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8 New and Used Automobiles

8.1 Introduction

Along with computers, new and used automobiles have received more attention in studies of price and quality change than any other product. In fact, it has been suggested that there is no need for yet another study of automobile prices, since it is possible to piece together a hedonic price index for automobiles, at least through 1971, from the various papers written by Zvi Griliches, both by himself (1961, 1964) and in collaboration with Makoto Ohta (1976).[1] My justification for including this chapter on automobiles is twofold. First, the most interesting issues and puzzles in the measurement of auto prices emerge in the period after the sample period of the Griliches and Ohta-Griliches regression equations (which spans 1947–71).[2] In particular, there is a much greater discrepancy between a hedonic regression index and the CPI for new cars after 1971 than over the 1947–71 period, which has been studied before. Second, the most important changes in automobile quality characteristics in the period after 1971, particularly safety and pollution equipment and changing fuel economy, are not particularly suited to the hedonic method. A full treatment of quality and price changes since 1971 requires that the hedonic technique be combined with the specification method and with a comparison of "closely similar" models over time. Thus, the main focus of this chapter is on the questions that cannot be answered by running "one more hedonic regression." This section introduces the main puzzles,

1. This point was made forcefully by Jack Triplett in his comments on the 1974 draft of this chapter.

2. In the original Griliches (1961) paper, the sample period includes 1937, 1950, and 1954–60. Griliches (1964) covers 1947–61. The Ohta and Griliches (1976) paper presents hedonic price indexes for new cars covering each year over the interval 1955–71 and for used cars over 1961–71. Ohta and Griliches (1986) estimate regression equations for the 1970s but do not include time dummy variables or calculate a hedonic price index from the estimated coefficients.

and the rest of the chapter is primarily devoted to combining old and new evidence in a way that helps solve them.

1. In contrast to the 1940s and 1950s, the time period covered in Griliches's first hedonic regression study, when a hedonic price index for new autos rises at a slower rate than the BLS indexes (CPI and PPI), the relation was completely reversed in the 1970s and 1980s. The hedonic price index for new cars developed here rises much faster than the BLS indexes after 1970, with an annual rate of increase for 1970–83 of 8.0 percent compared to an annual rate of increase for the CPI of just 5.0 percent. Can a case be made that the BLS indexes are biased downward, that the hedonic indexes are biased upward, or that the "truth" lies somewhere in between? To what extent can adjustments for safety and pollution devices in the BLS indexes explain this discrepancy, given that the hedonic technique cannot cope with changes in quality that take place on all models at the same time?[3]

2. A new issue that arises after 1970 is the divergent behavior of the CPI indexes for new and used cars. The annual rates of increase for 1970–84 are, respectively, 4.8 and 9.6 percent. If the average price of a one-year-old car was 22 percent less than the price of a new car in 1970, then the average price of a one-year-old car in 1984 would have been 45 percent more than that of a new car![4] Since this remarkable implication is at odds with the basic facts of the auto market in the 1980s, something must have gone wrong at the BLS to account for the inconsistent time-series behavior of the CPI indexes for new and used cars. I address this question by attempting to provide new quality adjustments for used cars that are consistent with the CPI quality adjustments for new cars.

3. The inconsistent behavior of the BLS price indexes for new and used cars is not just a harmless quirk, but has profound consequences for the PDE deflator, the main focus of this book. PDE for automobiles is calculated by adding purchases of new cars and then subtracting sales of used cars from the business sector to the household sector.[5] Because the price index for new cars (a component of the PPI that behaves similarly to the CPI for new cars) increases much more slowly than the CPI used car index used to deflate used car sales in the PDE, the resulting implicit deflator for auto PDE displays a time series path that can only be described as bizarre. As shown below in table 8.8 in columns 1 and 3, after increasing at an annual rate of 6.4 percent per year between 1970 and 1980 (not too far above the CPI rate of 5.2 percent), the PDE deflator for cars decreases at a rate of 7.1 percent per year from 1980 to 1984. This absolute decrease of over 25 percent in three years occurs at a time when the CPI index for new cars rises by 16 percent.

3. This limitation of the hedonic technique is discussed by Triplett (1969, 416–17).

4. In 1970, the nine Buick models in the data set sold as one-year-old cars for 78 percent of the price of the same models when new in 1969, according to the *NADA Used Car Guide*. The calculation in the text implicitly assumes that the CPI index for used cars, which applies to all ages of used cars, can be used to compute the price increase of one-year-old cars.

5. My understanding is that automobiles are the only category of PDE for which used purchases are subtracted from new purchases.

4. In keeping with the emphasis in this book on quality adjustments to take account of changes in energy efficiency, this chapter assesses the implications of previous studies of changes in automobile gas mileage by Crandall et al. (1986) and Wilcox (1984). Fuel economy changes are an important type of quality change with which the hedonic regression technique cannot cope, and previous investigators have found that fuel economy enters regression equations either insignificantly or with the wrong sign, partly because it is collinear with weight.[6] Changes in fuel economy call for explicit quality adjustments, like those introduced in the previous chapter on appliances. One might expect the neglect of improvements in fuel economy to impart an upward bias to an automobile price index. However, some of the improvement in fuel economy may already be implicit in the BLS indexes, which did not treat the "downsizing" of cars in the late 1970s as a quality deterioration, at least partially on the ground that smaller size was balanced by improved fuel economy.

A large number of technical topics in the construction of hedonic price indexes for automobiles is treated in the Ohta and Griliches (1976) paper (hereafter O-G), and I do not retrace the same ground here. The construction of hedonic price indexes is straightforward, and the presentation of results is brief, for the new work goes beyond previous hedonic studies mainly by extending the time coverage over the entire 1947–83 interval. Thus there are thirty-six adjacent-year regression equations for both new and used cars, compared to fourteen postwar new car equations in Griliches (1964), sixteen for new cars in O-G, and ten for used cars in O-G.[7]

After examining the hedonic regression results, I then turn to further adjustments needed to reconcile the behavior of the hedonic indexes and the CPI, and to explain the behavior of the used car indexes (both CPI and hedonic) relative to the corresponding new car indexes. Among the data sources used for these adjustments are the studies of safety and environmental equipment by Crandall et al. (1976), and of fuel economy by the Crandall team and by Wilcox (1984). Also examined is the time series of BLS quality adjustments made to the CPI over the 1968–84 period, based on BLS press releases, and a related unpublished list of year-to-year quality changes compiled by General Motors over the full postwar period.

8.2 Issues That Arise in Estimating Hedonic Regressions for Automobiles

8.2.1 The Distinction between Performance and Physical Characteristics

The hedonic analysis assumes a two-stage process in which the utility of the automobile user (for autos used as consumer goods) and the ability of autos

6. Hogarty (1972, 9) reports this negative finding and states that similar results were reported by Cowling and Cubbin (1972).

7. Other sources are Kravis and Lipsey (1971), which presents a hedonic price index for automobiles for the years 1953, 1957, and 1961–64, and Triplett (1969), which presents a hedonic index for 1960–66.

to produce capital services (for autos used as PDE) are functions of a vector of performance characteristics (z), which is in turn "produced" by a vector of physical characteristics (x):

$$U = U(z_1, \ldots, z_N) = U(z), \tag{8.1}$$

$$z = h(x_1, \ldots, x_N; t) = h(x; t), \tag{8.2}$$

where t enters (8.2) on the assumption that the production function converting physical into performance characteristics can change over time.

The principal performance characteristics (z) of an automobile are interior dimensions, opulence of upholstery and trim, quality of ride, trunk space, handling, braking, acceleration, fuel economy, frequency and cost of repair, and depreciation. Ideally, these characteristics could be used to explain the prices of automobiles in hedonic regression equations. However, owing to data limitations, most hedonic regression studies have been based on physical characteristics (x), typically weight, length, horsepower, and dummy variables for accessories (automatic transmission, power steering, power brakes, air conditioning, etc.). If relative input prices remain steady, and if technological change can be ignored (i.e., if the h function does not vary over time), then physical characteristics may be acceptable proxies for performance characteristics in hedonic regression equations. Indeed, O-G demonstrate (367–78) that performance and physical characteristics are able to explain automobile prices with an approximately equal fit for the short period 1963–66.[8] This would tend to indicate that the h function is stable, allowing the investigator to choose variables based on the accessibility of data.

But the use of either physical or available performance data entails problems. The existing performance data are imperfect and could introduce measurement error that might have a significant secular bias. While dimensions, fuel economy, and acceleration are amenable to precise measurement, quality of ride, handling, and quality of trim are not. Such descriptions as we have of these characteristics are qualitative. *CR*, which is the major source of performance data used in previous studies, explicitly warns readers that qualitative descriptions of ride or handling as "good" or "excellent" are valid only for comparisons of cars in a given year and do not have the same meaning in other years. For instance, *CR* intoned in 1957 (April, 160) that "a car reported as having a good ride in 1940 would by today's standards be intolerably poor."[9] While there are more precise engineering measures of ride

8. This simply indicates that the z and x variables were highly correlated over their particular time period and does not rule out secular shifts in the h function over longer periods. Hogarty (1972) also estimates hedonic regression equations with performance attributes over the longer period 1958–71 and finds only a minimal difference in the resulting price indexes compared to similar equations using physical characteristics.

9. The problem of comparability over time of qualitative remarks about performance is recognized by O-G, but then ignored in practice.

Table 8.1 Physical Characteristics of the 1976 and 1977 General Motors Full-sized Cars

	1976	1977	Change (%)
1. Exterior:			
Length (inches)	226.0	213.8	-5.4
Width (inches)	78.9	75.4	-4.4
Wheel base (inches)	123.4	115.9	-6.1
Weight (pounds)	4423	3685	-16.7
2. Interior:			
Front head room (inches)	38.3	38.8	1.3
Rear head room (inches)	37.2	38.0	2.2
Rear leg room (inches)	38.5	39.5	2.6
Rear knee clearance (inches)	3.6	3.7	2.8
Trunk capacity (cubic feet)	18.8	20.3	8.0
3. Other:			
Horsepower	145	145	0.0
EPA fuel rating (city/highway)	13/18	16/21	23/17
List price	$5,013	$5,357	6.9

Source: Sections 1 and 2 are from Callahan (1976) and refer to the Pontiac Catalina. Other figures refer to the Chevrolet Caprice.

(''spring rate'') and handling (''skid pad tests''), these are only imperfect proxies for what the consumer thinks of as ''ride'' and ''handling,'' and they are difficult to compile for a statistical study.[10]

While the physical characteristics used in this and other studies are quantitative, the *h* function linking them to performance may shift over time. In fact, one could view a basic function of engineers as working to achieve shifts in that function by finding ways of improving performance relative to ''physical inputs.'' A dramatic example of such a shift is provided by the downsizing of General Motors ''full-sized'' cars in 1977. In the course of a single model changeover, there were decreases in quantities of the physical characteristics that enter hedonic regression equations as explanatory variables, while simultaneously there were increases in many of the measures of performance characteristics.[11] As shown in table 8.1, weight declined by 738 pounds, or 16.7 percent, overall length dropped by over a foot, and exterior width was reduced by three inches. At the same time, each of the five interior dimensions rose. Further, there was no decrease in other aspects of performance. *CR* (February 1977, 81) praised the downsized Chevrolet Caprice (a twin of the Pontiac Catalina): ''General Motors has already shrunk its 'full-sized' [models]. And, judging by our tests of the Chevrolet Caprice, GM has in the process improved gas mileage while losing nothing in the comfort and interior roominess one expects of a large car. . . . So General Motors,

10. These examples of engineering proxies were suggested by Jack Triplett.

11. For an illuminating earlier discussion of the shifting relation between the weight characteristic and ''true quality,'' see Triplett (1969, 414–17). He points out that weight is actually an undesirable characteristic, and that this problem was also recognized by Griliches (1961) and Court (1939).

Table 8.2 **Factory Installed Equipment on U.S.-Made Cars, Selected Years, 1953–83 (all figures are percentages of total cars manufactured)**

	1948	1953	1958	1963	1968	1973	1978	1983
1. Automatic transmission	33.3	49.4	76.8	76.3	89.0	93.4	93.1	86.6
2. Four-speed transmission	N.A.	0.0	0.0	3.8	3.8	4.1	6.4	6.1
3. Air conditioning	0.0	0.0	4.6	14.1	44.3	72.6	80.8	83.5
a. Manual control						65.3	70.3	71.0
b. Automatic control						7.3	10.5	12.5
4. Disc brakes	0.0	0.0	0.0	0.0	12.7	85.7	100.0	95.2
5. Power steering	0.0	11.7	42.8	50.1	80.0	87.7	92.7	90.5
6. Power brakes	0.0	8.2	29.8	27.2	44.9	75.5	86.0	95.2
7. Radial tires	0.0	0.0	0.0	0.0	0.0	13.3	84.8	99.9
8. Radio	0.0	0.0	0.0	61.6	87.9	94.0	80.2	86.8
a. AM only						64.0	31.0	14.6
b. AM-FM only						9.3	12.6	3.7
c. Stereo radio						15.4	21.1	42.4
d. Stereo tape				0.0	2.4	5.3	15.5	26.1
9. Power door locks						13.8	26.1	39.0
10. Power seats, four or six way			9.0	7.3	9.3	14.3	19.5	30.3
11. Power windows		6.6	6.3	12.2	17.6	25.7	28.4	37.9
12. Vinyl roofs						48.9	35.5	26.5
13. Tinted glass		31.6	27.7	51.7	69.5	78.9	86.9	89.0
14. Wheel covers						72.0	70.8	N.A.
15. Clock						42.0	51.3	59.2
16. Adjustable steering column				2.5	9.5	18.6	38.7	56.2
17. Rear window defogger						16.4	39.1	59.0
18. Remote control side mirror						58.6	77.4	85.5
19. Cruise control				0.0	4.1	10.6	35.7	N.A.

Sources: *Wards Automotive Yearbook* and *Automotive Facts and Figures*, various issues.

long the champion of big cars, has proved that with good design a car doesn't need all that 'road-hugging weight' to handle well and ride comfortably."[12]

8.2.2 The Treatment of Extra Equipment, Both Standard and Optional

A problem with either physical or performance characteristics is the probable existence of omitted characteristics. Automobiles have been including more and more types of additional equipment that go beyond the traditional physical characteristics of weight, length, and horsepower. Table 8.2 brings together for selected years the available evidence on factory-installed equipment in domestic U.S. automobiles. For almost every type of equipment, the percentages indicate increased coverage over time, and only a few of these, particularly automatic transmission (AT), air conditioning (AC), power steering (PS), and power brakes (PB), have been explicitly taken into account in previous hedonic studies. A serious problem of interpretation of the

12. For further praise of this model, voted *Motor Trend*'s 1977 "Car of the Year," see *Motor Trend*, February 1977, 26–32.

data in table 8.2 arises, however, because, except for a few major items, we do not know what fraction of factory-installed equipment is standard equipment and what fraction is purchased as optional equipment. Since the dependent variable in a regression for new cars is the price including standard equipment but excluding options, while the price in a used-car regression includes both standard equipment and options, a growing share of optional equipment might create an inconsistency between new car and used car price indexes and might possibly help account for the greater relative rise over time of used car than of new car indexes.

Two approaches to the "extra equipment" issue have been taken in the past. A direct approach is to include dummy variables for the presence of each item. Multicollinearity may lead to unstable or wrongly signed coefficients on some of these variables, and, rather than estimating the price of a piece of equipment, the coefficients may pick up luxury models or classes of cars that come "highly equipped." A more direct approach, which is feasible only for some of the major pieces of equipment, is to "strip" the price of the item from the price of cars on which it is included as standard equipment. Two types of prices are defined in the data below, "loaded" with all items included as standard, and on a standardized "stripped basis" that includes only a heater and AM radio but is adjusted to exclude AT, AC, and other major types of equipment included as standard. For a car that includes a heater and AM radio as standard equipment, but that is equipped with AT and AC purchased as optional equipment, the loaded and stripped price would be the same.

O-G also standardize their price data to eliminate the need to include dummy variables for extra items of equipment. Instead of stripping, they standardize their observations to include the price of a heater, AT, and PS, and to exclude AC.[13] If the price of AT and PS increase at a slower rate than the "basic car," then the standardized O-G price would increase more slowly than the "stripped" price computed for this study.

Tables 8.3 and 8.4 list means of prices and the major physical characteristics separately for new cars and used cars, respectively. Both the loaded and the stripped price are shown for each year between 1947 and 1983, and table 8.5 shows the ratio of the stripped to the loaded price for both new and used cars. For new cars, the ratio of the stripped to the loaded price declined from 100 percent in the late 1940s to 87–89 percent after 1973. For used cars, the stripped price fell from 101 percent in the late 1940s to 88 percent since 1975.

