14	−2.1	0.0	−1.1
17. 1964–66	23" console color	1/2	−18.8	0.0	−9.9
18. 1965–66	25" console color	1/3	−4.7	0.0	−4.7
19. 1965–67	19"/18" portable B&W	14/15	−5.0	−6.0[e]	−5.7
20. 1966–68	23" console color	2/9	4.7	0.0	4.7
21. 1967–68	18" portable B&W	15/5	4.2	0.0	4.2
22. 1967–68	23" console color	10/9	−10.3	0.0	−10.3
23. 1966–73	12" portable B&W	11/12	−1.7[f]	0.0	−0.2
24. 1968–70	23" console color	9/7	7.5[g]	0.0	3.7
25. 1968–73	19" portable B&W	5/8	15.4	−7.1[h]	1.6
26. 1969–71	19" table color	15/17	4.5	−4.5[i]	0.0
27. 1970–72	23" console color	7/6	−17.2	0.0	−9.0
28. 1973–74	12" portable B&W	12/12	6.3[f]	0.0	6.3
29. 1972–74	25" console color	7/11	7.7	−4.2[k]	1.7
30. 1971–73	19" table color	17/15	8.2	5.0[j]	1.6
31. 1973–75	19" table color	15/15	9.9	0.0	4.8
32. 1973–76	19" portable B&W	8/11	0.5	0.0	0.2
33. 1974–77	12" portable B&W	12/10	3.6	0.0	1.2
34. 1974–77	25" console color	11/12	12.1	0.0	3.9
35. 1975–78	19" table color	15/15	3.9	0.0	1.3
36. 1977–80	12" portable B&W	10/14	−5.7	0.0	−1.9
37. 1977–80	25" console color	12/11	6.4[l]	0.0	2.1
38. 1979–85	13" portable color	16/21	−13.5	−1.4[m]	−2.7
39. 1980–82	12" portable B&W	14/16	3.6	0.0	1.8
40. 1980–86	25" console color	11/14	−28.9	0.0	−5.5

[a]Based on price history for RCA given in *CR* (July 1950, 297). 1947 price is that listed for September 1946, and 1948 price is that listed for September 1947, which corresponds also to the price listed in the January 1948 report.

[b]Sixteen inch in 1949, seventeen inch in 1951.

[c]Prices in the January 1953 *CR* were used for 1952, November 1953 used for 1953.

[d]*CR* states that the new nineteen-inch screen was 5.5 percent larger than the old seventeen-inch screen; 5.5 percent was added to the 1959 price to make the quality adjustment, based on an approximate unitary elasticity of price to screen size implied by picture tube (for *CR* $10 figure, see January 1961, 9) and $10 for improved serviceability (10). A 1957 comment states that a seventeen-inch set was priced 20 percent higher than an otherwise comparable fourteen-inch set.

Table 7.17 (continued)

[e]1965 models listed both with and without UHF tuners. 1967 UHF models compared with 1965 UHF-equipped models. No adjustment made for picture size, since *CR* states that the new-style eighteen-inch is equivalent to the old-style nineteen inch.

[f]Excludes Sony in 1973 and 1974 (not sold in 1966).

[g]Includes only models without remote control.

[h]Half include a cart in 1973. Allowing $20 as the value of the cart, $10 is deducted from the 1973 price. Also, all models have automatic VHF tuning.

[i]In 1969, all lack automatic fine tuning; in 1971, all have this feature. To adjust for this improvement, the quality change is arbitrarily set equal to the price change.

[j]$25.00 arbitrary adjustment for addition of quick warm-up, cable connection, and one-button tuning.

[k]$20.00 arbitrary adjustment for addition of quick warm-up and one-button tuning.

[l]Average prices exclude Sony and models with quartz tuning.

[m]1985 price adjusted downward $5.00 to allow for incorporation of cable connection.

[n]Rated models in 1986 include stereo, multiple audio and video jacks, remote control, and ability to handle twenty-three or more cable channels. However, prices are given for models excluding all these features that are comparable to models sold in 1980 and prior years.

Balancing any possible overestimate of the value of these improvements is the failure to allow for other additional features (e.g., lighted channel numbers and automatic color control). Also, the degree of similarity across models in particular comparisons is improved by excluding sets that had an attribute not available in an earlier year, including remote control, quartz tuning, stereo speakers, multiple audio and video jacks, and tuners able to handle more than the original eighty-two VHF-UHF channels.[43]

7.9.1 Improved Service Reliability and Reduced Energy Consumption

One estimate (*Consumer Appliances*, n.d., 13) divided up the lifetime cost of owning a color TV set into 53 percent for the purchase price, 35 percent for servicing costs, and 12 percent for electrical power costs. While costs other than the purchase price were not as large a share of the lifetime cost of TV sets as of refrigerators, nevertheless reductions in servicing costs and energy costs over time have been a major component of quality change. The details of the adjustments are laid out in table 7.18, where the top half refers to color TV sets and the bottom half to B&W sets. Using information from the MIT report and from *CR* product evaluations, it is possible to piece together the history of improvements in the incidence of repairs and of reductions in energy use. The sources tell a straightforward and relatively consistent story of a reduction

43. Some idea of the wide variety of new features on top-of-the-line TV sets in the 1980s can be gleaned from *CR* (January 1986, 16–17). Some, most, or all of these sets included quartz frequency-synthesized tuners with channels preprogrammed at the factory and allowing the change from one channel to any other while skipping any in between, stereo decoder and speakers, infrared wireless remote control, a self-censor feature to block children from watching particular channels, cable-readiness for up to 125 cable channels, a comb filter to increase resolution by about 20 percent (not available until "a few years ago"), direct video and audio inputs for using a VCR or computer, room-light sensor, one-button control to lock picture adjustments into a preset range, sleep timers, last-channel recall, and screen shield.