A problem that O-G ignore, and I handle only partially, was initially raised in chapter 3. This concerns the inconsistency of the price and weight data. The data on shipping weight used as an explanatory variable refer to the car

13. A second variant treats power steering as a "cost of weight and size" and includes the price of power steering only for those cars where it is standard equipment. However, a comparison of tables 8.2 and 8.3 indicates that power steering seems to be desired for itself, not as a byproduct of weight and size, since the average weight of new cars in the early 1980s plummeted well below the levels of the late 1940s and early 1950s, yet power steering was included on 91 percent of 1983 models, as compared to just 12 percent in 1953.

Table 8.3 Mean Values of New Car Sample, 1947–83

	Price Loaded	Price Stripped	Weight	Length	Brake Horsepower
1947	1,554	1,554	3,503	206.7	106
1948	1,737	1,735	3,482	207.0	105
1949	1,974	1,964	3,422	202.5	109
1950	2,023	1,997	3,525	204.8	111
1951	2,192	2,150	3,545	205.2	113
1952	2,390	2,343	3,600	206.3	124
1953	2,381	2,365	3,571	205.5	129
1954	2,326	2,313	3,557	207.0	140
1955	2,276	2,261	3,481	205.7	167
1956	2,347	2,290	3,514	206.0	192
1957	2,660	2,561	3,642	208.4	214
1958	2,858	2,747	3,743	213.0	229
1959	2,848	2,725	3,746	214.1	230
1960	2,753	2,640	3,658	211.0	208
1961	2,615	2,517	3,419	206.5	186
1962	2,593	2,495	3,164	201.6	167
1963	2,566	2,468	3,176	202.9	173
1964	2,580	2,481	3,253	205.7	184
1965	2,540	2,388	3,192	203.7	184
1966	2,578	2,426	3,261	204.1	187
1967	2,637	2,470	3,280	206.3	190
1968	2,796	2,624	3,356	207.0	197
1969	2,912	2,651	3,434	208.9	209
1970	3,059	2,768	3,549	211.4	216
1971	3,287	2,958	3,566	210.8	205
1972	3,333	2,984	3,591	210.4	200
1973	3,304	2,941	3,697	212.6	195
1974	3,783	3,348	3,847	213.6	212
1975	4,234	3,726	3,731	211.8	186
1976	4,484	3,924	3,763	211.1	192
1977	4,626	4,030	3,559	208.7	181
1978	5,111	4,461	3,402	205.8	178
1979	5,119	4,484	3,161	200.5	164
1980	5,677	4,996	3,077	200.4	152
1981	7,092	6,262	2,892	194.2	144
1982	7,588	6,822	2,879	191.1	138
1983	7,857	6,984	2,766	187.4	141

equipped with whatever equipment is provided as "standard" (i.e., as part of the price). While I attempt to strip out the weight of AT and PS, as discussed below in section 8.3, this has not been possible for other accessories for which the price is adjusted (e.g., air conditioning in the more recent years). If the price-to-weight ratio of AC is higher than that of the rest of the car, then the process of stripping price but not weight will slightly reduce the coefficient on weight. Similarly, when O-G add the price of AT to a car that is not so equipped, they are raising price without adjusting weight, leading to an upward bias on their coefficient on weight.

The possible inconsistency of the weight and price data raise two more general problems with the hedonic regression equations. First, weight is

Table 8.4 Mean Values of Used Car Sample, 1947–83

	Price Loaded	Price Stripped	Weight	Length	Brake Horsepower
1947	1,862	1,887	3,509	207.0	106
1948	2,017	2,032	3,477	206.4	105
1949	1,558	1,596	3,493	207.6	105
1950	1,545	1,571	3,462	207.2	108
1951	1,719	1,734	3,539	204.9	110
1952	1,860	1,873	3,577	206.0	114
1953	1,810	1,837	3,605	206.6	121
1954	1,624	1,660	3,561	205.9	126
1955	1,711	1,742	3,662	208.7	141
1956	1,684	1,661	3,649	208.8	163
1957	1,843	1,766	3,614	207.9	189
1958	1,800	1,712	3,675	208.9	208
1959	1,939	1,840	3,756	211.4	230
1960	1,896	1,773	3,857	214.4	245
1961	1,857	1,765	3,786	213.5	238
1962	1,760	1,676	3,549	209.1	204
1963	1,804	1,740	3,296	203.4	179
1964	1,790	1,723	3,228	202.7	176
1965	1,817	1,707	3,257	199.0	186
1966	1,693	1,577	3,249	204.5	191
1967	1,757	1,630	3,245	203.8	191
1968	1,910	1,777	3,331	205.6	198
1969	1,837	1,637	3,396	208.5	204
1970	2,100	1,867	3,465	209.9	213
1971	2,138	1,899	3,501	210.7	215
1972	2,321	2,058	3,548	210.5	212
1973	2,310	2,047	3,600	211.6	206
1974	2,479	2,194	3,674	212.5	200
1975	2,977	2,632	3,760	215.7	194
1976	3,452	3,048	3,776	209.4	197
1977	3,393	2,987	3,730	211.0	186
1978	3,763	3,311	3,564	208.1	182
1979	3,750	3,300	3,420	205.7	179
1980	4,142	3,644	3,283	203.5	170
1981	5,080	4,470	3,149	201.6	159
1982	5,574	4,905	3,051	200.0	149
1983	6,037	5,316	2,922	193.4	142

highly unsatisfactory as a proxy for desired performance characteristics, particularly "quality of ride." Even prior to the post-1973 era of high fuel prices, engineers strived to eliminate unnecessary weight, and cars of equivalent quality have become lighter. The downsizing of the full-sized GM models detailed in table 8.1 is the best example of this phenomenon, and the earlier examples of the "thin-wall" casting process and the utilization of aluminum, plastics, and light alloys were suggested by Triplett (1969, 416). Particularly in the post-1973 era of higher fuel prices, the inclusion of weight in a hedonic regression equation seems increasingly an anachronism. Weight acts as an unsatisfactory proxy both for size and for luxuriousness of equipment. An improved approach would be to replace the standard weight

Table 8.5 **Ratios from Tables 8.3 and 8.4**

	Stripped Used Price/New Price	Stripped Used/New 1.5 Years Back	New Cars Stripped/Loaded	Used Cars Stripped/Loaded
1947	1.21		1.00	1.01
1948	1.17		1.00	1.01
1949	0.81	0.97	0.99	1.02
1950	0.79	0.85	0.99	1.02
1951	0.81	0.88	0.98	1.01
1952	0.80	0.90	0.98	1.01
1953	0.78	0.82	0.99	1.01
1954	0.72	0.71	0.99	1.02
1955	0.77	0.74	0.99	1.02
1956	0.73	0.73	0.98	0.99
1957	0.69	0.78	0.96	0.96
1958	0.62	0.71	0.96	0.95
1959	0.68	0.69	0.96	0.95
1960	0.67	0.65	0.96	0.94
1961	0.70	0.66	0.96	0.95
1962	0.67	0.65	0.96	0.95
1963	0.71	0.69	0.96	0.96
1964	0.69	0.69	0.96	0.96
1965	0.71	0.69	0.94	0.94
1966	0.65	0.65	0.94	0.93
1967	0.66	0.68	0.94	0.93
1968	0.68	0.73	0.94	0.93
1969	0.62	0.64	0.91	0.89
1970	0.67	0.71	0.90	0.89
1971	0.64	0.70	0.90	0.89
1972	0.69	0.72	0.90	0.89
1973	0.70	0.69	0.89	0.89
1974	0.66	0.74	0.89	0.89
1975	0.71	0.84	0.88	0.88
1976	0.78	0.86	0.88	0.88
1977	0.74	0.78	0.87	0.88
1978	0.74	0.83	0.87	0.88
1979	0.74	0.78	0.88	0.88
1980	0.73	0.81	0.88	0.88
1981	0.71	0.94	0.88	0.88
1982	0.72	0.87	0.90	0.88
1983	0.76	0.81	0.89	0.88

Sources by column: (**1**) Table 8.4 col. 2 divided by tablc 8.3 col. 2. (**2**) Table 8.4 col. 2 divided by average of table 8.3, col. 2, dated one and two years earlier. (**3**) Table 8.3 col. 2 divided by table 8.3 col. 1. (**4**) Table 8.4 col. 2 divided by table 8.4 col. 1.

and length variables with interior dimensions and trunk capacity, and then to handle discrete items of equipment on a one-for-one basis. This procedure is not attempted here, simply because the basic data source, the used car guides, list the standard physical variables for each model but not the required interior dimensions and trunk space. While these are available from *CR*, the effort to match these with the corresponding new car and used car prices was beyond the feasible scope of the study.

The second problem applies to the suggestion in the previous paragraph that discrete items of equipment might be handled on a one-for-one basis, as in the CPI. The application of such adjustments to a hedonic index raises the possibility of double counting, due to the likelihood in principle that any left-out performance characteristic may be correlated with one or more of the variables included in the hedonic regression. For instance, environmental control or safety equipment (e.g., crash-resistant bumpers) may affect weight and/or horsepower, and an adjustment to subtract out the value of such equipment from a hedonic regression index that already incorporates the effect of weight and horsepower would involve double counting. I return to this issue below when examining differences in the secular behavior of the CPI and the hedonic regression index in the period since 1967, during which a substantial amount of environmental and safety equipment has been added to U.S. automobiles.

In addition to the major accessories (AT, PS, PB, and AC), numerous smaller items have been added to the standard equipment of automobiles over time (e.g., directional signals, seat belts, two-speed windshield wipers, and many others). If a complete list of the price and weight of these items were available for every model, the process of stripping could be applied to them as well. An improved hedonic index would result, subject to the limitation imposed by the second qualification above, that in principle there could be a correlation between one or more of these items and some variables besides weight that is included in the hedonic regression equation. Unfortunately, a complete list detailing all items added or subtracted from every model in every year is not available, preventing the technique of stripping from being applied.

In this study, government-mandated safety and antipollution devices are treated as improvements in quality rather than increases in price. This approach is followed to conform to BLS practice in the PPI and CPI, facilitating comparisons of those indexes with these results. There is a debate as to whether the BLS approach is appropriate. Some approve the BLS procedure of treating government-mandated devices as a quality improvement rather than a price increase, on the assumption that the democratic process that mandates these devices reflects "the will of the people" and that, implicitly, benefits from increased safety and cleaner air balance the costs. Others claim that the regulations have gone too far and have been inefficiently administered, leading to costs that have outweighed benefits (see, in particular, Crandall et al. 1976, 155–61). Probably the best approach is to keep track of quality adjustments for these government-mandated items separately, since it may be appropriate to include them as quality rather than price increases for some purposes (e.g., measuring productivity changes in the automobile-producing industry), while treating them as price rather than quality increases for other purposes (e.g., measuring the effective capital input of automobiles in industries using automobiles as a producer durable good).

8.2.3 Used Car Prices and the Transaction Prices of New Cars

The ideal price index for automobiles, as for any product, would be based on changes in transaction prices fully adjusted for changes in quality. Previous hedonic indexes for new cars have been based on manufacturers advertised list prices, which may differ from true transactions prices in the presence of discounts or premiums. Since about 1960, the CPI has kept track of discounts and thus is probably closer to a transaction price measure than a hedonic index based on list prices. However, the validity of allowance in the CPI for discounts and premiums before 1960 is open to question.

The last section of this chapter examines the effects of taking an index of late-model used car prices, adjusted for changes in the depreciation rate, as a proxy for the transaction prices of new cars. This makes a substantial difference in the late 1940s and early 1950s, due to premiums charged on new cars at that time.[14] By far the greatest difference between the CPI and my "final" index occurs in the early years of the postwar period, and I interpret this shift as a result of a change from premiums to discounts in the relation of transactions prices of new cars to list prices. Large differences also arise between hedonic indexes for new cars and the new car CPI, but these differences are probably the result of inadequate quality corrections in the hedonic indexes.

8.3 Data Used in the Hedonic Regression Study

The basic data for the hedonic regression equations in this chapter come from two sources. For the period 1947–69, the source is the 1 July edition of National Market Reports' *Red Book: National Used Car Market Report* (hereafter NMR), which was published every six weeks during that time period.[15] For the period 1969–83, the source was the October edition of the *NADA Official Used Car Guide,* which is published monthly.[16] Both guides contain data on physical characteristics, new car list prices, and estimates of retail used car transaction prices for all automobile models produced in the United States (and, recently, all major imports).

New car list prices in the guides are supplied by manufacturers. These include the cost of all standard equipment but no optional equipment. They also exclude state and local taxes, shipping charges, and dealer preparation charges. Where do the guides obtain their estimates of used car prices? There

14. In January 1949, *CR* calculates the percentage of the new list price that must be paid for used 1948 models as follows: Chevrolet 168 percent, Ford 153 percent, Buick 151 percent, Pontiac 165 percent, and Plymouth 148 percent. In contrast, in April 1970 (198), *CR* quotes an FTC study documenting the prevalence of discounts of from 15 to 20 percent of the sticker price.

15. I am grateful to Fred Heffinger, president of National Market Reports, for allowing me to monopolize his xerox machine for almost two days to copy the data.

16. Both sources apply to the central United States ("region A" for NMR, "Midwest region" for NADA). We have both sources for the overlap year 1969.

are two main sources.[17] First, sales reports are submitted from dealers. The number of transactions is claimed to be "large," and prices are presumably free from influence by any single dealer or group of dealers.[18] The second major source of information is the wholesale auto auction report. There are over 100 auto auctions located throughout the United States. Auctions may be better indications of value than dealer reports on wholesale prices, since the latter involve problems of interpreting inflated trade-in values. The major limitation of auctions is their thinness, but variations of prices so caused would presumably be dampened by the process of averaging over 100 auction reports. The NADA *Guide* is based roughly one-third on retail dealer used car reports, one-third on wholesale dealer used car reports, and one-third on auto auction reports.[19]

8.3.1 Characteristics of the Sample

The sample includes observations on every four-door sedan manufactured by Chrysler, Ford, and General Motors (the "Big Three") and by American Motors since 1977, except for the three luxury makes (Imperial, Lincoln or Continental, and Cadillac). The luxury makes are excluded to avoid biasing coefficients. Previous research has shown that these luxury makes are substantially overpriced in relation to their "quality" as measured by the standard hedonic physical characteristic variables.[20] Cars made by firms other than the Big Three are also excluded; this reduced the clerical time in collecting the data set while excluding only a small portion of sales. Imported cars are also excluded, so that the resulting hedonic price index (like the PPI) applies to domestic U.S. production, not domestic U.S. purchases.

In comparison to the O-G paper, the regression equations in this chapter include more observations in each year for new cars and fewer for used cars. This reflects a difference in emphasis. O-G included six vintages of used cars in each year of their sample period (1961–71) and made an extensive study of depreciation patterns and their interaction with make effects. There is no reason to duplicate this aspect of the O-G study, and instead only a single depreciation rate from one-year-old to two-year-old status is estimated. Other differences are that O-G include both four-door sedans and four-door hardtops, while I include only sedans; I include all trim variations and engine

17. The following description is paraphrased from the introduction of the *NADA Official Used Car Guide*, July 1973, E-1–E-8.

18. Fred Heffinger of NMR in a discussion with me estimated that, at the time (1970), roughly 10,000 dealer reports and other pieces of information are digested for each issue, and that each report refers to multiple transactions.

19. The NADA explanation also states that the raw data received by the publishers are edited to reduce measurement error. High and low limits from a norm are established to weed out clerical errors and "junker" sales.

20. Although most hedonic regression studies have included dummy variables for luxury cars ("prestige effects"), the original Griliches (1961) study did not. O-G report an average new car "make effect" for Cadillac, Continental, and Imperial beginning in 1960 of 31.4 percent relative to Chevrolet.

types (at least through 1976) while they include only a subset; and I treat accessories differently. As we shall see, these differences appear to make little difference in the results, as the new index for new cars is a virtual mirror image of the O-G index during the overlap period (1955–71), and the used car index is almost as close (for 1961–71). Because of this overlap, the discussion below concentrates on the periods where the new coverage is unique (1972–83 for new cars and both 1947–60 and 1972–83 for used cars).[21]

All the regression equations include make dummies, but these are not reported in tables 8.6 and 8.7 to save space. The make dummies control for systematic variations in price by make, and thus they minimize errors due to the changing number of observations of each make in adjacent years. An additional control is provided by excluding compact cars from any regression in which they would appear for only a single year, on the grounds that since compact cars tend to be overpriced in relation to quality, including such a car in only the second year of an adjacent-year equation might bias upward the coefficient on the time dummy.

Despite these exclusions, the sample is unnecessarily large. Models with identical weight, length, and engine characteristics are entered into the regressions between two and four times, reflecting differences in trim. Originally, this duplicative procedure was chosen to avoid possible errors that might have been introduced by the arbitrary choice of a single trim type, but the similarity of the new results to those of O-G suggest that it was not worth the trouble. Another related point is that the size of the sample may be misleadingly large because of the overlap in quality characteristics among different brand names of the same manufacturer (e.g., Ford and Mercury), further cutting the "true" degrees of freedom in this study. To some extent, the instability of some of the coefficients on the physical characteristic variables may reflect an inadequacy of sufficient independent variation over these dimensions.

8.3.2 The Process of "Stripping"

The general principle was to make each observation comparable by excluding all accessories except for a radio and heater. The practical procedures for carrying out the adjustments were as follows.

1. Beginning with medium-priced models in the 1950s, and extending to most large models in the 1960s, prices in the guides sometimes included AT and, later, PS. In the 1970s and 1980s, prices for many large cars also included AC. In most cases, the guides provided the required information on the list price (for new cars) or the amount to deduct (for used cars) that

21. Ohta and Griliches (1986) estimate cross-sectional regressions for used cars for April and October in each year from 1970 to 1981, but they do not include time dummies, nor do they calculate a hedonic price index.

allowed the price to be adjusted for the presence of this equipment. The adjustments were double-checked with the annual automobile issue of *CR*, which notes the list price of each test car and the options with which it is equipped.[22]

2. The used car price was calculated in the same way by adjusting the listed "retail price" in the guide. In the first decade, radios and heaters were not included in the basic price, but a separate table in the front of the book listed option prices of radios and heaters by vintage. After about 1956, the value of radios and heaters was included in all used car "retail price" estimates. Accessory lists are provided immediately adjacent to the prices of each model, indicating by how much to reduce the price if a car was lacking a particular item (AT, PS, etc.), and these lists were the source of the "stripping" adjustments.

3. The weight data published in the guides were adjusted for those models with AT and/or power steering included as standard equipment, using an estimation of the contribution of each item to the weight of a 1974 Chevrolet Impala.[23] This adjustment was performed on only a small number of models over most of the years of the study, since AT and PS did not become standard equipment on the full-sized Chevrolet until 1971, and later (or never) on smaller cars.

8.4 Regression Estimates for New Cars

The estimated hedonic regression equations are presented for the full period 1947–83 in table 8.6 for new cars and table 8.7 for used cars. Each table has the same format as for the hedonic regression studies of Sears catalog appliance data in chapter 7. In the left-hand column is a pooled regression for a set of years, and in the rest of the table are separate regressions for pairs of adjacent years. All these regression equations are based on a standardized approach.

1. A semilog specification is used to facilitate comparison with other studies. Each physical characteristic is entered as its arithmetic value (weight in thousands of pounds, brake horsepower in hundreds, and overall length in hundreds of inches). Dummies are entered for trim level (from 4 for cheapest to 1 for most expensive), type of engine (4, 6, straight 8, or V-8), and time.

2. While both pooled and adjacent-year equations are estimated, to maintain a consistent format with the appliance chapter, they yield similar results, and I compute hedonic indexes only for the adjacent-year equations.

22. When no information was given to allow a deduction for, say, AT, the price adjustment was taken from the next lower priced model of the same brand name, e.g., the Chevelle price for AT was used if the Impala price was missing. The radio adjustments for the last half of the 1960s were made by extrapolating the last available radio price listing on the assumption of a constant price. Radio prices appear to have been roughly constant for several decades, as shown in App. table B.2B.

23. Obtained from Robert T. Welch of the General Motors Corp.

Table 8.6 **Semilog Hedonic Regressions for New Cars and Four-Door Sedans, 1947–55, 1955–62, 1962–69, 1969–76, 1976–83**

A. 1947–55

	1947–55	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55
Weight	0.26 (8.07)	0.87 (10.9)	0.27 (4.07)	0.06 (1.94)	0.07 (1.58)	0.01 (0.12)	0.38 (8.14)	0.41 (7.64)	0.64 (6.04)
Length	0.76 (6.80)	−0.72 (−3.11)	0.26 (1.23)	1.40 (9.91)	1.37 (8.03)	1.34 (4.28)	0.46 (2.94)	0.66 (3.37)	−0.23 (−0.67)
Brake horsepower	0.14 (4.43)	−0.26 (−2.23)	0.47 (4.11)	0.49 (7.16)	0.20 (3.09)	0.24 (2.86)	0.17 (4.96)	0.13 (3.27)	0.03 (0.40)
6 cylinder	0.02 (1.62)	... ...	... ...	0.04 (2.08)	−0.01 (−0.55)	−0.04 (−1.33)	0.02 (1.40)	0.03 (1.80)	0.06 (1.72)
Straight 8	0.03 (2.03)	−0.06 (−2.80)	−0.07 (−2.93)	... ...	... ...	−0.06 (−1.40)	0.01 (0.45)	0.03 (1.45)	0.11 (0.01)
Trim	−0.03 (−6.01)	−0.04 (−3.90)	−0.03 (−4.43)	−0.02 (−4.66)	−0.02 (−3.64)	−0.04 (−3.42)	−0.04 (−5.68)	−0.04 (−4.88)	−0.04 (−3.45)
Intercept	4.68 (28.7)	6.05 (19.9)	5.42 (15.6)	3.92 (17.6)	4.31 (16.8)	4.68 (12.0)	5.21 (25.9)	4.75 (17.2)	5.88 (12.6)
1948	0.12**	0.14**	...	...	...	...	...	...	...
1949	0.30**	...	0.16**	...	...	...	...	...	...
1950	0.27**	...	...	−0.04**	...	...	...	...	...
1951	0.35**	...	...	...	0.08**	...	...	...	...
1952	0.37**	...	...	...	...	0.02	...	...	...
1953	0.37**	...	...	...	...	...	0.00	...	...
1954	0.34**	...	...	...	...	...	...	0.03**	...
1955	0.35**	...	...	...	...	...	...	...	0.05*
$\bar{R}^2$	0.941	0.961	0.936	0.970	0.955	0.951	0.990	0.978	0.903
S.E.E.	0.060	0.039	0.048	0.033	0.041	0.047	0.025	0.036	0.066
Observations	344	73	79	84	80	69	69	76	83

B. 1955–62

	Pooled 1955–62	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61	1961–62
Weight	0.21 (7.48)	0.59 (4.69)	0.45 (5.74)	0.58 (6.90)	0.50 (4.27)	0.20 (2.59)	0.13 (2.20)	0.03 (0.80)
Length	0.12 (0.98)	0.57 (1.35)	1.08 (4.17)	0.48 (1.49)	1.70 (3.16)	−0.14 (−0.47)	0.17 (0.65)	0.68 (4.24)
Brake horsepower	0.05 (3.04)	0.07 (1.00)	0.03 (0.74)	0.00 (0.11)	0.08 (2.96)	0.12 (3.59)	0.07 (2.73)	0.09 (3.92)
Trim	−0.05 (−9.1)	−0.04 (−4.77)	−0.05 (−7.06)	−0.06 (−6.42)	−0.05 (−7.88)	−0.04 (−3.65)	−0.04 (−4.77)	−0.05 (−7.14)
Intercept	6.70 (37.7)	4.58 (7.35)	4.09 (10.9)	4.93 (10.3)	2.43 (2.83)	7.32 (17.7)	6.94 (19.3)	6.25 (27.7)
1956	0.00	−0.02	...	...	...	...	...	...

1957	0.06**	. . .	0.01**	. . .	. . .	. . .	. . .	. . .
1958	0.08*	. . .	. . .	−0.01	. . .	. . .	. . .	. . .
1959	0.10**	. . .	. . .	. . .	0.02	. . .	. . .	. . .
1960	0.09**	. . .	. . .	. . .	. . .	−0.01	. . .	. . .
1961	0.02**	. . .	. . .	. . .	. . .	. . .	0.01	. . .
1962	0.17**	. . .	. . .	. . .	. . .	. . .	. . .	0.04**
$\bar{R}^2$	0.857	0.909	0.966	0.944	0.971	0.845	0.856	0.903
S.E.E.	0.074	0.057	0.038	0.050	0.027	0.067	0.064	0.052
Observations	368	83	83	83	79	86	101	116

C. 1962–69

	Pooled 1962–69	1962–63	1963–64	1964–65	1965–66	1966–67	1967–68	1968–69
Weight	0.16 (15.1)	0.06 (1.59)	0.23 (6.97)	0.13 (7.79)	0.07 (3.10)	0.19 (12.5)	0.19 (13.9)	0.19 (7.10)
Length	0.11 (3.10)	0.58 (3.86)	−0.02 (−0.21)	0.16 (2.54)	0.35 (4.52)	0.03 (0.82)	0.05 (1.46)	0.06 (0.66)
Brake horsepower	0.08 (11.6)	0.08 (3.40)	0.01 (0.43)	0.10 (6.83)	0.11 (7.26)	0.04 (3.38)	0.05 (4.84)	0.10 (8.65)
6 Cylinder	0.02 (3.35)	0.01 (0.34)	. . . . . .	0.04 (3.78)	0.04 (3.29)	0.01 (0.72)	. . . . . .	0.05 (4.49)
Trim	−0.04 (−16.5)	−0.05 (−6.29)	−0.05 (−7.54)	−0.05 (−11.6)	−0.04 (−11.5)	−0.04 (−12.4)	−0.04 (−13.1)	−0.04 (−9.82)
Intercept	7.02 (148.9)	6.44 (30.0)	7.22 (45.7)	6.97 (78.9)	6.73 (65.6)	7.12 (139.)	7.09 (153.)	6.97 (63.6)
1963	−0.00	−0.02	. . .	. . .	. . .	. . .	. . .	. . .
1964	0.00	. . .	−0.01	. . .	. . .	. . .	. . .	. . .
1965	−0.04*	. . .	. . .	−0.02	. . .	. . .	. . .	. . .
1966	−0.03	. . .	. . .	. . .	0.01*	. . .	. . .	. . .
1967	−0.02	. . .	. . .	. . .	. . .	0.01**	. . .	. . .
1968	0.02**	. . .	. . .	. . .	. . .	. . .	0.04**	. . .
1969	0.02**	. . .	. . .	. . .	. . .	. . .	. . .	−0.02*
$\bar{R}^2$	0.903	0.886	0.895	0.939	0.931	0.941	0.954	0.923
S.E.E.	0.047	0.057	0.049	0.033	0.033	0.030	0.027	0.039
Observations	701	125	134	155	174	177	170	245

(*continued*)

Table 8.6 (continued)

	D. 1969–76							
	1969–76	1969–70	1970–71	1971–72	1972–73	1973–74	1974–75	1975–76
Weight	0.30 (22.8)	0.17 (7.87)	0.22 (11.1)	0.31 (12.3)	0.31 (7.87)	0.37 (8.88)	0.30 (11.4)	0.19 (6.25)
Length	0.01 (0.15)	0.17 (2.14)	0.39 (5.46)	0.27 (2.82)	0.21 (1.50)	−0.10 (−0.68)	−0.11 (−1.60)	−0.10 (−1.48)
Brake horsepower	0.06 (6.80)	0.12 (10.8)	0.08 (6.23)	0.04 (2.71)	0.15 (3.90)	0.08 (1.74)	0.08 (1.88)	0.14 (3.26)
4 Cylinder	0.05 (1.53)	0.09 (3.42)	0.10 (3.24)	0.13 (3.17)	. . . . . .	. . . . . .	. . . . . .	. . . . . .
6 Cylinder	0.02 (3.05)	0.06 (5.73)	0.04 (3.61)	0.01 (1.22)	. . . . . .	. . . . . .	. . . . . .	. . . . . .
Trim	−0.03 (−10.1)	−0.04 (−9.99)	−0.03 (−7.72)	−0.03 (−6.11)	−0.04 (−5.12)	−0.04 (−5.71)	−0.04 (−4.95)	−0.07 (−7.58)
Intercept	6.80 (110.1)	6.79 (62.2)	6.26 (65.1)	6.36 (53.0)	6.37 (36.8)	6.86 (37.0)	7.22 (68.1)	7.83 (65.4)
1970	0.02**	0.03*	. . .	. . .	. . .	. . .	. . .	. . .
1971	0.08**	. . .	0.07**	. . .	. . .	. . .	. . .	. . .
1972	0.05**	. . .	. . .	−0.04	. . .	. . .	. . .	. . .
1973	0.02**	. . .	. . .	. . .	−0.02	. . .	. . .	. . .
1974	0.10**	. . .	. . .	. . .	. . .	0.07**	. . .	. . .
1975	0.25**	. . .	. . .	. . .	. . .	. . .	0.16**	. . .
1976	0.30**	. . .	. . .	. . .	. . .	. . .	. . .	0.05**
$\bar{R}^2$	0.932	0.930	0.955	0.970	0.955	0.931	0.881	0.884
S.E.E.	0.059	0.041	0.038	0.035	0.045	0.054	0.065	0.065
Observations	612	246	170	127	114	142	113	97

E. 1976–83

	1976–83	1976–77	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83
Weight	0.01 (1.00)	−0.01 (−0.25)	−0.06 (−0.99)	0.09 (1.46)	0.06 (0.84)	0.05 (0.82)	0.01 (0.90)	0.01 (0.59)
Length	0.44 (8.53)	0.74 (3.79)	0.81 (4.75)	0.11 (0.59)	−0.01 (−0.08)	0.00 (−0.02)	0.35 (4.33)	0.70 (8.29)
Brake horsepower	0.12 (5.80)	0.17 (3.24)	0.00 (1.14)	0.06 (0.67)	0.09 (1.05)	0.16 (2.55)	0.08 (2.29)	0.23 (3.62)
4 Cylinder	0.03 (1.67)	... ...	−0.10 (−1.54)	0.06 (1.58)	0.09 (2.06)	0.07 (1.89)	0.00 (−0.14)	... ...
6 Cylinder	0.01 (0.90)	... ...	−0.02 (−0.07)	... ...	0.03 (1.14)	0.04 (1.69)	... ...	−0.02 (−0.88)
Trim	−0.08 (−8.11)	−0.07 (−5.53)	−0.05 (−2.91)	... ...	... ...	... ...	... ...	... ...
Intercept	7.41 (73.4)	6.47 (29.2)	6.98 (35.9)	7.90 (39.0)	8.25 (45.4)	8.29 (57.5)	8.04 (54.3)	7.32 (50.3)
1977	0.03*	0.03	...	...	...	...	...	...
1978	0.18**	...	0.14**	...	...	...	...	...
1979	0.23**	...	...	0.04*	...	...	...	...
1980	0.34**	...	...	...	0.11**	...	...	...
1981	0.59**	...	...	...	...	0.23**	...	...
1982	0.68**	...	...	...	...	...	0.08**	...
1983	0.71**	...	...	...	...	...	...	0.04**
$\bar{R}^2$	0.862	0.720	0.707	0.485	0.532	0.834	0.643	0.822
S.E.E.	0.092	0.091	0.081	0.078	0.066	0.056	0.072	0.075
Observations	424	120	122	106	102	98	89	100

*Indicates significance at the 5 percent level.