Table 7.18 **Repair and Energy Costs of Television Sets, Various Years and Intervals**

Year	Estimated Lifetime Repair Incidence (1)	Cost per Repair (2)	Lifetime Repair Cost (3)	Energy Use (watts) (4)	Adjustments (percent) Repairs (5)	Adjustments (percent) Energy (6)
Color:						
1964	11.0[a]	$20[b]	$220	350[j]	. . .	. . .
1972	5.5[c]	30[b]	165	200[j]	−11.8	−7.5
1978	2.2[d]	45[e]	99	150[k]	−12.7	−6.2
1981	1.5[f]	65[f]	98	116[l]	−5.2	−3.9
1986	0.8[g]	80[h]	64	. . .	−7.3	. . .
B&W:						
1948	10.0[i]	10[i]	100	230[m]	. . .	. . .
1964	4.4[i]	10	44	200[n]	−18.2	−4.1
1972	2.2[i]	15	33	110[o]	−10.8	−17.8
1978	0.9	23	21	73[o]	−8.5	−19.9
1981	0.6	36	22	60[p]	−3.5	−6.4
1986	0.3	40	12	. . .	−5.5	. . .

[a]Two repairs in the first year, from *Consumer Appliances* (n.d., 25) and one repair per year thereafter (*CR*, May 1969, 258).

[b]*Consumer Appliances* (n.d., 24).

[c]One repair in the first year from *Consumer Appliances* (n.d., 25) and one repair every two years thereafter (*CR*, January 1972, 15).

[d]Interpolated between 1972 and 1981.

[e]*CR*, January 1978, 14.

[f]Average set required .125 repairs in a given year (*CR*, January 1981, 36). Repair cost of $65 for average set from the same source.

[g]*CR* (January 1986, 16) states that 40 percent of sets bought in 1980 have needed at least one repair, and 10 percent of sets bought in 1984.

[h]Estimated on basis of growth in an economy-wide wage index.

[i]1974 and 1972 incidence for B&W sets is half that for color sets, from *Consumer Appliances* (n.d., 25). Forty percent figure used for other years, and 1950 figure is estimated. B&W cost per repair for 1981 from *CR* (January 1981, 36) estimated to be half color cost in other years. Cost for 1948 is based on a *CR* statement that RCA offered a service contract for an unspecified flat fee plus $5.95 per visit, implying that the cost per visit paid for without a contract must have exceeded $5.95. Also, note that all makes reviewed in January 1948 (10) offered installation plus a one-year parts and labor warranty for $55 above the listed price of the set, which apparently did not include any warranty. *CR* (July 1949, 302) estimates the yearly cost of repairs and service at $50.

[j]*Consumer Appliances* (n.d., 9) states that power consumption had been reduced from 300–400 watts on earlier all-tube sets to "as few as 140 watts in some of today's solid-state sets." On this basis, 1964 was set at 350 watts and 1972 at 200, on the grounds that not all sets sold in 1972 were solid state.

[k]Interpolated between 1972 and 1981.

[l]Average of actual reported figures in ratings of twenty-five-inch consoles from *CR* (January 1980).

[m]Power consumption range of 210–250 watts given in *CR* (January 1948), and 150–300 watts in *CR* (July 1949, 302).

[n]*CR* (January 1967) states that a B&W set was 200 watts, in comparison to 350 watts for a typical color set.

[o]Interpolated from 1964 to 1981.

[p]Nineteen-inch color sets had a power consumption ranging from 61 to 115 watts, with a mean of 88 watts (*CR*, January 1981). Power use of B&W sets, which are mainly sold in smaller sizes, is set at 60 watts, the lower end of the range for nineteen-inch color sets.

in servicing requirements by a factor of more than ten for color TV sets between 1964 and 1986, and by combining the same sources with plausible guesses, we arrive at an improvement in the repair incidence of B&W TV sets by a factor of thirty between 1950 and 1986.[44] The basic source of evidence on the improvement in repair incidence, the *CR* frequency of repair surveys, is particularly good, since it is based on hundreds of thousands of questionnaire responses.

The data on energy usage in table 7.18 are also pieced together from both the MIT report and *CR* product evaluations. Fortunately, both sources provide a consistent figure of 350 watts of power consumption for the color TV sets of the mid-1960s, and *CR* has a model-by-model listing of power consumption (averaging 116 watts) in 1980. I take no account of any added power requirements of the many extra features present on 1980 sets compared to 1964 sets. For B&W sets, we also have two consistent figures for power consumption in the late 1940s and one little-changed consumption figure for the mid-1960s. The real saving in energy use came in the 1970s with the transition to all solid-state sets, and in the column 4 of table 7.18 this is phased in gradually between 1964 and 1981.

In valuing the saving in repair costs and electricity consumption, I use the same 3 percent discount rate as in the previous calculations for refrigerators, room air conditioners, and clothes dryers. The assumed lifetime is ten years, taken from the MIT report (11). If anything, these estimates may be on the conservative side, since, even without applying a discount factor, the $165 lifetime repair cost for 1972 (table 7.18, col. 3) plus the implied $87.60 power cost is well under the price of a typical color TV set ($650 for a 25-inch color console and about $430 for a 19-inch table model), whereas the MIT report states that for 1972 the lifetime cost of repair and energy consumption is 47/53 of the purchase price. Also, the 1948 figure for repair costs on the early B&W sets implies a yearly cost of just $10, in contrast to the explicit statement in *CR* (July 1949, 302) that purchasers should plan on a $50 annual repair and servicing cost over the lifetime of a TV set, and that power and servicing made up 63 percent of the lifetime cost of owning a TV set, even when a seven-year lifetime was assumed. Thus, there is a good case for believing that the price indexes adjusted for the reduced cost of service and energy, as presented in the next section, may significantly understate the true reduction in price achieved by continuous technical advances by the firms manufacturing TV sets.

44. The only inconsistency is that the MIT report (*Consumer Appliances*, n.d.) states that color TV sets in 1965 required an average of two service calls per year and in 1972 one service call per year (23). However, the results of the *CR* frequency-of-repair questionnaire cited in nn. a and c to table 7.18 yielded an estimate of once per year in 1969 for sets manufactured between 1964 and 1968, and once every two years in 1972 for sets manufactured through 1972. I combine the lower *CR* figures with the MIT figures for the incidence of repair in the first year of ownership.