**Indicates significance at the 1 percent level.

Table 8.7 **Semilog Hedonic Regressions for Used Cars and Four-Door Sedans, 1947–55, 1955–62, 1962–69, 1969–76, 1976–83**

A. 1947–55

	1947–55	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55
Weight	0.11 (5.73)	0.05 (1.30)	0.08 (2.36)	0.06 (2.25)	0.07 (3.36)	0.32 (6.57)	0.22 (4.91)	0.04 (1.40)	0.11 (2.50)
Length	0.58 (8.47)	0.74 (4.22)	0.28 (2.51)	0.04 (0.41)	0.05 (0.59)	−0.37 (−2.24)	0.25 (1.63)	1.11 (10.5)	1.16 (6.95)
Brake horsepower	0.22 (8.68)	−0.08 (−0.08)	0.02 (0.21)	0.26 (3.73)	0.33 (4.77)	0.11 (2.54)	0.10 (2.72)	0.12 (3.81)	0.09 (2.09)
Age	−0.20 (−36.9)	−0.16 (−13.4)	−0.15 (−21.1)	−0.20 (−24.5)	−0.21 (−27.2)	−0.17 (−28.2)	−0.20 (−28.9)	−0.22 (−31.1)	−0.24 (−20.9)
6 cylinder	−0.02 (−2.47)	−0.03 (−1.63)	−0.03 (−2.02)	... ...	... ...	... ...	−0.01 (−0.72)	... ...	... ...
V 8	0.01 (0.89)	0.01 (0.30)	0.02 (0.92)	0.06 (2.25)	0.05 (2.21)	0.03 (1.74)	0.03 (2.27)	0.06 (3.67)	0.04 (1.55)
Trim	−0.02 (−5.12)	−0.04 (−4.34)	−0.03 (−4.27)	−0.02 (−3.66)	−0.03 (−5.30)	−0.02 (−4.60)	−0.02 (−3.84)	−0.05 (−7.67)	−0.04 (−3.27)
Intercept	5.93 (57.40)	6.07 (21.7)	6.98 (38.2)	7.07 (42.0)	6.91 (44.4)	7.20 (33.4)	6.40 (32.3)	5.22 (33.9)	4.86 (19.3)
1948	0.18**	0.17**	...	...	...	...	...	...	...
1949	−0.09**	...	−0.27**	...	...	...	...	...	...
1950	−0.08**	...	...	0.00	...	...	...	...	...
1951	0.01	...	...	...	0.08**	...	...	...	...
1952	0.08**	...	...	...	...	0.08**	...	...	...
1953	0.01	...	...	...	...	...	−0.06**	...	...
1954	−0.09**	...	...	...	...	...	...	−0.10**	...
1955	−0.12**	...	...	...	...	...	...	...	−0.04**
$\bar{R}^2$	0.904	0.886	0.955	0.902	0.927	0.954	0.960	0.971	0.941
S.E.E.	0.062	0.047	0.040	0.051	0.048	0.038	0.039	0.039	0.056
Observations	608	95	136	155	167	169	157	143	144

B. 1955–62

	1955–62	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61	1961–62
Weight	0.25 (7.99)	0.44 (6.88)	0.29 (3.58)	0.43 (3.89)	0.12 (2.09)	0.14 (3.00)	0.14 (2.51)	0.07 (1.41)
Length	−0.03 (−0.22)	0.53 (2.38)	0.66 (2.41)	0.06 (0.16)	1.03 (3.96)	0.96 (4.01)	−0.13 (−0.59)	0.01 (0.04)
Brake horsepower	−0.01 (−0.36)	0.00 (0.06)	0.05 (1.02)	−0.03 (−0.39)	0.14 (3.25)	0.03 (1.30)	0.05 (2.34)	0.08 (4.07)
Age	−0.29 (−33.3)	−0.28 (−20.9)	−0.29 (−17.4)	−0.28 (−13.3)	−0.23 (−14.0)	−0.25 (−19.3)	−0.29 (−25.1)	−0.29 (−27.4)
6 cylinder	−0.10 (−6.01)	−0.04 (−1.61)	... ...	... ...	... ...	... ...	... ...	−0.09 (−1.77)
Straight 8	−0.09 (−2.04)	−0.03 (−0.93)	... ...	... ...	... ...	... ...	... ...	... ...
Trim	−0.03 (−0.67)	0.03 (1.19)	... ...	... ...	... ...	... ...	−0.06 (−0.95)	−0.05 (−0.86)
Intercept	7.09 (34.4)	5.20 (16.2)	5.34 (1.40)	6.26 (9.92)	5.10 (10.9)	5.31 (12.3)	7.63 (24.6)	7.60 (29.2)
1956	−0.03**	0.02	...	...	...	...	...	...

1957	0.01**	. . .	0.04**	. . .	. . .	. . .	. . .	. . .
1958	0.04**	. . .	. . .	−0.07**	. . .	. . .	. . .	. . .
1959	0.02**	. . .	. . .	. . .	0.01	. . .	. . .	. . .
1960	0.01**	. . .	. . .	. . .	. . .	−0.06**	. . .	. . .
1961	0.03*	. . .	. . .	. . .	. . .	. . .	−0.01	. . .
1962	0.01**	. . .	. . .	. . .	. . .	. . .	. . .	0.01
$\bar{R}^2$	0.862	0.949	0.943	0.899	0.916	0.936	0.924	0.937
S.E.E.	0.083	0.051	0.055	0.070	0.062	0.055	0.057	0.054
Observations	660	155	160	161	164	164	169	178

	C. 1962–69							
	1962–69	1962–63	1963–64	1964–65	1965–66	1966–67	1967–68	1968–69
Weight	0.13 (8.48)	0.09 (1.98)	0.06 (1.49)	0.19 (8.81)	0.20 (8.61)	0.05 (1.10)	0.05 (0.89)	0.23 (5.46)
Length	0.02 (0.68)	−0.05 (−0.23)	0.13 (0.71)	−0.03 (−1.27)	−0.02 (−0.76)	0.34 (1.89)	0.27 (1.27)	−0.34 (−2.38)
Brake horsepower	0.10 (7.31)	0.07 (3.28)	0.08 (3.14)	−0.01 (−0.22)	0.06 (2.30)	0.16 (4.67)	0.16 (4.46)	0.12 (6.38)
4 cylinder	−0.10 (−3.74)	−0.21 (−5.49)	−0.20 (−6.27)	−0.21 (−6.45)	−0.13 (−3.88)	−0.06 (−0.99)	0.02 (−0.28)	−0.06 (−1.48)
6 cylinder	−0.02 (−1.60)	−0.04 (−2.05)	−0.06 (−2.82)	−0.08 (−3.74)	. . . . . .	0.04 (1.22)	0.04 (1.24)	0.04 (2.54)
Age	−0.26 (−36.8)	−0.29 (−26.3)	−0.27 (−25.7)	−0.25 (−23.1)	−0.27 (−23.9)	−0.29 (−18.9)	−0.25 (−16.1)	−0.24 (−30.1)
Trim	−0.07 (−7.17)	. . . . . .	. . . . . .	−0.06 (−0.88)	−0.06 (−0.84)	−0.07 (−0.67)	−0.07 (−0.70)	−0.07 (−10.1)
Intercept	7.26 (125.0)	7.58 (27.4)	7.34 (28.8)	7.41 (78.2)	7.21 (72.6)	6.70 (25.1)	6.84 (22.5)	7.61 (43.1)
1963	0.04*	0.08**	. . .	. . .	. . .	. . .	. . .	. . .
1964	0.04*	. . .	0.00	. . .	. . .	. . .	. . .	. . .
1965	0.03**	. . .	. . .	−0.02	. . .	. . .	. . .	. . .
1966	−0.07**	. . .	. . .	. . .	−0.10**	. . .	. . .	. . .
1967	−0.02*	. . .	. . .	. . .	. . .	0.06**	. . .	. . .
1968	0.04**	. . .	. . .	. . .	. . .	. . .	0.07**	. . .
1969	0.01**	. . .	. . .	. . .	. . .	. . .	. . .	−0.03
$\bar{R}^2$	0.842	0.932	0.939	0.935	0.927	0.853	0.814	0.918
S.E.E.	0.092	0.059	0.059	0.061	0.067	0.097	0.098	0.062
Observations	1117	201	213	253	283	318	329	327

(*continued*)

Table 8.7 (continued)

	D. 1969–76							
	1969–76	1969–70	1970–71	1971–72	1972–73	1973–74	1974–75	1975–76
Weight	0.11 (7.59)	0.23 (5.07)	0.21 (4.76)	0.17 (4.76)	0.28 (8.55)	0.18 (4.69)	−0.01 (−0.68)	0.03 (1.14)
Length	−0.11 (−2.48)	−0.45 (−2.86)	−0.69 (−4.21)	−0.34 (−2.78)	−0.38 (−3.26)	−0.50 (−3.41)	−0.06 (−1.00)	0.02 (0.41)
Brake horsepower	0.16 (18.2)	0.15 (7.90)	0.23 (12.1)	0.18 (9.42)	0.04 (2.52)	0.12 (5.57)	0.17 (4.81)	0.13 (3.63)
4 cylinder	0.02 (0.64)	−0.04 (−1.29)	0.16 (3.79)	0.09 (1.82)	−0.05 (−0.81)	−0.19 (−2.00)	. . . . . .	. . . . . .
6 cylinder	0.04 (4.34)	. . . . . .	0.12 (6.90)	0.07 (−4.10)	−0.02 (−1.36)	0.02 (1.44)	. . . . . .	. . . . . .
Age	−0.26 (−44.1)	−0.25 (−23.6)	−0.26 (−23.6)	−0.23 (−23.2)	−0.22 (−16.2)	−0.28 (21.4)	−0.27 (−26.5)	−0.25 (−22.3)
Trim	−0.05 (−16.1)	−0.06 (−10.8)	−0.05 (−8.23)	−0.03 (−4.70)	−0.05 (−7.37)	−0.05 (−7.39)	−0.06 (−8.84)	−0.06 (−7.50)
Intercept	7.49 (115.5)	7.84 (38.7)	8.14 (39.1)	7.73 (48.4)	7.81 (51.9)	8.40 (45.0)	8.23 (96.4)	8.21 (87.9)
1970	−0.02	−0.01	. . .	. . .	. . .	. . .	. . .	. . .
1971	0.13**	. . .	0.16**	. . .	. . .	. . .	. . .	. . .
1972	0.18**	. . .	. . .	0.06**	. . .	. . .	. . .	. . .
1973	0.22**	. . .	. . .	. . .	−0.01**	. . .	. . .	. . .
1974	0.27**	. . .	. . .	. . .	. . .	0.03**	. . .	. . .
1975	0.46**	. . .	. . .	. . .	. . .	. . .	0.20**	. . .
1976	0.57**	. . .	. . .	. . .	. . .	. . .	. . .	0.11**
$\bar{R}^2$	0.903	0.912	0.890	0.877	0.887	0.818	0.863	0.892
S.E.E.	0.085	0.067	0.067	0.076	0.075	0.086	0.071	0.066
Observations	1007	326	243	263	254	302	208	157

	E. 1976–83							
	1976–83	1976–77	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83
Weight	0.04 (4.03)	0.10 (3.03)	0.19 (3.26)	0.00 (−0.05)	−0.12 (−1.35)	−0.10 (−2.31)	0.09 (1.55)	0.07 (4.40)
Length	0.10 (2.04)	−0.10 (−0.97)	−0.45 (−2.32)	−0.02 (−0.06)	0.08 (0.34)	0.24 (2.08)	0.14 (1.03)	0.39 (5.80)
Brake horsepower	0.03 (1.34)	0.14 (3.13)	0.13 (2.43)	0.08 (0.78)	0.16 (1.44)	0.02 (0.37)	0.08 (1.33)	0.20 (2.91)
4 cylinder	−0.03 (1.57)	. . . . . .	−0.02 (−0.22)	0.02 (0.27)	0.02 (0.41)	−0.01 (−0.35)	0.07 (1.90)	. . . . . .
6 cylinder	−0.01 (−0.80)	. . . . . .	−0.01 (−0.26)	. . . . . .	. . . . . .	0.00 (−0.23)	0.02 (1.10)	−0.03 (−1.18)
Age	−0.22 (−16.0)	−0.23 (−17.0)	−0.24 (−18.3)	−0.21 (−8.82)	−0.19 (−8.23)	−0.23 (−20.1)	−0.23 (−20.1)	−0.23 (−17.4)
Trim	−0.06 (−5.77)	−0.05 (−5.70)	−0.03 (−1.94)	. . . . . .	. . . . . .	. . . . . .	. . . . . .	. . . . . .
Intercept	8.14 (90.6)	8.20 (60.0)	8.54 (38.0)	8.49 (26.2)	8.54 (30.5)	8.47 (65.1)	8.21 (60.6)	7.78 (73.5)
1977	−0.01	−0.01	. . .	. . .	. . .	. . .	. . .	. . .
1978	0.14**	. . .	0.15**	. . .	. . .	. . .	. . .	. . .
1979	0.14**	. . .	. . .	−0.02	. . .	. . .	. . .	. . .
1980	0.27**	. . .	. . .	. . .	0.11**	. . .	. . .	. . .
1981	0.48**	. . .	. . .	. . .	. . .	0.20**	. . .	. . .
1982	0.58**	. . .	. . .	. . .	. . .	. . .	0.09**	. . .
1983	0.67**	. . .	. . .	. . .	. . .	. . .	. . .	0.11**
$\bar{R}^2$	0.787	0.713	0.725	0.377	0.389	0.824	0.775	0.816
S.E.E.	0.129	0.098	0.098	0.167	0.161	0.074	0.078	0.086
Observations	897	226	237	218	224	218	204	192

*Indicates significance at the 5 percent level.

**Indicates significance at the 1 percent level.

Turning now to table 8.6, which presents five pooled equations and thirty-six adjacent-year equations, the included variables appear to provide a good explanation of automobile prices, with an average standard error in the adjacent-year equations of about 5 percent, less in some years, and more in others, particularly after 1976. The values and significance levels of the coefficients on the three physical characteristic variables are erratic due to multicollinearity, and twelve out of the 108 coefficients on these variables in the adjacent-year equations have the wrong (negative) sign. All the coefficients on these variables in the pooled equations, however, have the correct sign.

The significance of the weight variable exhibits cycles, with high significance in adjacent-year regressions beginning in 1947, 1948, 1952–60, and 1964–76. Interestingly, the weight variable becomes very insignificant after 1976, reflecting in part the down-sizing of some cars without a corresponding reduction in their price. The significance of the length variable exhibits shorter cycles, with relatively high significance in 1949–54, 1961–66, 1970–72, 1976–78, and 1981–83.

The coefficients on the time dummies for the adjacent-year equations are converted into a hedonic price index for new cars in table 8.8 and compared there with the CPI and with hedonic indexes developed by Griliches (1964) and Ohta and Griliches (1976). Despite differences in methodology, the new index agrees very closely with O-G over the full 1955–71 interval, including both the secular rate of increase and the year-to-year fluctuations. The correspondence with the Griliches (1964) index is much less close. While the year-to-year pattern is quite different, the overall rate of increase between 1951 and 1961 is not too far apart, with total increases of 4.1 percent for the new index and 1.3 percent for the Griliches index. There is also less than a perfect correspondence between the Griliches (1964) index and those (not shown) presented in his first paper (1961), which covers only 1937, 1950, and 1954–60. The two Griliches indexes for 1950–54 show growth rates of 2.8 and 11.2 percent, respectively. But the story is radically different from 1947 to 1951, with an increase in the new index of 40.5 and in the Griliches (1964) index of 8.2 percent. The Griliches index seems implausible, in view of the sample means in table 8.3 that show a 41.1 percent increase in price from 1947 to 1951, with hardly any change in weight, length, or horsepower. Griliches does not exhibit his sample means, but for the low-priced three subset of his sample, the mean price increases by 49.1 percent (even more than the 41.1 percent in my sample, as shown in table 8.3), yet there is only a small increase in the three main physical characteristics.[24]

24. Griliches (1964, table 6, p. 395). Between 1947 and 1951, weight increased only from 3,166 to 3,303, length increased from 197.4 to 199.3, and horsepower increased from 92 to 103. The G_A quality index increased only by 6.7 percent.