Table 7.19 Alternative Prices for Television Sets, 1947–84 (1967 = 100)

				Consumer Reports	
Years	CPI	PPI (12-52)	Sears Matched Models	Unadjusted for Repairs and Energy	Adjusted for Repairs and Energy
1947	...	...	...	505.1	723.9
1948	...	...	...	442.2	623.7
1949	...	...	...	355.2	493.1
1950	159.7	...	...	267.9	366.0
1951	156.3	...	...	223.1	300.0
1952	137.9	124.1	220.9	179.2	237.1
1953	132.6	124.1	199.1	157.5	205.1
1954	123.9	118.5	159.4	140.3	179.8
1955	116.8	115.1	142.5	124.9	157.5
1956	117.3	116.0	139.6	132.9	165.0
1957	122.4	117.4	145.2	141.4	172.7
1958	124.6	117.7	145.2	138.7	166.8
1959	126.2	116.3	149.1	137.9	163.2
1960	127.1	114.9	140.6	135.5	160.2
1961	123.8	113.8	122.6	133.0	157.4
1962	117.7	110.3	122.6	127.9	148.9
1963	114.7	108.1	122.6	115.9	132.8
1964	112.1	106.4	112.3	114.2	126.5
1965	107.3	103.6	108.5	108.2	115.7
1966	102.1	101.8	100.0	100.5	104.0
1967	100.0	100.0	100.0	100.0	100.0
1968	99.8	97.5	100.0	102.9	99.5
1969	99.6	92.6	100.0	104.7	97.8
1970	99.8	91.9	96.2	106.1	95.8
1971	100.1	92.8	98.1	104.1	90.8
1972	99.5	90.7	94.3	102.5	86.5
1973	98.0	88.4	94.3	103.7	83.7
1974	98.9	88.9	103.8	107.1	82.8
1975	101.6	92.2	103.8	109.9	81.3
1976	102.9	91.8	109.4	111.7	79.0
1977	101.7	85.6	109.4	114.1	77.3
1978	101.6	84.4	113.2	114.7	74.3
1979	103.0	85.8	113.2	114.8	72.0
1980	104.4	89.0	107.5	113.9	69.1
1981	105.3	88.3	107.5	111.5	65.5
1982	103.9	86.1	109.4	109.1	63.3
1983	100.3	83.2	109.4	104.7	60.0
1984	95.3	80.0	...	100.5	56.8

7.9.2 Alternative Price Indexes for TV Sets

The alternative price indexes for TV sets are presented in table 7.19. Table 7.20 contrasts the CPI and PPI with three other indexes, a matched model index from the Sears catalog (compiled by the same method as for clothes dryers, as described in chap. 10), and two *CR* indexes for "closely similar models", both without and with adjustments for reductions in the costs of repairs and power consumption. The break years are 1950 (the first year of the

Table 7.20 Annual Percent Growth Rates of Alternative Price Indexes for Television Sets, 1950–83 and Subintervals

	1950–72	1952–72	1972–83	1952–83
CPI	−2.13	−1.62	0.07	−1.02
PPI	. . .	−1.56	−0.78	−1.28
Sears matched model	. . .	−4.17	1.36	−2.24
CR unadjusted	−4.27	−2.67	0.19	−1.72
CR adjusted for repairs and energy	−6.35	−4.92	−3.27	−4.34

CPI), 1952 (the first year of the PPI and the Sears index), and 1972. The final year is 1983.

Ignoring the *CR* index that is adjusted for the decline in repair and power costs, the main disagreement among the indexes in table 7.20 occurs before 1972, when both the Sears and the *CR* indexes indicate more rapid rates of price decline than the CPI or PPI. Particularly interesting are the almost identical annual growth rates of the CPI and unadjusted *CR* indexes after 1972. TV sets represent the only product category for which the pre-1972 Sears index declines at an appreciably faster rate than the unadjusted *CR* index. Such a discrepancy might occur because the *CR* index links together the model types that appear in the product evaluations, whereas the Sears index represents a broader range of model types in the year-to-year price comparisons. In particular, the decline in the Sears index relative to the unadjusted *CR* index occurs in the 1950s, when the *CR* index is based mainly on a single model type for each pair of years. Possibly new types of models registering greater price declines were introduced more rapidly into the Sears catalog than into the *CR* testing program. A further discrepancy is in the more rapid rate of increase of the Sears index than the unadjusted *CR* index after 1972; this also occurs for clothes dryers and may reflect a shift in marketing strategy that resulted in an upward adjustment of Sears's rank in the price-quality ranking.

7.9.3 Unmeasured Dimensions of Quality Improvement

While the *CR* price indexes developed above incorporate quantitative adjustments for the addition of particular features to TV sets, and while a second index includes adjustments for reduced repair and energy costs, there remain other dimensions of improvement for which no adjustments have been made. The most important of these are the improved provision of warranties and a continuous improvement in picture quality.

No adjustment is made for warranties, because it is difficult to put together a consistent time series, and because the valuation of warranties is complex, in light of changes in repair incidence that have occurred. But there seems little doubt that consumers receive better warranty protection now than they did in the late 1940s. The prices of TV sets in the *CR* index for 1948 do not include the extra $55 that was charged for installation and first-year service; of this, in-text comments by *CR* indicate that about $15 was for installation and the rest was for service. The introduction of the one-year warranty apparently dates to the 1960s:

> Since the advent of the consumer advocacy movement in the early 1960s, the television industry has seen the one-year labor and parts warranty become an industry standard, primarily due to consumer and competitive pressures that caused manufacturers to assume greater responsibility for early failures of their products. This is a vast change from prior warranty practices which had manufacturers typically assuming responsibility only for parts failures during the first 90 days of ownership, putting much heavier service-cost burden on the consumer. [*Consumer Appliance*, n.d., 15]

The *CR* ratings of January 1974 confirm the MIT statement; all sets are listed as including not just a two-year warranty on the picture tube, but also a one-year warranty on parts and labor, while one set offered a two-year warranty on parts and labor and another a four-year warranty on parts and the picture tube. By 1986, matters had become more complex. The two-year warranty on the picture tube was still almost universal for the eighteen sets listed, with the only exceptions being one case of thirty months and one of forty-eight months. Parts warranties were thirteen cases of one year, three of two years, one of thirty months, and one of forty-eight months. Labor warranties included seven of three months, eight of twelve months, and one each of twenty-four, thirty, and forty-eight months. It is difficult to place a value on improved warranty coverage, although the MIT report (15) places a value of $3.00 per set on the ninety-day parts-only warranty common before the mid-1960s, and a value of $25 per set for the period 1969–72. This difference would reduce the *CR* price index by another 5 percent over the period when the extended warranty was introduced, presumably the mid-1960s.