Table 8.8 **Alternative Price Indexes for New and Used Cars (1967 = 100)**

	New Cars						Used Cars		
	CPI (1)	PPI (2)	PDE Deflator (3)	Griliches (4)	O-G (5)	This Study Hedonic (6)	CPI (7)	O-G (8)	This Study Hedonic (9)
1947	69.2	69.8	57.4	91.1		67.7			124.6
1948	75.6	77.2	65.3	96.4		77.9			147.7
1949	82.8	87.9	69.8	101.7		91.4			112.7
1950	83.4	88.2	70.6	99.5		87.8			112.7
1951	87.4	88.7	84.8	98.6		95.1			122.1
1952	94.9	96.0	95.6	104.8		97.0			132.3
1953	95.8	95.6	77.0	104.7		97.0	89.2		124.6
1954	94.8	96.8	86.1	102.3		94.2	75.9		112.7
1955	90.9	88.1	80.3	98.3	98.1	99.0	71.8		108.3
1956	93.5	93.5	113.8	99.1	100.2	97.0	69.1		106.2
1957	98.4	98.2	106.3	100.3	100.5	98.0	77.4		110.5
1958	101.5	102.0	116.1	101.4	98.7	97.0	80.2		103.0
1959	105.9	107.1	101.6	101.7	97.5	99.0	89.5		104.1
1960	104.5	105.8	99.1	101.6	98.3	98.0	83.6		98.0
1961	104.5	105.0	103.3	99.9	99.9	99.0	86.9	91.9	97.0
1962	104.1	105.0	98.9		102.5	103.0	94.8	92.2	98.0
1963	103.5	105.0	100.9		101.3	101.0	96.0	104.2	106.2
1964	103.2	103.0	98.1		100.0	100.0	100.1	103.9	106.2
1965	100.9	101.6	93.9		94.1	98.0	99.4	103.5	104.1
1966	99.1	100.0	97.5		98.5	99.0	97.0	98.2	94.2
1967	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0
1968	102.8	103.6	98.9		103.1	104.1	104.0	103.4	107.3
1969	104.4	104.6	101.6		104.1	102.0	108.1	106.2	104.1
1970	107.6	108.5	118.0		106.5	105.1	104.3	104.3	103.0
1971	112.0	111.9	110.6		113.3	112.7	110.2	117.8	120.9
1972	111.0	111.9	108.3			108.3	110.5		128.4
1973	111.1	111.1	105.6			106.2	117.6		127.1
1974	117.5	118.5	106.1			113.9	122.6		131.0
1975	127.6	128.8	127.9			133.6	146.4		160.0
1976	135.7	136.7	124.9			140.5	167.9		178.6
1977	142.9	143.1	124.6			144.8	182.9		176.8
1978	153.8	154.8	139.3			166.5	186.5		205.3
1979	166.0	166.3	156.5			173.3	201.0		201.4
1980	179.3	180.2	189.8			193.5	208.1		224.8
1981	190.2	191.3	166.7			243.5	256.9		274.6
1982	197.6	198.4	156.5			263.8	296.4		300.4
1983	202.6	203.6	151.2			274.6	329.7		335.4
1984	208.5	209.5	141.5				375.7		

Sources by column: **(1, 2)** *Business Statistics* (U.S. Department of Commerce), 1975 and 1984 editions. **(3)** NIPA May 1986 tape, deflator for new cars from gross auto output table, table 1.17 divided by table 1.18. **(4)** Griliches (1964, D coefficients in table 4, p. 393). **(5)** Ohta and Griliches (1976, table 26, col. 1, p. 384). **(6)** This study, table 8.6, computed from adjacent-year coefficients. **(7)** Same as col. 1. **(8)** Ohta and Griliches (1976, table 24, col. 1, p. 381). **(9)** This study, table 8.7, computed from adjacent-year coefficients.

Returning now to the comparison of new car indexes in table 8.8, it seems ironic that there is a very small difference in the total price increase registered by the CPI and by the new hedonic index over the full period between 1947 and 1974, 69.8 and 68.2 percent, respectively. The lack of a major difference with the CPI seems surprising in light of the widespread impression that the extent of quality adjustments in the CPI was less extensive before 1960 than afterward. Even between the CPI and the linked Griliches indexes, the difference is relatively minor over the 1951–71 period, with increases of 28.1 and 12.9 percent, respectively, a difference that amounts to an annual growth rate over the period of just 0.6 percent, not much to get excited about, and very small compared to the differences between the new "alternative" indexes and the PPI in other parts of this book. The closeness of the new index to that of O-G after 1955 supports their conclusion (and that of Triplett) that the CPI may have understated the rate of price increase during the period 1960–66, although such a conclusion hinges on the validity of the hedonic price technique using these physical "proxy" variables, which are subject to the criticism (reviewed above) that it makes a virtue of increased weight over periods when engineers may have been working to reduce weight. I return to this question below in a comparison of several "closely similar" models that span the 1960s.

After 1974, however, there is a substantial difference between the CPI and the hedonic index for new cars. From 1974 to 1983, the CPI increases by 77.4 percent, much less than the 141.8 percent increase in my hedonic price index for new cars. At annual rates, the hedonic index increases at 10.3 percent, a rate 3.7 percent faster than the 6.6 percent annual rate of increase of the CPI over this period. As we shall see below, *all* this discrepancy can be explained by the allowance in the CPI for quality improvements taking the form of government-mandated safety and antipollution devices, in contrast to the hedonic index that makes no such allowances.

8.5 Hedonic Regression Estimates for Used Cars

We enter into more virgin territory in the treatment of used car prices. Although he estimated cross-sectional regressions for used cars in several papers (Griliches 1961; Ohta and Griliches 1986), Griliches has published a hedonic price index for used cars covering only the limited period 1961–71 (Ohta and Griliches, 1976). Because my used and new car samples are comparable, in the sense that the one-year-old and two-year-old used cars in the sample are exactly the same makes and models as are the new cars (except in introductory years), the ratio of the mean stripped price of used cars relative to new cars is a meaningful indicator of the postwar history of the relative price of used cars. This ratio, shown in the first column of table 8.5, remained in the range of 64–71 percent through the period 1957–74. In the first decade, from 1947 to 1957, the used/new price ratio fell dramatically, reflecting the transition from premiums to discounts on new cars. In the final decade, the ratio increased from an average of 67.1 percent in 1964–73 to 72.9 percent in 1974–83. This transition may have reflected, at least in part, reduced discounts on new cars resulting from reduced margins allowed to dealers by manufacturers and hence less "bargaining room."

The regression estimates for 1947–83 are presented in table 8.7; all details of implementation are identical to those in the new car regressions. The average standard error is somewhat higher than the average for new cars, perhaps because of measurement error in the used car price estimates, a greater importance of "left-out" variables, or the extra variance introduced by including two vintages for each year.[25] The coefficients on the major quality characteristics are somewhat more erratic than in the new car equations, with horsepower and the V-8 dummy relatively more significant in many years, and length relatively less important. The rate of depreciation between ages 1 and 2 appears to have been relatively slow in the first few years of the postwar period, with an average rate of 18 percent in the four equations spanning 1947–53, as compared to an average rate of 27 percent for 1953–63, 25 percent for 1963–73, and 23 percent for 1973–83.

Returning now to table 8.8, we can compare the hedonic price index for used cars with the O-G index covering 1961–71 and the CPI used car index covering the full period since 1953. The correspondence between my index and that of O-G is almost as close as for new cars, except for their much greater price increase in 1962–63. For 1963–71, the increases in my index and theirs are a very close 13.8 and 13.9 percent, respectively.

Several interesting ratios are provided in table 8.9 to summarize the results for used cars. The first column lists the average stripped price of used cars relative to new cars, set on a base of 1967 = 1.0, from tables 8.3 and 8.4. This shows, as we saw previously in table 8.5, that the index of raw (quality unadjusted) used car prices stayed in a relatively constant relation to a similar index of new car prices from 1957 to 1974. Prior to 1957, used car prices declined relative to new car prices, as did the used hedonic index relative to the new hedonic index in column 2. After 1974, used car prices averaged 112 percent of new car prices on a base of 1967 = 100; this increase may have reflected some combination of a reduction in the magnitude of dealer discounts and a reduction in the depreciation rate, as occurs in the coefficients on age in the hedonic regression equations for used cars.

The next column (2) in table 8.9 shows that the ratio of the used hedonic price index from table 8.8 rises relative to the new hedonic index, particularly in the 1970–72 period. It is interesting to recall that this was a period of price controls on new cars, so that the jump in used car prices might reflect an

25. For the adjacent-year equations spanning 1961–71, my standard error is 0.069, compared to 0.098 for Ohta and Griliches. However, the samples are not comparable, since I include several trim classes for each model, and they include six vintages instead of my two.

Table 8.9 Key Ratios for Automobiles, 1947–83 (1967 = 1.0 or 100)

	Used/New Means (1)	Used/New Hedonic (2)	Used Mean/ Used Hedonic (3)	(1)/(2) (4)	Used Hedonic/ Used CPI (5)	Transaction Price Adjustment (6)
1947	1.84	1.84	0.93	1.00		164.4
1948	1.77	1.90	0.84	0.94		161.9
1949	1.23	1.23	0.87	1.00		115.6
1950	1.19	1.28	0.85	0.93		117.4
1951	1.22	1.28	0.87	0.95		113.2
1952	1.21	1.36	0.87	0.89		120.5
1953	1.18	1.28	0.90	0.92	1.40	118.2
1954	1.09	1.20	0.90	0.91	1.49	112.6
1955	1.17	1.09	0.99	1.07	1.51	117.7
1956	1.10	1.09	0.96	1.00	1.54	115.9
1957	1.04	1.13	0.98	0.93	1.43	113.1
1958	0.94	1.06	1.02	0.89	1.28	97.6
1959	1.02	1.05	1.08	0.97	1.16	103.7
1960	1.02	1.00	1.11	1.02	1.17	106.6
1961	1.06	0.98	1.12	1.08	1.12	107.8
1962	1.02	0.95	1.05	1.07	1.03	104.0
1963	1.07	1.05	1.01	1.02	1.11	108.9
1964	1.05	1.06	1.00	0.99	1.06	105.7
1965	1.08	1.06	1.01	1.02	1.05	110.2
1966	0.98	0.95	1.03	1.04	0.97	102.3
1967	1.00	1.00	1.00	1.00	1.00	100.0
1968	1.03	1.03	1.02	1.00	1.03	101.5
1969	0.94	1.02	0.96	0.92	0.96	97.7
1970	1.02	0.98	1.11	1.04	0.99	101.4
1971	0.97	1.07	0.96	0.91	1.10	99.5
1972	1.04	1.19	0.98	0.88	1.16	107.0
1973	1.05	1.20	0.99	0.88	1.08	117.0
1974	0.99	1.15	1.03	0.86	1.07	109.8
1975	1.07	1.20	1.01	0.89	1.09	113.2
1976	1.18	1.27	1.05	0.93	1.06	119.1
1977	1.12	1.22	1.04	0.92	0.97	115.6
1978	1.12	1.23	0.99	0.91	1.10	111.8
1979	1.12	1.16	1.01	0.96	1.00	105.4
1980	1.11	1.16	0.99	0.95	1.08	110.4
1981	1.08	1.13	1.00	0.96	1.07	107.6
1982	1.09	1.14	1.00	0.96	1.01	108.5
1983	1.15	1.22	0.97	0.94	1.02	115.6

Sources by column: (**1**) Table 8.4, col. 2, divided by table 8.3, col. 2, expressed as an index number, 1967 = 1.0. (**2**) Table 8.8, col. 9, divided by col. 6. (**3**) Table 8.4, col. 2, rebased to 1967, and divided by table 8.8, col. 9. (**4**) Table 8.9, col. 1, divided by col. 2. (**5**) Table 8.8, col. 9, divided by col. 7. (**6**) Exponential index created from the logs of two indexes, (1) the average of the ratio of the used/new means and the ratio of the used/new hedonic (cols. 1 and 2), and (2) an index of $1/(1 - d_1)$, where d_1 is the absolute value of the "age" coefficients for each year from the adjacent-year used-car regressions in table 8.7.

excess demand for cars, as one might expect during a period of controls. The partial reversal of this phenomenon in 1973–74 reinforces the view that an effect of controls may have been involved. Nevertheless, there does seem to have been an increase in quality-adjusted used car prices in the past decade. One good measure of this is the ratio in column 2 for the postcontrols period (1976–83) of 119 percent, as compared to the 1962–71 decade, when the same ratio was 102 percent. This increase in the relative price of used cars seems implausibly large to be accounted for solely by a shrinkage in discounts; another source may be an inconsistency in the number of options included in the new car and used car observations in the hedonic regression equations. I return to this issue below in section 8.8.

An interesting index of the quality of used cars, as evaluated on the used car market, is provided in column 3, which displays the ratio of an index of the mean price of used cars to the used hedonic index. When this ratio increases, it indicates an increase in the quality of used cars. For instance, if the actual price of used cars increased by 15 percent while the hedonic index remained constant, this set of facts could be interpreted as implying a 15 percent improvement in quality. As shown in column 3 of table 8.9, there was a marked improvement in quality from 1947 to 1958, with a "quality peak" reached in 1961 at a level 20 percent higher than 1947, but then a decline in quality set in, until in the last decade the implicit quality index in table 8.9 reached an average level of 101, the same level as 1958, and only a modest improvement from 1947.

The next column in table 8.9, column 4, shows the ratio of the used/new mean ratio in column 1 to that for the used and new hedonic indexes in column 2. This column can be interpreted as providing a relative quality evaluation index, since high numbers indicate that quality is valued more highly in the used car market, while low numbers indicate that quality is valued more highly in the new car market. While the numbers jump around, reflecting in part the lag in the adjustment of the used car market to the new car market, there is no trend over the full period, and the 1982–83 figures are not far from the 1947 and 1967 values of one.

Finally, column 5 exhibits the ratio of the used hedonic price index to the used auto price component of the CPI. There was a major downtrend of the hedonic index that lasted from the inception of the used car CPI in 1953 through the mid-1960s. After that, there was little trend, as indicated by the ratio of 1.02 in 1983 on a 1967 = 1.00 base. The discrepancy between my index and the CPI for used cars before 1965 is large but not unexpected. Only Chevrolets, Fords, and Plymouths were priced by the CPI before 1962, no allowance was made for optional equipment before 1966, and there has been no other allowance for changes in quality.[26] More interesting is the lack of

26. These statements are based on "Seasonal Demand and Used Car Prices," *Monthly Labor Review* (March 1967): 12–16.

difference in the growth rate of the hedonic used car index after 1965 and the CPI for used cars. If the latter incorporates few if any quality adjustments, then we might infer either that on balance there was no net quality improvement, or alternatively that the hedonic index for used cars misses some types of quality change.

8.6 Changes in Quality Mandated by Safety and Environmental Regulations

The three major types of government regulation affecting the automobile are safety standards, air pollution standards, and the regulation of fuel economy. This section treats the value of equipment added to automobiles to comply with safety and pollution regulations, and the next section reviews evidence on changes in fuel economy. The safety and environmental adjustments cover only the period after 1967, since the major legislation has taken effect only since that date, particularly the National Traffic and Motor Vehicle Safety Act of 1966, the Motor Vehicle Information and Cost Savings Act of 1972, the Clean Air Act Amendments of 1970 and 1977, and the Energy Policy and Conservation Act of 1975. In the next section, the measures of changing fuel economy extend over the whole postwar period, since changes in fuel economy are desirable in themselves and have occurred continuously, although their pace was accelerated after the early 1970s not only by fuel economy legislation but by the 1973–74 and 1979–80 increases in the relative price of gasoline.

Details on the legislation are provided by Crandall et al. (1986) and White (1982). The 1970 Clean Air Act set the ambitious target of reducing the level of auto emissions by 90 or 95 percent of the average 1968 level, although this standard was relaxed to about 80 percent by the 1977 Clean Air Act Amendments. Safety standards are set by the National Highway Traffic Safety Administration (rather than by Congress, as in the case of emissions regulations) and include more than fifty separate standards for passenger vehicles. The 1966 act that began the process of safety regulation occurred before the major environmental legislation, and thus major changes in automobile equipment in the late 1960s involved safety items (e.g., seat belts).

The most controversial issues involving safety and environmental regulations involve measuring their benefits, rather than their costs. Beginning with the 1967 model year, the BLS has issued an annual release providing a breakdown of the value of its quality adjustments for automobiles into three categories, safety equipment, emissions control equipment, and other changes. In some years, the safety equipment is further subdivided into two categories, items formally mandated and those added voluntarily or in anticipation of future regulations. The CPI adjustments are displayed in table 8.10 and are subsequently incorporated into the final price index for new cars.