The record on improved picture quality consists of a series of quotes from *CR* over the years. In 1950, five of fourteen rated sets were labeled "poor" or "unacceptable" in regard to their picture quality. By 1953, we read that all nine receivers tested were acceptable, and that "the performance of most of the sets was appreciably better than the TV sets of the same brands which CU tested in 1952" (January, 15). There was a brief period of quality deterioration noted in 1962; most of the sets suffered from "pincushion distortion" and "horizontal nonlinearity," apparently as the consequence of a shift to shorter picture tubes that allowed "slim sets." But by 1967 there was no mention of these problems, and "the top-ranked sets showed clearer, crisper pictures than any we have seen for a number of years" (March, 135).

As for color sets, *CR* branded their picture quality universally poor in 1964. In 1968, the complaint was the difficulty of tuning: "Troublesome as color adjustment is, most users would probably accept the bother cheerfully if they could get it over with at the start of each viewing session'' (January, 17). But matters improved rapidly. By 1972, large consoles as well as 19-inch table sets were equipped with automatic fine tuning and automatic gain control, and ''the picture quality of the three check-rated models was just about the best we've ever seen'' (January 1972, 8). In January 1978 (13), we find that ''the technology needed to produce a fine color television picture has apparently reached the point where every TV manufacturer can turn the trick. All fifteen of the 19-inch sets CU tested for this report delivered pictures of very high quality.'' By 1980, we read that, ''as a group, all the tested sets proved admirably sharp'' and that the new quartz tuners were ''very impressive'' (January, 13). Finally, in January 1981 (34), ''CU's tests suggest that good picture quality can almost be taken for granted in today's color-TV sets. A majority of the sets delivered a picture that was nearly as good as the picture on the 'state-of-the-art' receiver/monitor in our laboratory.''

There is other confirming evidence on improved quality. Comparing 1974 TV sets with their 1967 counterparts, Kleinfield (1974) wrote: ''Today's color set differs from its 1967 counterpart in that it is all solid-state, its parts last longer and are easier to service, it consumes less electricity, it is two to four times brighter, it has better contrast and it has automatic tuning.'' In a more recent evaluation, Fantel (1984) wrote that, on the latest models, ''The first thing you notice is that the picture is sharper, brighter, and more ''contrasty'' in broad daylight. . . . The main reason the picture is sharper than in the past is that many of the better sets use a so-called comb filter, which separates the color signal from the black-and-white signal. Up to now this fancy circuit was too bulky and expensive to use in TV sets. . . . But in recent years new electronic chips have been developed to perform these filter functions.'' Fantel (1986) quantifies the improvement further: ''In the specifications of a television set or video monitor, resolution . . . is indicated mainly by the horizontal line count. . . . Over the years, video designers have been working hard, and with considerable success, to increase the count. Only a short time ago, horizontal line counts as low as 230 were not uncommon. Today, some of the best sets go as high as 500.'' Other dimensions of quality improvement in TV sets, cited by Fantel (1984), include the addition of terminals for connecting VCRs, reduction of optical distortion in better-shaped picture tubes made possible by better glass-molding methods, the use of a ''black matrix'' to improve contrast and reduce reflections, and reduction in picture shrinkage and ''overscan,'' allowing the full transmitted picture to be routinely displayed.

7.10 Other Products

While the evaluation of appliance prices in this chapter has treated some of the most important consumer durable goods, others have been omitted. Taking the figures for 1983 in table 7.1, the most important omissions by value of

Table 7.21 **Comparisons of "Closely Similar" Models of Three Products from Consumer Reports**

	Type[a]	Number of Models	Price Change
Under-counter dishwashers:			
1. 1952–65	A	4/4	−34.3
2. 1965–71	A	4/3	0.7
3. 1965–71	B	9/6	−4.5
4. 1971–74	A	3/1	−18.9
5. 1971–74	B	6/8	−11.2
6. 1971–74	C	7/6	−12.4
7. 1974–80	B	8/2	26.3
8. 1974–80	C	6/10	41.8
9. 1980–83	B	2/1	6.1
10. 1980–83	C	10/8	22.2
Microwave ovens:			
1. 1968–73	A	1/12	−24.8
2. 1973–76	A	12/5	−22.3
3. 1976–81	B	11/7	−6.0
4. 1981–85	C	10/5	−47.3
Videocassette recorders:			
1. 1980–82	A	3/4	−38.7
2. 1982–85	B	4/8	−65.0

[a]*Dishwashers:* type A: one cycle only; type B: basic cycle and rinse-hold cycle; includes dispenser and rinse conditioner; type C: at least three cycles, including heavy duty, scour, or pots and pans. *Microwave ovens:* type A: only one heat setting, mechanical controls; type B: basic setting and at least one reduced setting; type C: temperature probe, variable heat settings, touch panel controls with facility for more than one programmable setting. *Videocassette recorders*: (VHS only): type A: two heads, wire remote with pause control only, no search; type B: multifunction infrared remote, two heads, fourteen-day multiprogram capability, cable ready.

shipments are kitchen ranges, dishwashers, microwave ovens, and VCRs. I do not compute a price index for gas or electric kitchen ranges, because *CR* product evaluations have appeared only infrequently, making it difficult to control for the numerous relevant quality characteristics of this complex product. However, it is feasible to develop *CR* price indexes of "closely similar" models for the other three products. In order to limit the scope of this chapter, each of the three indexes is described more briefly in this section than the other five products treated previously.

7.10.1 Under-Counter Dishwashers

The automatic electric dishwasher is a postwar product, introduced at about the same time in the late 1940s as the clothes dryer, and accounting for about the same value of shipments (as shown by the weights in the notes to table 7.23 below). Although not introduced into the PPI until December 1966, *CR* rated under-counter dishwashers as early as 1952. Measures of price change displayed in the top section of table 7.21 are based on six *CR* evaluations between 1952 and 1983.[45] The only quality adjustment made prior to

45. There was also a report in 1959, but this could not be included here as the *CR* volume was missing from the Northwestern library at the time this chapter was written.

calculating the price change between pairs of years was to sort the rated models into three type classes differing by the number of automatic cycles.

Because 1952 models had only one basic cycle, just this simple type (A) could be compared between 1952 and 1966. However, for the other pairs of years, at least two model types could be compared, and three for 1971–74. Both types B and C have more than one cycle; type B machines have a basic cycle and a rinse-hold cycle, while type C machines add a heavy-duty wash cycle (called variously "extended wash," "scour," "pots-and-pans," or other such names). Machines became still more complex in the 1980s, and to maintain homogeneity I omitted complex models having such features as heater turnoff, choice of 120- or 140-degree water temperature, or all push-button control.