Table 8.10 Components of CPI Price and Quality Adjustment and of Hedonic Price and Quality Change, Index Numbers, 1967 = 100

	Components of CPI Price and Quality Change						Hedonic		
			Components of Quality Adjustment						
	Unadjusted Price Change (1)	Total Quality Adjustment (2)	Safety (3)	Environmental (4)	Other (5)	Net Price Change (6)	Sample Mean Price Change (7)	Quality Adjustment (8)	Price Index (9)
1967	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1968	103.9	101.8	101.3	100.5	100.0	102.0	106.2	102.1	104.1
1969	105.7	101.8	101.9	100.5	99.4	103.8	107.3	105.2	102.0
1970	110.3	103.7	103.0	100.7	100.0	106.4	112.1	106.6	105.1
1971	117.2	103.9	103.5	100.7	99.8	112.9	119.8	106.2	112.7
1972	118.1	104.6	103.6	100.9	100.2	112.9	120.8	111.6	108.3
1973	123.6	109.4	106.8	101.9	100.6	113.0	119.1	112.1	106.2
1974	136.5	114.0	110.8	102.0	100.9	119.7	135.5	119.0	113.9
1975	155.0	118.8	111.2	106.0	100.9	130.5	150.9	112.9	133.6
1976	164.5	119.2	111.6	106.2	100.7	138.0	158.9	113.1	140.5
1977	182.0	121.2	111.9	106.6	101.7	150.2	163.2	112.7	144.8
1978	201.6	122.6	111.9	106.8	102.7	164.4	180.6	108.5	166.5
1979	215.3	123.9	112.0	107.1	103.4	173.8	181.5	104.8	173.3
1980	232.1	130.2	112.3	109.7	105.8	178.2	202.3	104.5	193.5
1981	257.0	144.1	112.4	120.0	106.9	178.4	253.5	104.1	243.5
1982	282.9	147.3	112.4	121.8	107.7	192.1	276.2	104.7	263.8
1983	296.2	150.5	112.4	123.1	108.9	196.8	282.8	103.0	274.6
1984	306.2	153.1	112.2	124.2	110.0	200.0			
1985	318.4	156.5	112.2	124.6	112.1	203.4			

Sources by column: (**1–6**) The source was a complete set of annual BLS press releases covering the 1967–85 model years. Each press release gives the dollar change in total price and the dollar change in quality, subdivided into three categories, safety, environmental legislation, and "other." The net price change, when not given specifically, is computed as the dollar change in the unadjusted price minus the dollar quality adjustment. Adjustments were given in both dollars and percentage of retail price in 1967 and 1968, allowing the computation of the unadjusted price each year. Percentage changes are then computed from the dollar changes divided by the unadjusted price, updated each year. Index numbers are developed from the cumulative percentage changes, using the formula $100 \times \exp[\ln(X_{t-1}) + x_t]$, where X_{t-1} is last year's value (starting from 1967 = 100), and x_t is the change in the item from last year to this year. (**7**) Table 8.3, col. 2. (**8**) Index created exponentially from col. 7 divided by col. 9. (**9**) Table 8.8, col. 6.

Previous authors have presented time series of the dollar cost of safety regulation (Crandall et al. 1986, 35–37; White 1982, 60–65). In some cases, the cumulative dollar costs are actually exhibited without any correction for inflation, which seems inappropriate in light of the tripling of the average selling price of new cars (table 8.3) over the 1967–83 period. Fortunately, the BLS releases on safety and emission control equipment provide enough information to convert the value of the changes in each year to a percentage figure, expressed as a percent of the average selling price of cars in that particular year. This is feasible because, in 1967 and 1968, the BLS lists each change both in dollar terms and as a percentage of the average retail selling price. Each successive release provides the information only in dollars, but these can be converted into percentages by cumulating the 1968 selling price by the total dollar price change in each year. Both the dollar price changes and the 1968 selling price are expressed as retail rather than wholesale values, so that the percentage changes are computed on a consistent basis. The index of the average unadjusted price is shown in column 1 of table 8.10, where it can be compared with the mean unadjusted price in the new car hedonic sample. Over the full 1967–83 period, the unadjusted CPI price grows at an annual rate of 7.0 percent, close to the 6.7 percent growth rate of the hedonic sample mean. Over shorter periods, the growth rates of the two average price figures differ by more than this, with the CPI figure growing more rapidly from 1974 to 1980, while the hedonic sample mean grows much more rapidly from 1980 to 1981.

Column 2 displays the total CPI quality adjustment as an index number, computed from the dollar quality adjustments expressed as a percentage of the previous year's average selling price. The total quality adjustment is then broken down into its three components—safety, emission control, and other—in columns 3–5. The safety adjustments came in the first decade after 1967 and were minimal after 1975. The emission control adjustments were made in two stages, 1973–75 and 1979–81. The "other" adjustments were surprisingly small from 1967 to 1976, and then proceeded at a rate of about 1 percent per year thereafter. One puzzle involving the small "other" adjustments between 1967 and 1976 is that data from General Motors (discussed below) indicate that important options, especially AT and PS, became standard equipment on full-sized Chevrolets in 1971, and presumably around that time on other popular makes.

Overall, the quality adjustments reduce the annual 1967–83 increase in the CPI from an unadjusted 7.0 percent to an adjusted 4.3 percent.[27] In contrast, columns 8–9 show that, on balance, there was virtually no quality improvement implicit in the hedonic regression estimates, in that the increase in the hedonic regression price index in column 9 was almost as rapid as in the raw unadjusted mean price in the hedonic sample displayed in column 7. The hedonic quality index in column 8 simply picks up the fact, already obvious in the means of table 8.3, that cars became larger and heavier through the mid-1970s and then became smaller. An interesting artifact of the shifting coefficients in the adjacent-year regressions is that, although the average values of all three physical characteristics were significantly lower in 1983 than in 1967, the implicit quality index in column 8 is 3 percent higher. This is possible in principle if the coefficients in the 1967–75 period placed a higher value on the increase in physical characteristics than the coefficients of

27. The index values in col. 6 of table 8.10 may not correspond exactly to the published CPI in col. 1 of table 8.8, since the former are based on price changes between introductory months one year apart, usually September or October, while the published CPI is an annual average of monthly figures. However, the difference in the annual growth rates is small, 4.3 percent for table 8.10 vs. 4.5 percent for the published CPI.

the 1976–83 period placed on the decline in those characteristics. In particular, recall that the coefficient on weight drops to a low or even negative value in the new car hedonic regression equations of table 8.6 beginning in 1975–76 and in the used car regression equations of table 8.7 beginning in 1974–75.

8.7 Fuel Economy

Fuel economy has long been recognized as an important performance attribute of automobiles, and Crandall et al. (1976, 133) quote a government estimate that the ratio of the present value of gasoline costs to that of capital costs for a car held for four years was 31 percent for 1972 model automobiles and 42 percent for 1981 model cars. Recently Ohta and Griliches (1986) have carried out an extensive study of hedonic regression equations including fuel economy variables (but without time dummies—hence the omission of this study from table 8.8). In the past, the main problem precluding quality adjustments for changes in fuel economy was the very high negative correlation of fuel economy and weight, precluding independent estimates of coefficients for the fuel economy and weight variables. However, recent research on fuel economy, particularly that of Wilcox (1984), has circumvented this problem by estimating constant-quality fuel economy indexes based on hedonic-like regression equations in which fuel economy is the dependent variable and various physical characteristics are explanatory variables.[28]

Wilcox's basic index is displayed as column 1 of table 8.11. It displays a slow increase through 1968, a small decline through 1971, and then a rapid increase to 1980. For the overlap period 1971–80, we also have a regression-based fuel economy index developed by Crandall et al. (1976), and this increases much less during the overlap period than the Wilcox index. There are three reasons to prefer the Wilcox estimates. First, he estimates adjacent-year equations rather than a single pooled equation, thus allowing coefficients to shift. Second, and probably more important, he includes many explanatory variables that are missing from the Crandall study, yet are known to affect fuel economy.[29] Third, the gas mileage concept explained by the Wilcox regressions is constant speed gas mileage, whereas Crandall uses the more ambiguous figures for "city driving" and "highway driving." As Wilcox

28. As an historical note, Wilcox was a research assistant working on this book in the mid-1970s and carried out his research on fuel economy as an independent project (later updated through 1980), using my complete file of postwar *CR* articles on automobiles.

29. Both studies include weight and front-wheel drive. Crandall includes displacement as an indicator of engine size, whereas Wilcox chooses acceleration as a measurement of engine performance. Variables included by Wilcox but omitted by Crandall are dummy variables for PS, PB, AT, AC, overdrive, extra forward transmission gears, and diesel engines. Crandall also includes three "corporate" dummies that are all insignificant.

Table 8.11 **Alternative Fuel Economy Indexes**

	Wilcox Fuel Economy Index (1)	Crandall Fuel Economy Index (2)	White Emissions Control Penalty (3)	Linked Emission-adjusted Index (4)
1947				82.5
1948				82.5
1949	82.5			82.5
1950	85.0			85.0
1951	85.0			85.0
1952	86.8			86.8
1953	86.4			86.4
1954	84.5			84.5
1955	84.3			84.3
1956	84.5			84.5
1957	84.2			84.2
1958	84.3			84.3
1959	88.6			88.6
1960	95.3			95.3
1961	92.4			92.4
1962	91.6			91.6
1963	92.8			92.8
1964	92.0			92.0
1965	95.0			95.0
1966	99.8			99.8
1967	100.0			100.0
1968	101.3			101.3
1969	98.9			98.9
1970	97.7			97.7
1971	96.0	98.0	100.0	96.0
1972	101.2	98.0	100.0	101.2
1973	107.4	99.0	108.0	115.9
1974	119.2	99.0	108.0	128.8
1975	113.4	102.0	101.0	114.6
1976	114.7	112.7	101.0	115.8
1977	120.9	112.7	103.0	124.6
1978	132.6	112.7	103.0	136.6
1979	139.2	113.9	103.0	143.4
1980	143.2	113.9	106.0	151.8
1981		118.5	107.0	159.5
1982		119.7	107.0	161.1
1983		131.0	107.0	176.2
1984		123.4	107.0	166.0

Sources by column: (**1**) Wilcox (1984), index computed by taking exponents of successive changes recorded in table 1, pp. 378–79. (**2**) Crandall et al. (1976), index computed by taking exponents of successive changes recorded in table 6–4, col. 4, p. 129. (**3**) Same source as col. 2, table 6–5, col. 2, p. 130. (**4**) *1947–48:* linked to col. 1 in 1949. *1949–70:* same as col. 1. *1970–80:* exponential index created from col. 1 times col. 3. *1981–83:* column 2 linked to col. 4 in 1980, adjusted by col. 3.

(1984, 382) shows for 1953–66, regression indexes based on these vague standards are biased downward, since they fail to hold speed and acceleration constant and because *CR* has gradually changed the tests to make them "tougher."

The Crandall discussion points out an additional issue that Wilcox neglects, and this is the fact that regression-based gas mileage indexes do not take into account the penalty imposed by pollution control equipment. If the latter is classified as part of the cost of environmental legislation, then "true" gas mileage should be adjusted upward to take out the negative effect of emissions control equipment. The Crandall study uses the estimates by White (1982), shown in column 3 of table 8.11. My linked gas mileage index combines the Wilcox figures through 1980 and the linked Crandall index for 1980–84 and adjusts both for the emissions control penalty. The Wilcox index is extended back from 1949 to 1947, assuming no change in those two years.

8.8 Discounting, Premia, and the "Transaction Price Proxy"

8.8.1 Perfect Substitutability and the Estimation of First-Year Depreciation

An important defect of all hedonic regression studies of new car prices, including mine, is the use of manufacturers' list prices. However, the price quotations in the used car regressions (coming from dealer reports and auctions) are much closer to the desired transaction price concept. A useful working assumption is that late-model used cars are perfect substitutes for new cars, except for age. Since the depreciation rate from the true transaction price at age 0 to the transaction price at age 1 is not observable, perfect substitutability can be interpreted as imposing the assumption that depreciation is geometric from the initial date of sale, that is, that the unobserved depreciation rate from age 0 to age 1 is the same as the observed rate from age 1 to age 2 (or, more generally, to the average observed depreciation rate over all ages after the first year). This implies that price fluctuations in quality-adjusted used car prices relative to the quality-adjusted list prices of new cars reflect changing discounts or premiums of new car transaction prices from new car list prices.

This section first describes the procedures followed to implement the assumption that age-adjusted prices of used cars can be used as a proxy for the transaction prices of new cars, and then it considers possible objections and qualifications to the assumption. To supply the missing proxy for the depreciation from the "true" new price to the observed age 1 price, it seems reasonable to assume a zero-to-one depreciation rate (d_0) equal to the one-to-two year depreciation rate (d_1) estimated in the hedonic regression equations of table 8.7. This rate rises from an average of 17 percent for

1947–51 to the range of 27–29 percent during most of the postwar period, with a slight decline to around 23 percent toward the end of the 1970s. Since by definition the observed price at age 1 (P_1) equals the true new price (P_0) adjusted for the true depreciation rate,

$$P_1 = (1 - d_0)P_0 , \tag{8.3}$$

by assuming $d_0 = d_1$, we can calculate the "transaction price proxy" (*TPP*, or P^*_0) as

$$P^*_0 = P_1/(1 - d_1). \tag{8.4}$$

By allowing the geometric depreciation rate to vary each year, this procedure does not impute to new car prices changes in used car prices due solely to changes in depreciation rates observable on used cars.

8.8.2 Calculation of the Transaction Price Proxy

In order to carry out the calculation of the TPP, we need some measure of quality-adjusted used car prices relative to quality-adjusted new car prices. We cannot use the CPI, since quality adjustments are not carried out consistently in the CPI new and used car indexes. The obvious choice would seem to be the ratio of the used to the new hedonic index. This has the advantage that the same physical characteristics enter the quality-adjustment procedure for new cars and used cars. The main disadvantages are two: both the new and used hedonic indexes are prone to implausible jumps up and down, due to erratic movements in the estimated coefficients on the time dummy variables, and the coefficients in the used car regressions differ from those in the new car regressions and may not reflect buyer tastes in the new car market.

An alternative would be to use the ratio of the raw unadjusted mean price in the used car sample to the new car sample. This has the advantage that these are unadulterated raw numbers, not prone to jumps imposed by the regression procedure, but with the disadvantage that quality improvements that are accompanied by price increases are introduced into the new car mean 1.5 years prior to their introduction in the used car mean, causing a drop in the ratio when new car quality improves, and vice versa. The used/new ratio of mean prices appears in table 8.9, column 1, and can be compared to the used/new hedonic index ratio in column 2 of the same table. The overall secular behavior of both ratios is similar, although year-to-year movements are quite different. Because the case for either index is not overwhelming, the calculations of table 8.11 are based on an average of the used/new mean price ratio and the used/new hedonic index ratio.

The TPP adjustment displayed in column 6 of table 8.9 is simply this average ratio from columns 1 and 2, times an index of $1/(1 - d_1)$ from the used car regressions in table 8.7, restated as an index number with

1967 = 100. After the very large adjustments of 1947–48 reflecting premia over list prices (discussed below), the discount adjustment (expressed as an index number on a 1967 base) averages 116 for 1949–57, 103.5 for 1958–72, and 112.2 for 1973–83. How should these movements be interpreted? First, to take a year when the index is at a low level, and using data in table 8.12 for the full-sized Chevrolet as an example, the used price of a one-year-old V-8 Impala model in 1969 was $1,970 and the estimated transaction price of a new 1969 model (using the estimated 25 percent depreciation rate) is $2,627, indicating a discount of 12.4 percent from the 1969 list price of $2,999.[30] In 1977, the same calculation (using a depreciation rate of 21 percent) indicates a discount of 7.2 percent. In contrast, the used price of a one-year-old model in 1948 was $2,045 and the estimated transaction price of a new 1948 model was $2,400, indicating a premium of 71 percent over the 1948 list price of $1,345.

Are these values plausible? *CR* in 1970 (April, 198) reported the results of an FTC study indicating that half the full-sized models "went at prices from 15 to 20 percent less than the sticker price," which is regrettably vague but at least not inconsistent with my implied discount of 12.4 percent. The 1977 value also seems plausible in light of the calculation by Bresnahan and Reiss (1985, 267) that the average new car retailed at 95 percent of list in 1977, and we would expect the discount of a large Chevrolet to be higher than average since the markup of list price over dealer cost is greater for larger models.[31]

As for 1948, the problem is more complicated. Why would purchasers pay so much more for a used car than a new model? The first reason is that the list prices were fictitious, as illustrated in the invoice for a 1948 Hudson displayed in *Consumer Reports* (May 1948, 205). Although the list price was $1,870, the price actually paid net of sales tax was $2,315, or about 24 percent above the list price. It is probably no coincidence that the price of a used 1948 Hudson in the 1 July 1948 *Red Book* (equipped with heater) was 29 percent higher than the stripped list price. Of the 24 percent premium, 14 percent represents extra amounts needed to obtain the basic stripped model, and the other 10 percent reflects the costs of accessories.

But this example cannot explain a 71 percent premium in price as calculated above for the Chevrolet. Part may be due to the greater popularity of the Chevrolet than the Hudson in 1948, since the ratio of used to new Chevrolet prices (69 percent) was higher than for any other make displayed by *CR* (January 1949, 10). Much of the rest may be explained by the fact that, in a period of shortages and waiting lists, purchasers were willing to pay a premium for a used unit to the extent that the waiting period for a new model

30. In this and the following example, the prices refer to the most expensive Chevrolet four-door sedan equipped with radio and heater but not AT, PS, or PB.