As shown in table 7.22, the resulting *CR* price index declines during the 1952–65 period, when there was no PPI, and increases at only about half the rate of the PPI after 1966. Nevertheless, there are at least four reasons to suspect that the *CR* index may understate the extent of quality improvements and thus overstate the rate of price increase. First, dishwashers appear to have increased in capacity (as did automatic washing machines and clothes dryers). In 1952, larger models were reported to accommodate eight place settings, while the rest held six settings. However, by 1980, *CR*'s standard test load was ten place settings, and several models held eleven. Second, performance improved. *CR* wrote in 1965 that "all do wash better than most of the models tested in 1959" (November, 527). Third, there may have been some improvement within the model-type classes. For instance, *CR* complained in 1952 that with some of the models (all of which had just one basic cycle) there was no ability to vary the cycle at all by interrupting or speeding it up. Fourth, there appears to have been an energy-saving reduction in the use of hot water in relation to capacity, but insufficient data are provided to allow a formal adjustment for energy efficiency. Overall, the *CR* dishwasher index seems to understate the extent of the 1952–83 price decline, in light of the observed facts that the average price in 1952 was $328 for simple models with a single cycle, whereas in 1980 and 1983 models with two automatic cycles were available for an average of $290 and $310, respectively.[46]

7.10.2 Microwave Ovens

The two "hot" household appliances of the 1980s are microwave ovens and VCRs. As shown in the notes to table 7.23, microwave ovens by 1983 outsold any of the products covered in this chapter, with the exceptions of refrigerators and color TV sets. Microwave sales were stimulated by a dramatic decline in prices, by improved quality, and by eased concerns about safety, but, strangely enough, the PPI for microwave ovens, introduced only in 1978, shows only an 8 percent price decline between 1978 and 1985. Five

46. These are the type B models shown in the 1980–83 comparison in table 7.21.

Table 7.22 **Alternative Indexes for Three Products, 1952–85 (1982 = 100)**

	Under-counter Dishwashers		Microwave Ovens		Videocassette Recorders
Year	PPI (1)	*CR* (2)	PPI (3)	*CR* (4)	*CR* (5)
1952		121.0			
1953		117.3			
1954		113.6			
1955		110.0			
1956		106.6			
1957		103.2			
1958		100.0			
1959		96.9			
1960		93.4			
1961		90.9			
1962		88.1			
1963		85.3			
1964		82.7			
1965		80.1			
1966		79.8			
1967	53.9	79.6			
1968	53.6	79.3		207.1	
1969	54.5	79.0		196.0	
1970	52.3	78.7		185.5	
1971	56.1	78.5		175.4	
1972	55.4	74.7		166.0	
1973	54.6	71.1		157.1	
1974	55.7	67.6		144.9	
1975	58.8	71.1		133.7	
1976	66.5	74.8		123.3	
1977	69.0	78.6		121.8	
1978	72.5	82.6	100.4	120.3	
1979	80.0	86.9	98.9	118.8	
1980	87.0	91.3	108.4	117.4	154.3
1981	93.1	95.6	103.8	115.9	124.2
1982	100.0	100.0	100.0	100.0	100.0
1983	103.1	104.6	99.4	86.3	74.4
1984			98.9	74.4	55.4
1985			92.7	64.2	41.2

CR product evaluations of microwave ovens were published between 1968 and 1985, and the pairwise price comparisons are shown in the middle section of table 7.21.

As for dishwashers, the only quality adjustments are the identification of model types. Type A has mechanical controls, a timer dial, and a single power setting. Type B offers at least one reduced power setting but still has mechanical controls and a timer dial. Type C is much improved, having a temperature probe, many variable power settings, and touch-panel controls with at least two automatic programmable settings. One reason for the growing popularity of microwave ovens in the 1980s was their increased availability in compact sizes; I control for size, using *CR*'s measurements, and include only those 1985 models with capacities of 1.0 cubic foot or more. This explains why only five models are included in 1985. To provide examples of prices, in 1981 type B models were available at an average of $393 and type C at an average of $556. By 1985, the type C price of large 1.0-cubic-foot models had fallen to $293, while thirteen additional models with capacities of 0.6–0.7 cubic foot were available for an average of $272. By November 1986, the eight type C models of 0.6-cubic-foot capacity had fallen further in price to $191. These prices contrast with type A, sold in 1968 for $495.

The *CR* price index for microwave ovens is compared with the PPI in table 7.22. The overall geometric annual rate of change of the *CR* index between 1968 and 1985 is −6.7 percent, and the rapid decline in the *CR* index between 1980 and 1984 differs from the PPI by more than 10 percent per year.

As with other products, there are additional dimensions of quality improvement. The most important is safety. As *CR* wrote in 1985, "In the early 1970s, we found that some microwave ovens leaked radiation in troubling amounts when we subjected them to deliberate abuse. Since then—and partly as a result of CU's efforts—the design of microwave ovens has improved. . . . As in our last two reports on microwave ovens, we found radiation leakage to be quite low in all models" (November, 647). The other main improvement is size, since for a microwave oven compactness is a virtue rather than a defect, at least within limits. As *CR* stated in 1985, "Smaller sizes have solved one of the biggest problems consumers have had with microwave ovens—too much oven in too little kitchen" (November, 644). Despite the virtues of small sizes, the price comparisons in table 7.21 compare models of identical capacities. Nevertheless, it seems clear from the smaller sizes of models tested by *CR* in 1986 than in 1985, and in 1985 than in 1981, that consumers prefer small sizes. In addition to the space-saving aspects, smaller ovens consume less energy to achieve routine chores like defrosting frozen food, although there is not enough information to attempt an energy-efficiency adjustment, and I doubt that it would amount to much, given the limited number of hours per year that a microwave oven would typically be used (especially in contrast to refrigerators, color TV sets, and clothes dryers).

7.10.3 VCRs

The VCR was introduced in the mid-1970s and was first rated by *CR* in 1978. Yet its popularity was so great that by 1983 the value of shipments of VCRs was equal to that of washing machines and was greater than the value of shipments of room air conditioners and clothes dryers combined (see the notes to table 7.23). Only three *CR* evaluations are used in developing the price comparisons of table 7.21 (1980, 1982, and 1985), since the 1978 report included models that were so simple (no remote control, no programming capability) that they could not be compared to the standard models of 1980.