31. The Bresnahan-Reiss study refers only to 1977 and does not provide data for any other year.

Table 8.12 **New and Used Prices for Top-of-Line Chevrolet, 1947–83**

	New Car List Price	Used Price			Depreciation		
		Age 0	Age 1	Age 2	List to Age 0	List to Age 1	Age 1 to Age 2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1947	1,256		1,620			1.29	
1948	1,407		2,045	1,695		1.45	0.83
1949	1,601		1,485	1,350		0.93	0.91
1950	1,591		1,545	1,200		0.97	0.78
1951	1,862		1,530	1,335		0.82	0.87
1952	1,811		1,710	1,455		0.94	0.85
1953	1,936		1,560	1,280		0.81	0.82
1954	1,946		1,575	1,130		0.81	0.72
1955	1,994		1,550	1,275		0.78	0.82
1956	2,126		1,530	1,150		0.72	0.75
1957	2,452		1,825	1,320		0.74	0.72
1958	2,609		1,815	1,440		0.70	0.79
1959	2,772		1,925	1,625		0.69	0.84
1960	2,759		1,980	1,445		0.72	0.73
1961	2,759		1,975	1,565		0.72	0.79
1962	2,769		1,990	1,555		0.72	0.78
1963	2,769		2,030	1,635		0.73	0.81
1964	2,779		2,025	1,625		0.73	0.80
1965	2,779		1,975	1,630		0.71	0.83
1966	2,783		1,875	1,475		0.67	0.79
1967	2,828		1,930	1,515		0.68	0.78
1968	2,951		2,150			0.73	
1969	2,999		1,970	1,555		0.66	0.79
1970	3,132		1,770	1,375		0.57	0.78
1971	3,742		2,500	1,925		0.67	0.77
1972	4,009		2,475	1,950		0.62	0.79
1973	4,176		2,875	2,100		0.69	0.73
1974	4,877	4,200	3,300	2,650	0.86	0.68	0.80
1975	5,290		3,600	2,725		0.68	0.76
1976	5,465		4,050	3,100		0.74	0.77
1977	5,864	5,450	4,300	3,400	0.93	0.73	0.79
1978	6,408	6,000	5,050	3,725	0.94	0.79	0.74
1979	7,229	5,675	4,525	3,775	0.79	0.63	0.83
1980	7,824	6,150	5,075	4,025	0.79	0.65	0.79
1981	8,419	7,950	6,400	5,125	0.94	0.76	0.80
1982	9,152	8,750	7,100	5,925	0.96	0.78	0.83
1983	9,898	9,650	8,150	6,800	0.97	0.82	0.83

Sources by column: (**1–4**) Sources for prices are the same as for the new car and used car hedonic regression equations. Prices are standardized for both new and used cars as follows: all years include radio and heater; 1971–73 observations include automatic transmission and power steering; 1974–83 observations include automatic transmission, power steering, and air conditioning. Engine is six-cylinder 1947–56 and V-8 for the interval 1957–83. (**5**) Column 2 divided by col. 1. (**6**) Column 3 divided by col. 1. (**7**) Column 4 divided by col. 3.

Table 8.13 **New and Used Price Ratios for Top-of-Line Chevrolet, Selected Intervals, 1947–83**

	Depreciation		
	List to Year 1	Year 1 to Year 2	Implied Discount
1949–53	0.89	0.85	1.05
1954–58	0.75	0.76	0.99
1959–63	0.72	0.79	0.91
1964–68	0.69	0.80	0.86
1969–73	0.64	0.77	0.83
1974–78	0.72	0.77	0.94
1979–83	0.73	0.82	0.89
1982–83	0.80	0.83	0.96

Source: Table 8.12.

imposed a nonpecuniary cost on them. In an attempt to explain the high used car prices during this period, *CR* (January 1949, 10) cited "dealer acceptance of tips or bonuses, juggling of waiting lists, loading of cars with accessories, and 'stealing' of used cars traded in by allowing only a fraction of their worth."

While the decline in used car prices relative to the list prices of new cars in the first postwar decade can plausibly be attributed to the transition from premiums to discounts, the increase in the relative value of used cars in the post-1970 period requires further discussion. To facilitate this, table 8.12 presents the price data from the hedonic regression data base for one particular model, the most expensive full-sized Chevrolet four-door sedan listed in each year. Original sources have been checked again to maintain a consistent treatment of accessories on each model observed in a given year. Engine types and included equipment are upgraded in 1957, 1971, and 1974 (see notes to table 8.12), implying that no comparisons can be made of the raw prices over time, but only between new and used models in a given year.

The information in table 8.12 is summarized in table 8.13 by taking five-year averages. Here, the final column labeled "Implied Discount" is stated as the implied ratio of the new car transaction price to the new car list price. This ratio shows a sharp jump (i.e., discounts dropped) between the 1969–73 and the 1974–78 periods. The apparent reversal of this change in 1979–83 is due to the temporary decline in the prices of used large "gas guzzlers" in the years of peak gasoline prices, 1979–80. By 1982–83, the ratio was above 95 percent, indicating that discounting had almost disappeared.

8.8.3 Possible Objections to the Transactions Price Proxy

The assumption that quality- and age-adjusted used car prices can be taken as a proxy for the unobservable transactions prices of new cars may ignore factors that can cause short-run deviations between true new car prices and observed new car prices. A used-car price quotation represents the price of a stock and can fluctuate in response to demand shifts over a wider range than the price of a new car. When there is a sharp drop in the demand for a particular model car, as in the case of large cars in the aftermath of the 1974 and 1979 oil price shocks, the price of the used car may fall below the transaction price of the new car. A dealer may limit the new-car discount that is offered, choosing to retain unsold cars as inventory (in the hope that demand will revive) rather than selling them at a loss. When there is a sharp rise in the demand for a particular model car, the price of the used car may rise above the transaction price of the new car, although there is no limit in the premium that dealers can charge (and dealers are known to have charged substantial premiums in 1983–85 on Japanese cars in short supply because of import quotas).

While correct in principle, this objection to the transaction price proxy methodology seems to have more force for individual models than for the U.S. car market as a whole. Episodes of shortage and surplus, while common for individual models, have been relatively rare and short lived for the aggregate car market. The major exception is the early postwar period, when high used car prices may reflect a combination of premiums above list price and the imputed value of waiting time for new cars in scarce supply. For this period, the transaction price proxy amounts to a shadow price of new cars as viewed by the consumer.

A second problem with my approach is that the used car price quotations do not refer to a uniform month of the year. Quotations are for July during 1947–69, October during 1977–83, and a mixture of months (April, July, and October) during 1970–76. The use of October rather than July in recent years tends to impart a slight downward bias to the increase in the hedonic used car price index (and to the used car price averages) in table 8.9. Another difficulty is that model years run from September to September, beginning in the year before the designation of the model's year, so that the average age of a "one-year-old" 1982 car observed in October 1983 is actually 1.5 years. Assuming that depreciation begins with the date of delivery, the use of the depreciation rate for year 1–2 to proxy the unobserved depreciation rate for year 0–1 may understate the depreciation that actually occurs over the 1.5 years before the "age 1" price quotation, and hence overstate the discount.

Further information on the behavior of prices during that initial 1.5-year period is provided in table 8.12 for full-sized Chevrolet models. For the years based on October observations, 1974 and 1977–83, I show in column 2 the price of an "age 0" car, that is, a 1983 model sold as used in October 1983. Although just 86 percent of the new list price in 1974, the "age 0 used price" rose to a remarkable 97 percent in 1983. Even if there were no discount at all on a new model, it seems implausible that people would have been willing to pay almost as much for a used 1983 model having an average age of six months as for a brand new model.[32] I am not aware that full-sized Chevrolets were being sold at a premium in 1982–83.

This leads to the third objection, that more optional equipment may be included in the used-car quotations than in the new-car list price, causing an upward bias in the transaction price proxy for new cars. The list prices of new cars and the retail values of used cars are adjusted to provide a consistent treatment of automatic transmission, power steering, and air conditioning. But, as shown in table 8.2, there has been a marked increase in the fraction of automobiles equipped with particular types of factory-installed equipment. And, within categories, there has also been a shift to higher quality, for example, from AM radios to stereo tape decks, and from manual to automatic control air conditioning. To the extent that my prices of used cars fail to "strip out" the value of these additional items that are not included as standard in the list price of the new car, there will be a spurious increase in the ratio of the used price to the new list price and a spurious finding of a reduction in discounting.

Fortunately, the used car guides that serve as data sources for this study make a fairly careful attempt to list the retail value of optional equipment separately from the value of the car equipped with standard items. For instance, the price for a one-year-old full-sized 1982 Chevrolet in the 1983 *NADA Official Used Car Guide* explicitly lists separate retail values for the following items, thus excluding them from the used one-year-old price quotation: vinyl roof, AM/FM/stereo with or without tape, power seats, power windows, power door locks, rear window defroster, wire wheel covers, tilt steering wheel, cruise control, luggage rack, and custom paint. Air conditioning is included, although not standard equipment, but I have stripped the value of air conditioning, automatic transmission, and power steering, from both the new list and the used price quotations. Of the items in table 8.2 that might be optional equipment but are not listed separately in the *Used Car Guide*, this leaves deluxe (automatic control) air conditioning, tinted glass, adjustable steering column, and remote control side mirror. Other items that are not listed in table 8.2 but that might be included as optional equipment are

32. An interesting comparison can be made between year 0–1 and year 1–2 depreciation rates for 1974 and 1977–83. From table 8.12, we have:

	1974	1977	1978	1979	1980	1981	1982	1983
0–1	21	21	16	19	17	19	19	16
1–2	20	21	26	17	21	20	17	17

For 1974–77 and 1981–83, the depreciation rates are quite close. The zigzags in 1979–80 may have been related to the oil price shocks. As for 1978, it is interesting to speculate that the used-car market treated the 1977 downsized Chevrolet as substantially more valuable than the previous larger-size 1976 model.

deluxe interior and exterior trim packages, bumper guards, and other items. It seems plausible to guess that the typical one-year-old full-sized Chevrolet in 1983 might have been equipped with $200–$300 in optional equipment that was not included in the list price of the new 1983 model. This would imply that the transaction price proxy overstates the 1983 price by 2–3 percent. Since this degree of possible overstatement seems relatively minor in comparison with other possible sources of error, it is neglected in the final calculations in the next section.

8.9 The "Final Alternative" Index

Tables 8.14 and 8.15 exhibit the steps taken to create the "final alternative" price index. Shown in the first three columns of table 8.14 are the CPI, the CPI before adjustment for quality change (available only after 1966), and the new car hedonic index from table 8.8. The ratio of the hedonic index to the CPI through 1966 and to the unadjusted CPI after 1966 is shown in column 4. This ratio shows remarkably little trend, remaining flat between 1947 and 1967, declining to 0.83 in 1980, and then jumping back to 0.90 in 1983. The 1967–80 decline indicates an improvement in quality as evaluated by the hedonic index, relative to the quality implicit in the unadjusted CPI. Another reason for the lesser rise in the hedonic index during the 1972–80 period and 1980–83 turnaround is that it excludes the prices of imported cars, which are included in the CPI. The depreciating dollar during 1972–80 boosted the relative prices of imported cars, while the appreciating dollar during 1980–83 reduced the relative prices of imported cars.

Because the CPI (unadjusted after 1966) and hedonic index have different strengths and weaknesses, I take their average as the "base price" for further quality adjustments. The feature they share in common is that neither index adjusts for the value of safety and pollution devices or changes in fuel economy. The unadjusted CPI has the advantage that (at least in theory) it takes into account changing discounts and warranty provisions, while the hedonic index has the advantage that it provides at least a crude adjustment for major changes in weight, length, and horsepower. The average of these two indexes is displayed in column 5 of table 8.14 and in column 6 is compared with the adjusted CPI.

Turning now to table 8.15, the "base" price index is copied into column 1. But the base index does not take account of safety and emission-control equipment. To achieve a correction for the value of this equipment, I take the component of the CPI quality adjustment due to safety and emissions-control equipment from table 8.10, columns 3 and 4, and display an index of the combined CPI adjustment in table 8.15, column 2. This is stated as an inverse of the quality index, in order to indicate the amount by which the price index needs to be reduced to account for the addition of safety and emission-control equipment.

Table 8.14 **Calculation of "Base" Price Index for New Cars, 1947–83 (1967 = 100)**

	CPI (1)	Unadjusted CPI (2)	New Car Hedonic Index (3)	Ratio of (3) to (1) or (2) (4)	Average of (3) and (1) or (2) (5)	Ratio of (4) to CPI (6)
1947	69.2		67.7	0.98	68.5	0.99
1948	75.6		77.9	1.03	76.7	1.02
1949	82.8		91.4	1.10	87.1	1.05
1950	83.4		87.8	1.05	85.6	1.03
1951	87.4		95.1	1.09	91.3	1.04
1952	94.9		97.0	1.02	96.0	1.01
1953	95.8		97.0	1.01	96.4	1.01
1954	94.8		94.2	0.99	94.5	1.00
1955	90.9		99.0	1.09	95.0	1.04
1956	93.5		97.0	1.04	95.3	1.02
1957	98.4		98.0	1.00	98.2	1.00
1958	101.5		97.0	0.96	99.3	0.98
1959	105.9		99.0	0.93	102.5	0.97
1960	104.5		98.0	0.94	101.3	0.97
1961	104.5		99.0	0.95	101.8	0.97
1962	104.1		103.0	0.99	103.6	0.99
1963	103.5		101.0	0.98	102.3	0.99
1964	103.2		100.0	0.97	101.6	0.98
1965	100.9		98.0	0.97	99.5	0.99
1966	99.1		99.0	1.00	99.1	1.00
1967	100.0	100.0	100.0	1.00	100.0	1.00
1968	102.8	104.7	104.1	0.99	104.4	1.02
1969	104.4	106.3	102.0	0.96	104.2	1.00
1970	107.6	111.5	105.1	0.94	108.3	1.01
1971	112.0	116.3	112.7	0.97	114.5	1.02
1972	111.0	116.1	108.3	0.93	112.2	1.01
1973	111.1	121.6	106.2	0.87	113.9	1.03
1974	117.5	133.9	113.9	0.85	123.9	1.05
1975	127.6	151.5	133.6	0.88	142.6	1.12
1976	135.7	161.8	140.5	0.87	151.2	1.11
1977	142.9	173.1	144.8	0.84	159.0	1.11
1978	153.8	188.6	166.5	0.88	177.6	1.15
1979	166.0	205.6	173.3	0.84	189.5	1.14
1980	179.3	233.5	193.5	0.83	213.5	1.19
1981	190.2	274.0	243.5	0.89	258.7	1.36
1982	197.6	291.0	263.8	0.91	277.4	1.40
1983	202.6	305.0	274.6	0.90	289.8	1.43

Sources by column: (1) Table 8.8, col. 1. (2) Table 8.10, col. 1, multiplied by ratio of CPI in col. 1 to adjusted CPI in table 8.10, col. 6. (3) Table 8.8, col. 6. (4) Column 3 divided by col. 1 through 1966 and by col. 2 after 1966. (5) Average of cols. 3 and 1 through 1966 and of cols. 3 and 2 after 1966. (6) Ratio of col. 4 to col. 1.