Just two model types are identified. Type A has a wired remote control only able to make the tape action pause but having no other feature, and this type also lacks search and cue capability. Type B, which was a super deluxe model in 1982 but standard in 1985, has a "full-featured" infrared remote control and fourteen-day programming capability, but just two recording heads. By 1985, VCRs with three and four recording heads had begun to appear, but these are not included. Despite the plummeting price of type B from the $1,500 to the $600 range between 1982 to 1985, the best was yet to come. Such models were widely available for $275 in late 1986, and higher-priced models included still more features not available in type B machines, including slow motion and stereo sound.

Table 7.23 **Divisia Price Indexes for Eight Appliances, 1947–84[a]**

	Annual Growth Rates			Price Indexes (1967 = 100)		
	Unadjusted *CR* (1)	Adjusted *CR* (2)	PPI (3)	Unadjusted *CR* (4)	Adjusted *CR* (5)	PPI (6)
1947	. . .	. . .	. . .	307.1	441.0	117.5
1948	−0.2	−0.8	6.4	306.4	437.6	125.4
1949	−12.2	−12.7	−3.0	271.3	385.4	121.7
1950	−13.8	−16.0	1.1	236.3	328.4	123.0
1951	−10.7	−12.9	4.4	212.2	288.7	128.6
1952	−8.9	−14.2	−0.4	194.2	250.5	128.0
1953	−5.8	−11.1	0.4	183.2	224.3	128.5
1954	−5.8	−10.6	−1.2	172.9	201.8	126.9
1955	−7.4	−7.5	−3.7	160.6	187.1	122.3
1956	−1.5	−1.7	−1.8	158.2	184.1	120.2
1957	−1.5	−1.7	−2.0	155.8	180.9	117.8
1958	−3.9	−5.0	−0.8	149.8	172.0	116.9
1959	−3.2	−4.4	−1.4	145.1	164.7	115.3
1960	−5.2	−5.3	−2.4	137.7	156.1	112.5
1961	−5.1	−5.1	−2.2	130.9	148.3	110.1
1962	−5.7	−6.4	−2.8	123.6	139.1	107.1
1963	−6.6	−7.5	−2.1	115.7	129.1	104.9
1964	−2.5	−4.3	−1.3	112.9	123.7	103.6
1965	−4.6	−7.3	−2.5	107.6	115.0	101.0
1966	−5.4	−8.6	−0.8	102.0	105.5	100.2
1967	−2.0	−5.3	−0.2	100.0	100.0	100.0
1968	−0.3	−2.9	0.2	99.8	97.1	100.2
1969	1.6	0.2	−1.8	101.3	97.3	98.4
1970	1.9	0.5	0.2	103.3	97.8	98.5
1971	−0.0	−2.0	1.7	103.3	95.9	100.3
1972	−0.1	−2.0	−1.5	103.1	94.0	98.8
1973	1.3	−1.3	−1.3	104.4	92.9	97.5
1974	1.9	−0.6	4.1	106.4	92.3	101.6
1975	6.9	3.4	8.0	114.0	95.5	110.1

Table 7.23 (continued)

	Annual Growth Rates			Price Indexes (1967 = 100)		
	Unadjusted *CR* (1)	Adjusted *CR* (2)	PPI (3)	Unadjusted *CR* (4)	Adjusted *CR* (5)	PPI (6)
1976	3.9	0.4	3.5	118.5	95.9	113.9
1977	3.2	0.7	−1.0	122.5	96.5	112.0
1978	2.6	0.0	1.9	125.5	96.5	114.9
1979	2.4	0.3	2.9	128.6	96.8	118.3
1980	2.4	0.2	6.0	131.8	97.0	125.7
1981	−1.6	−3.5	2.6	129.7	93.7	124.0
1982	−3.5	−4.8	1.4	125.3	89.3	130.8
1983	−5.5	−6.3	0.3	118.6	83.9	131.2
1984[b]	−5.7	−6.4	0.1	112.0	78.7	131.4

[a]The percentage weights applied to the appliances are as follows:

	1948–57	1958–68	1969–76	1977–84
Refrigerators	43.5	21.2	19.1	18.2
Room air conditioners	1.0	8.5	8.8	4.6
Washing machines	20.1	13.8	11.7	8.9
Clothes dryers	1.3	5.0	6.6	4.4
TV sets	32.5	51.4	45.5	33.1
Dishwashers	1.5	3.8	6.5	5.3
Microwave ovens	0.0	0.0	1.3	11.3
VCRs	0.0	0.0	0.0	14.3

Sources for weights: 1948–57 are based on 1949 and 1977–84 based on 1984 from table 7.1. 1958–68 are based on 1965 and 1969–76 based on 1972, both from *Statistical Abstract*. The weight for video equipment in table 7.1 is divided between TV sets and VCRs from details in the 1985 *Statistical Abstract* (777).

Note: Weights are set equal to zero in years when no index change is available, and remaining products are reweighted so that weights sum to 100 percent.

[b]Change in PPI used for 1984 for these three products.

There is no PPI with which the *CR* index can be compared, for the simple reason that no VCRs are produced in the United States. Any difference between official price indexes and the alternative price indexes introduced by the inclusion of the VCR price index is relevant for the deflation of U.S. consumption, investment, capital stock, and imports, but not for the deflation of GNP. The same is true for the imported component of all the other products discussed in this chapter, a qualification of more importance for microwave ovens and TV sets than for the others.

7.11 Overall Price Indexes and Conclusion

This chapter has created seventeen new price indexes for eight major household appliances: refrigerators, room air conditioners, automatic washing machines, clothes dryers, TV sets, under-counter dishwashers, microwave ovens, and VCRs. These represent all the "white goods" produced by the appliance industry (as listed in table 7.1) except for electric and gas ranges. Included are the most important types of "brown goods," but excluded are radios and other audio equipment. The new price indexes can be classified as follows:

1. eight *CR* price indexes lacking any adjustment for energy efficiency or repair costs;
2. four additional *CR* price indexes incorporating such adjustments (refrigerators, room air conditioners, clothes dryers, and TV sets);
3. three hedonic regression indexes based on Sears catalog data and available in two versions for each product, one with six to nine years pooled together, and the second with adjacent years only (the three products are refrigerators, room air conditioners, and washing machines); and
4. two matched model indexes based on Sears catalog data (clothes dryers and TV sets).

These new "alternative" price indexes are compared to the official PPI in two tables. First, table 7.23 reports weighted averages of the two types of *CR* indexes and of the corresponding PPI indexes (the behavior of the Sears indexes are summarized subsequently). The columns labeled "adjusted *CR*" are based on the energy- and repair-adjusted *CR* indexes for the four products listed above and the unadjusted *CR* indexes for the other four products. These are Divisia indexes, in which current value weights are applied to annual percentage price changes of the individual commodity price indexes. A zero weight is applied in years when no price change can be computed because a component index is unavailable, and the remaining indexes are reweighted to sum to 100 percent. Because the PPI is introduced later than the *CR* index for some products, the greater rate of decline (or smaller rate of increase) of the *CR* indexes combines two sources of difference—different index behavior in overlapping years together with the impact of rapid price declines in the early years of a product cycle before the PPI is introduced (these two different sources are disentangled in table 7.24 below). To maximize the period of comparability for the two products where the PPI starts prior to the *CR* index (two years earlier for refrigerators and one year earlier for washing machines), the change in the *CR* index is set equal to the change in the Sears index or the PPI in those years.[47]

The first three columns in table 7.23 show percentage changes at annual rates for the three indexes, and the next three columns convert these to price indexes on a base of 1967 = 100. The value weights and their sources are listed in the notes to the table. For the period 1948–57, the weights are dominated by three products, refrigerators, washing machines, and TV sets, accounting for 96.2 percent of the value of shipments. By 1977–84, the three

47. Thus, the percentage change in the *CR* index for refrigerators is set equal to that of the Sears index for 1948–49 and the PPI for 1947–48; the change in the *CR* index for washing machines is set equal to that of the PPI in 1947–48.

Table 7.24 **Average Annual Rates of Change, by Type of Price Index, Selected Intervals 1947–84**

	1947 or Earliest Date to 1957	1957–67	1967–77	1977–83/84	1947 or Earliest Date to 1983–84
Full period, eight products:					
1. PPI	0.03	−1.63	1.21	2.20	0.30
2. *CR* unadjusted	−6.56	−4.34	2.03	−1.25	−2.69
3. *CR* adjusted	−8.53	−5.76	−0.36	−2.02	−4.55
4. *CR* unadjusted—PPI	−6.59	−2.71	0.82	−3.45	−2.99
5. Energy-repair effect	−1.97	−1.42	−2.39	−0.77	−1.86
Comparable periods, five products, earliest date to 1983					
6. PPI	−0.86	−1.63	1.22	2.40	0.24
7. Sears	−5.09	−3.39	1.45	3.97	−0.79
8. *CR* unadjusted	−4.07	−4.38	2.29	2.71	−0.89
9. *CR* unadjusted—PPI	−3.21	−2.75	1.07	0.31	−1.13
10. Sears—*CR* unadjusted	−1.02	0.99	−0.84	1.26	0.10
11. *CR* vs. PPI	−8.56	−4.13	−1.57	−4.22	−4.85
a. Mix effect	−3.38	0.04	−0.25	−3.76	−1.72
b. Price index effect	−3.21	−2.75	1.07	0.31	−1.13
c. Energy-repair effect	−1.97	−1.42	−2.39	−0.77	−1.86

Sources for row 11: Row 11a: row 3 minus row 1 minus row 11b minus row 11c. Row 11b: row 9. Row 11c: row 5.

top products are refrigerators, TV sets, the VCRs, but these account for just 65.5 percent of the weight. In contrast to the PPI listed in column 6, which is at 111.8 percent of its 1947 value in 1984, the unadjusted *CR* index declines in 1984 to 36.5 percent on a 1947 base, and the adjusted *CR* index declines in 1984 to 17.8 percent.

The differences between the *CR* and the PPI indexes are quite radical in size and implications, especially in contrast to the much smaller differences found by Triplett and McDonald (1977) between the PPI for refrigerator-freezers and their quality-adjusted PPI based on hedonic regression coefficients. Part of the greater rate of decline of the *CR* indexes occurs because they generally commence earlier than the PPI and for some products display rapid rates of price decline in the years when the PPI for that product does not exist (an extreme case is the VCR, which has no PPI at all). To address this issue, table 7.24 summarizes the annual growth rates of alternative price indexes for appliances. The top section of the table simply reports the average growth rates of the three indexes in table 7.23 over selected intervals. The bottom part of the table summarizes growth rates of the five products where we also have Sears indexes (pooled rather than adjacent-year hedonic indexes are used for three products and matched model indexes for two products). The five-product comparisons differ in that the growth rates are computed only for those years when *CR*, Sears, and the PPI are all available, and thus none of the differences displayed in rows 9 and 10 can be attributed to differences in the time span of coverage.

The implications of the alternative indexes and methods of calculation are shown in rows 4, 5, and 9–11. For the full period when the *CR* indexes are available, the unadjusted *CR* index changes at an annual rate of −2.99 percent relative to the PPI (row 4), and this difference ranges from −6.59 percent in 1947–57 to 0.82 in 1967–77. In addition, the adjustment of the *CR* indexes for energy and repair costs (row 5) introduces an additional average annual change of −1.86 percent, and this ranges between −2.39 percent in 1967–77 to −0.77 percent in 1977–84.

The average annual difference between the *CR* index and the PPI shown in row 9 for five products and comparable time periods is much smaller than for eight products and the full time period in row 5. This difference is called the *mix effect,* is reported separately in row 11a, and is very large in 1947–57 and in 1977–84, but is quite small during the middle two decades (1957–77). In the early period, this difference reflects primarily the extremely rapid rate of decline of the *CR* price index for television sets from 1947 to the introduction of the PPI for TV sets in 1952. Yet this typical "new product learning-curve effect" was not limited to a product with a tiny initial sales volume. Instead, the value of TV set shipments was already very significant by 1949, with a one-third share of the six products covered in this chapter (see the notes to table 7.23). In the final interval of 1977–84, the "mix effect" in line 11a reflects the influence of both microwave ovens and VCRs, with the *CR* index for microwaves having a much more rapid rate of decline than that of the PPI, and with the very fast decline in VCR prices missing from the PPI. Recall that the change in the *CR* index for VCRs applies only to the limited time period 1980–84.

The unadjusted *CR* index is compared to the Sears indexes for five products in row 10. As in rows 6–9, indexes for a given product are compared only for the time span for which all three indexes (PPI, Sears, and *CR*) are available. In row 10, we see that, on average from the earliest comparable date to 1983, the weighted average change in the Sears index was just 0.10 percent per annum greater than that of the unadjusted *CR* index. Differences were greater in individual subintervals, ranging from −1.02 percent from the earliest date through 1957, to 1.26 percent for the final subinterval (1977–83).

The final results of the chapter are summarized in row 11, which reports the difference between the adjusted *CR* index and the PPI, and decomposes this difference into a mix effect, the "price index effect" (i.e., different measures of price change for the same product over the same period), and the energy-repair cost effect. The mix effect is a slight misnomer, since it combines a different mix of products for the years when the PPI is unavailable with the different rates of price change for two of the products (dishwashers and microwave ovens) included in the group of eight but not the group of five. The energy-repair cost effect is simply the difference between the two *CR* indexes and is copied from row 5 into row 11c. The price index effect applies to the five common products and is copied from row 9 into row 11b. The mix effect is a residual, calculated as row 11 (which in turn equals row 3 minus row 1) minus row 11b minus 11c.

We can see that the three sources of difference between the adjusted *CR* index and the PPI vary in importance over the different subintervals. The mix effect and price index effect are of roughly equal importance before 1957. The mix effect is close to zero from 1957 to 1967, when the price index effect is of greatest importance. The differences between the unadjusted *CR* index and the PPI during this period occur by a similar order of magnitude for four out of the five common products, with virtually no difference for TV sets. After 1967, the pure price index effect reverses sign, since the PPI increases less rapidly than the unadjusted *CR*. This finding is supportive of the hypothesis that the BLS has adjusted for quality improvements (excluding energy and repair costs) more completely and accurately in the last half of the postwar period than in the first half. After 1967, the continued decline of the *CR* adjusted index relative to the PPI is mainly attributable to the energy-repair adjustment in 1967–77 (this was the period of the greatest improvements in the repair and energy costs of TV sets), and to the mix effect (mainly microwave ovens and VCRs after 1977).

This chapter concludes that the PPI radically understates the enormous decline in the prices of electric appliances that has occurred over the postwar years. The conclusion for the CPI is the same, since the CPI and PPI exhibit similar behavior, except that the greater decline in the CPI than in the PPI for refrigerators and TV sets from 1947 to 1957 would add about 1.3 percent to the weighted average annual rate of price decline exhibited by the PPI for that interval in table 7.24.[48] This difference between the new indexes and the PPI is attributed to three main factors. First is the conceptual difference that no explicit allowance is made by the PPI for changes in energy and repair costs attributable to the manufacturer (i.e., changes from one model to the next computed at constant energy and repair prices). Second is the fact that the PPI is often introduced several years after the introduction of new products that typically exhibit their greatest rates of price decline in the first part of their product cycle. Late introductions in the PPI are most important for TV sets and dishwashers. The CPI is even worse, with indexes for room air conditioners and clothes dryers introduced more than a decade after the comparable PPIs. The third factor is the traditional concern of the literature on quality change—an upward bias in the PPI due to the failure to adjust adequately for quality improvements (other than energy and repairs) for comparable products over comparable time intervals. This bias was significant before 1967, at a rate of about 3 percent per year, but disappeared after 1967.

The extent of the pure quality-change effect is based on the behavior of the unadjusted *CR* indexes, which, unlike the Sears catalog indexes, compare the prices of all the best-selling models, with as many as fifteen or twenty brands included in the majority of the price comparisons. The PPI has greater coverage across time, since monthly price changes are compiled, but this

48. As in the rest of the book, I stress the behavior of the PPI here, since it is the source of the NIPA deflators for producers durable equipment.

advantage is unimportant for the study of price changes over multiyear intervals. Outweighing the greater temporal time coverage of the PPI is the greater brand-name coverage of the *CR* indexes, and the fact that *CR* reflects market trends by concentrating on the model types that account for the greatest share of sales of a given product.[49] Thus, in the sense relevant for multiyear price comparisons, the *CR* indexes are probably based on more brands and more observations than the PPI. This is particularly true after 1959, when the *CR* published prices for most products are themselves averages of shopper surveys that collect numerous price quotations for each specific model included in the ratings. Thus, the *CR* indexes after 1959 can be interpreted as quality-adjusted indexes of true "transactions prices."

There is little reason to believe that the PPI is any more accurate for products omitted from this chapter than from those included. The most important omission, by value of shipments in 1983, is audio equipment. There can be no doubt that solid-state technology, quartz tuning, and other improvements have resulted in dramatic reductions in the price of audio equipment relative to performance. Prices of compact-disk players have been dropping as rapidly as those of VCRs. Yet the 1985 PPI for "other home electronic equipment" was 100.5 on a 1967 base. And electronics are also becoming more common in "white goods" (i.e., major appliances), allowing very rapid reductions in the price of including advanced electronic control features.[50]

As radical as the *CR* price indexes may seem, with a weighted average rate of price *decline* for appliances (including the energy-repair adjustment) of 4.55 percent a year compared to the 0.30 percent annual *increase* registered by the PPI, for each of the eight product categories this chapter has provided information on dimensions of quality improvement that are not taken into account in the quantitative measures of price change taken from *CR*. Thus, surprising as it may seem, a good case can be made not only that the PPI (and to a lesser extent the CPI) understates the rate of price decline by a large amount, but that even the new *CR* indexes contain at least a modest further understatement as the result of additional unmeasured quality improvements.

49. Triplett and McDonald (1977, 140) comment that "the number of refrigerator-freezer prices collected for the WPI is far too small to estimate reliable hedonic functions."

50. General Electric has introduced refrigerators that have an array of diagnostic options and a sensor that notes when the door is left open, and dishwashers that have a programmable timer and washer load options and that also shut off and alert the user if the spray arm is blocked. The electronics on the first "digital dishwasher" cost $200, but by 1984 had fallen to $50 and were projected to decline to $25 in subsequent years ("Look Ma, No Dials," *Business Week*, 12 November 1984, 97).