The adjustment for premiums and discounts displayed in column 3 is taken to be half the transaction price adjustment from table 8.9, column 6. I choose to include only half this adjustment, for two reasons. First, the base index is based on both the CPI and the hedonic index, but the CPI (at least since about 1960) is in principle already adjusted for changing discounts, and thus the transaction price adjustment should be applied only to the hedonic part of the base price index. Second, I suggested above that part of the large transaction price adjustment for 1947–48 represents the imputed value of consumer

Table 8.15 Calculation of Alternative Price Index for New Cars, 1947–83 (1967 = 100)

	"Base" Price Index (1)	CPI Safety and Environmental Quality Adjustment (2)	Adjustment for Discounts (3)	Adjustment for Value of Fuel Economy (4)	Final Alternative Index (5)	Ratio of (5) to New Car CPI (6)
1947	68.5		128.2	106.1	93.1	134.6
1948	76.7		127.2	106.1	103.6	137.1
1949	87.1		107.5	106.1	99.4	120.0
1950	85.6		108.4	105.2	97.6	117.0
1951	91.3		106.4	105.2	102.1	116.8
1952	96.0		109.8	104.5	110.1	116.0
1953	96.4		108.7	104.6	109.7	114.5
1954	94.5		106.1	105.3	105.6	111.4
1955	95.0		108.5	105.4	108.6	119.5
1956	95.3		107.6	105.3	108.0	115.5
1957	98.2		106.3	105.5	110.2	111.9
1958	99.3		98.8	105.4	103.4	101.9
1959	102.5		101.8	103.8	108.3	102.3
1960	101.3		103.2	101.5	106.1	101.5
1961	101.8		103.8	102.5	108.3	103.6
1962	103.6		102.0	102.8	108.5	104.2
1963	102.3		104.3	102.4	109.2	105.5
1964	101.6		102.8	102.6	107.2	103.9
1965	99.5		105.0	101.6	106.1	105.1
1966	99.1		101.1	100.1	100.2	101.1
1967	100.0	100.0	100.0	100.0	100.0	100.0
1968	104.4	98.2	100.7	99.6	102.8	100.0
1969	104.2	97.6	98.8	100.3	100.9	96.6
1970	108.3	96.4	100.7	100.7	105.9	98.4
1971	114.5	96.0	99.7	101.3	111.1	99.2
1972	112.2	95.7	103.5	99.6	110.7	99.7
1973	113.9	91.9	108.2	95.5	108.1	97.3
1974	123.9	88.4	104.8	92.5	106.2	90.3
1975	142.6	84.9	106.4	95.9	123.4	96.7
1976	151.2	84.4	109.1	95.5	133.0	98.0
1977	159.0	83.9	107.5	93.4	133.9	93.7
1978	177.6	83.7	105.7	90.8	142.7	92.8
1979	189.5	83.4	102.7	89.4	145.0	87.3
1980	213.5	81.1	105.1	87.9	159.9	89.2
1981	258.7	74.2	103.7	86.5	172.2	90.5
1982	277.4	73.1	104.2	86.3	182.1	92.1
1983	289.8	72.3	107.5	83.9	188.9	93.2

Sources by column: (1) Table 8.14, col. 5. (2) Exponential index created from minus the logs of the indexes exhibited in table 8.10, cols. 3 and 4. (3) Exponential index created from 0.5 of the log of the transaction price adjustment displayed in table 8.9, col. 6. (4) Exponential index created by taking −0.31 times the log of the fuel economy index in table 8.11, col. 4. (5) Exponential index created from the sums of the logs of the indexes in this table, cols. 1–4. Column 2 excluded from 1947 to 1966. (6) Column 5 divided by table 8.14 col. 1.

waiting time, rather than a pecuniary premium paid to automobile dealers, and the inclusion of this imputed value of waiting time would be inappropriate for an automobile price index intended for the deflation of expenditures on producer durable equipment.

The adjustment for fuel economy needs to place a value on the linked fuel economy index from table 8.11, column 4. I join Crandall et al. (1976, 133) in using a Department of Transportation estimate of 31 percent for the present value of gasoline costs to that of capital costs for 1972 (the other figure given is 42 percent for 1981, but I ignore this larger figure in order to arrive at a relatively conservative adjustment). To convert the index of improved fuel economy into an index of saving in capital cost, −0.31 is multiplied by the log of the fuel economy index and converted to an index in column 4 of table 8.15.

This procedure is subject to several qualifications. The use of the new hedonic index as half the base index is subject to all the criticisms of hedonic indexes and in particular the possibility that the hedonic index may exaggerate the decline in quality associated with downsizing since 1976. The CPI "other" quality adjustments indicate a 10 percent improvement in quality between 1967 and 1983, beyond the effect of safety and emission-control equipment. By excluding any adjustment for these "other" quality improvements, I lean toward an overstatement of price increases. However, an offsetting understatement of price increases may occur if there is double counting of the value of fuel economy. Unfortunately, the BLS press releases are inconsistent, mainly including changes involving fuel economy in the "other" category (which I exclude), but sometimes including those changes in the emission-control category, with no information on the portion attributable to fuel economy. Without further information on their relative sizes, the size of these offsetting biases cannot be estimated.

The final alternative price index in column 5 of table 8.15 combines the base price index with the three adjustment factors in columns 2, 3, and 4. The ratio of the alternative index to the CPI for new cars is shown in column 6. There are up-and-down movements but essentially no drift in this ratio from 1958 to 1976, and a decline in the ratio to an average for 1977–83 of 91.2 percent. Considering the large differences between the new car hedonic index and the new car CPI, or between the used car and new car CPI, the differences between the final index and the CPI over the 1957–83 period seem relatively minor. In the first decade of 1947–57, however, the differences are more substantial. These differences are mainly due to the discounting and fuel economy adjustments, since there is very little difference in the growth rates of the new car hedonic index and the CPI between 1947 and 1958.

8.10 Comparisons of "Closely Similar" Models

In a previous paper (Gordon 1971b), and in an earlier version of this book, substantial attention was paid to comparisons over a decade or more of models having roughly the same physical and performance attributes. Because such comparisons have been rightly criticized as subjective and anecdotal, I do not place much emphasis on them here. Nevertheless, such comparisons are interesting in providing another view of at least the order of magnitude of price changes over substantial periods. Both comparisons involve full-sized Chevrolet four-door sedans and cover, respectively, the intervals 1960–71 and 1962–77. Numerous details on specifications are provided in the exhibits prepared by General Motors (tables 8A.1 and 8A.2). This section compares the price changes over the intervals calculated by General Motors, after adjustment for changes in standard equipment, as well as safety and pollution equipment, with the CPI and a version of the "final alternative index" for new cars that incorporates the CPI safety and emissions-control adjustments but excludes the fuel economy and discounting adjustments, since the General Motors data are for list prices and make no adjustment for fuel economy.[33]

Change In:	1960–71	1962–77
General Motors adjusted price	6.6	35.3
CPI	7.6	37.3
New hedonic index with safety and emissions control adjustments	10.8	17.4

In both comparisons, the change in the CPI is closer to the General Motors adjusted price change than is the adjusted new hedonic index. This is not surprising, since General Motors is one of the main sources of the CPI data, and the General Motors adjustments for safety, emission-control, and optional equipment made standard are among the main sources of the CPI quality adjustments. The adjusted hedonic index is fairly close to the General Motors adjusted price change for 1960–71 but registers less than half the increase for 1962–77, with the discrepancy presumably occurring between 1971 and 1977.

A hint as to the problem with the new hedonic index is that the mean unadjusted price in the hedonic sample rises by just 36 percent between 1971 and 1977, compared to 55 percent for the unadjusted CPI price mean (in contrast to the full 1967–83 period in table 8.10, when the respective increases are 183 and 196 percent). This suggests that there may be a timing problem in using the hedonic index over short intervals, since the unadjusted price means agree fairly closely over longer intervals. A related fact is that the ratio of the used hedonic to the new hedonic index rises by 15 percent between 1971 and 1977 (table 8.9, col. 2), which could reflect in part shrinking discounts on new cars, but also a decline in quality as measured by the used car regression coefficients as contrasted with the new car coefficients.

8.11 Conclusion

This chapter has presented a wide variety of new evidence on new and used automobile prices, including hedonic regression indexes estimated from data on both new cars and used cars over the full 1947–83 period, and has

33. Also excluded is the dealer preparation fee for the 1971 car, since it was not included in 1960.

developed adjustments from the BLS statements on the value of safety and emissions-control equipment, and adjustments from previous investigators on the value and extent of improved fuel economy. The result is a price index that increases at roughly the same rate as the CPI between 1958 and 1983 (annual growth rates of 2.4 percent for the new index and 2.8 percent for the CPI). Before 1958, the new index declines substantially relative to the CPI, reflecting primarily the effects of a shift from premiums to substantial discounts from list price in new car transaction prices.

There are greater differences between the new index and the CPI over shorter intervals. These timing differences could reflect any number of factors, including shifts in the mix of the hedonic sample, erratic changes in hedonic coefficients, and the fact that the hedonic prices and characteristics are copied from a used car guide for a single month each year, in contrast to the CPI, which is an annual average. However, there is a clear substantive reason that explains in part why the final index falls relative to the CPI in the late 1970s and recovers in the early 1980s. Since the CPI includes imported cars, but the final index does not, one would expect the CPI to rise more rapidly when the foreign exchange rate of the dollar is depreciating, as in 1976–80, and to rise more slowly when the exchange rate of the dollar is appreciating. The timing in column 6 of table 8.12 is just right for this interpretation, since the ratio of the final index to the CPI dips from 98.0 percent in 1976 to 89.2 percent in 1980, and then recovers to 93.2 percent in 1983. Another period when the final index rises relative to the CPI is 1959–65. This is consistent with the previous work of Ohta and Griliches and of Triplett, in that both studies concluded that the CPI may have registered too low a rate of price change in the first half of the 1960s.

Despite these differences, the general agreement between the new index and the CPI after 1957 is reassuring, and the differences are relatively small as compared to the enormous differences since 1970 in the used car CPI contrasted with the new car CPI, and between an unadjusted hedonic price index for new cars and the new car CPI. It is clear that a hedonic index cannot be used by itself and must be adjusted for changes in quality taking the form of safety and emission-control equipment, and for changes in fuel economy. As for the CPI used car index, it suffers from exactly the same flaw as the unadjusted hedonic price index for new cars. As shown in column 5 of table 8.9, there is virtually no secular drift in the ratio of the used car hedonic index and the CPI for used cars from 1964 to 1983. Since there is no drift in the same period between the used hedonic index and the unadjusted mean price of used cars in the sample, we can deduce that there is essentially no adjustment for quality change in either the used car hedonic index or in the CPI for used cars.

Thus, the CPI indexes for new cars and used cars are simply inconsistent, and the latter index should be discarded. As long as the BLS continues to publish its misleading used car index, users of the statistics will be tempted to compare the CPI used car and new car indexes and reach erroneous conclusions. The most obvious example of this is the use of both indexes by the BEA in its PDE deflator for automobiles. Since business purchasers of new cars are deflated by the new car CPI (or equivalent new car PPI), while business sales to households are deflated with the inconsistent and non-quality-adjusted used car CPI, the BEA is mixing apples and oranges and as a result publishes a nonsensical PDE deflator for automobiles that actually declines by 25 percent from 1980 to 1984 (see table 8.8). It would be far better for the BEA to construct its own used car index, by introducing the published quality adjustment factors from the new car CPI (as recorded in table 8.10, cols. 3–5), assuming that the CPI "other" quality adjustment (excluded from the final index) at least partially takes into account improvements in fuel economy.

Appendix

Table 8A.1 General Motors Comparison of Price and Quality Characteristics of 1960 and 1971 Chevrolet Impala

	1960 Impala Four-Door Sedan	1971 Impala Four-Door Sedan
V-8 engine:		
Gross horsepower	250	245
Cubic-inch displacement	348	350
Gross torque at 2,800 rpm	355	350
Curb weight (pounds) with powerglide and power steering	4,025	4,093[a]
Exterior dimensions (inches):		
Wheelbase	119.0	121.5
Overall length	210.8	216.8
Overall width	80.8	79.5
Overall height—Loaded	56.0	54.1
Tread width		
Front	60.3	64.1
Rear	59.3	64.0
Interior dimensions (inches):		
Head room		
Front	39.5	38.9
Rear	38.2	38.0
Leg room		
Front	44.5	42.5
Rear	42.5	39.2
Hip room		
Front	65.3	62.0
Rear	65.4	61.9
Shoulder room		
Front	60.5	64.3
Rear	59.0	63.5
Entrance height		
Front	29.4	30.9
Rear	28.0	31.0

Table 8A.1 (continued)

	1960 Impala Four-Door Sedan with V-8 Engine, List ($)	1971 Impala Four-Door Sedan with V-8 Engine, List ($)
Base car price	2,462.00	3,542.00
Options offered in 1960 made standard:		
Heater and defroster	69.00	Standard
Luggage compartment lamp	2.25	Standard
Permanent coolant	5.00	Standard
Instrument panel pad	17.00	Standard
Outside rearview mirror	4.25	Standard
Two-speed wipers and washers	15.00	Standard
Nonglare inside rearview mirror	4.00	Standard
Increased tire size	14.00	Standard
Increased engine size	75.00	Standard
	205.50	
Subtotal	2,667.50	3,542.00
Options offered after 1960 made standard:		
Padded sun visors	6.00	Standard
Two rear seat belts	12.00	Standard
Two front seat belts	17.50	Standard
Front seat belt retractors	4.00	Standard
Hazard warning flasher	11.00	Standard
Exhaust emission control (including PCV valve)	47.50	Standard
Shoulder belts	22.00	Standard
Front and rear center seat belts	12.00	Standard
Depressed park windshield wipers	18.00	Standard
Head restraints	16.00	Standard
Variable ratio power steering	110.00	Standard
High-level ventilation system	15.00	Standard
Bias belt tires	30.00	Standard
Turbo-hydra-matic transmission	205.00	Standard
Evaporative emission control	35.00	Standard
Power disc brakes	61.00	Standard
Increased wheel size	8.00	Standard
	630.00	
Total base car adjusted to 1971 standard equipment	3,297.50	3,542.00[b]
Optional equipment:		
AM pushbutton radio	65.00	63.00
Whitewall tires	34.00	29.00
Electric clock	Standard	16.00
	99.00	108.00
Total car and options	3,396.00	3,650.00

Note: Standard equipment in 1971 is not identical to the optional items shown in prior years: the optional items most nearly comparable were selected.

[a]Shown for comparability purposes; effective 1 May 1971, the turbo-hydra-matic transmission became standard, increasing the weight by seventy-three pounds.

[b]Includes $31 dealer preparation charge that may be claimed by dealer on completion of new car preparation.

Table 8A.2 **General Motors Comparison of Price and Quality Characteristics of 1962 and 1977 Chevrolet Impala (from General Motors News Release #8210, July 1977)**

DETROIT—Today's American automobile is worth more than its 1962 ancestor, from the standpoint of both adjusted price and technological improvement.

Commenting on a recent study of vehicle design over a 15-year period, Robert D. Lund, Chevrolet general manager and General Motors vice president, believes the automobile has not only maintained, but increased its value compared with its 1962 predecessor. The results of the study seem to dispell the myth that "they don't build 'em the way they used to."

"We think the 1977 full-size Chevrolet, for example, has far greater value than its 1962 counterpart from virtually any standard of comparison including economy, performance, maintenance, ride, handling, durability, quietness, comfort and interior roominess," Lund said.

"To prove this contention, we took the base prices of a 1962 and 1977 Chevrolet Impala sedan and adjusted them according to the standard U.S. Bureau of Labor cost of living scale.

"Adjusting the list price of the 1962 Impala for increases in the Consumer Price Index (all items average) as published by the U.S. Department of Labor, and including adjustments for equipment, safety and emission items, the price level today would approximate $6,000," said Lund.

"This simply means that the Manufacturer's Suggested Retail Price of our 1977 Impala at $4,900.65 is nearly $1,100 *less* than the adjusted price of the 1962 Impala, a definite bargain when considering increases in the cost of living scale since 1962."

Lund noted the recent study showed a price breakdown of the two vehicles as follows:

	List Price
1962 Impala 4-Door Sedan	$2,529
1977 Impala 4-Door Sedan	4,887
Net Increase	$2,358
Detail of Net Increase:	
Safety and Emissions	$ 537
Added Value-Equipment	546
Economics and Other	1,275
Total	$2,358

The 1977 Chevrolet Caprice and Impala are the first of a new wave of more cost effective vehicles and Lund believes these cars will become increasingly popular "because of dramatically changing social, economic and environmental conditions in the world today."

Besides having an overall roominess index superior to the 1962 Impala, the '77 model shows dimensional advantages in rear head room, front and rear leg and shoulder room. The '77 also has greater total glass area, more usable luggage space, and a lower curb weight.

Lund said the EPA city/highway fuel economy rating for the '77 is 16 and 21 mpg respectively, while figures simulated by GM for the 1962 Impala are 14.6 and 15.9 mpg. Acceleration at zero-to-sixty mph favors the 1977 Impala with 12.3 seconds to 14.2 seconds for the 1962.

Seven complete emission control systems are offered on the '77 Impala: fuel evaporation control, positive closed crankcase ventilation, controlled combustion system, carburetor hot air, early fuel evaporation, exhaust gas recirculation and underfloor catalytic converter. The 1962 Impala offered only the positive crankcase ventilation system.

The study also shows that 1962 recommended service intervals called for vehicle maintenance every 1,000 miles, or 50 times in 50,000 miles. Current vehicle service intervals require visits for maintenance only six or seven times in 50,000 miles.

Lund commented on the marked improvement of automobile engineering and design technology, particularly with the debut of the 1977 Chevrolet Caprice, recipient of the MOTOR TREND "Car-of-the-Year" award.

Table 8A.2 (continued)

"The 1977 Caprice and Impala use the most advanced automobile technologies available including computer finite element modeling, plastic model stress analysis, ride simulation and aerodynamic wind-tunnel testing.

"As a result, the '77 Caprice and Impala provide greater fuel economy, more interior and trunk space, and significant overall reduction in vehicle mass.

"We feel that the significant improvement in value to our customers over the past 15-year period is typical of the kind of progress our industry has made since 1962," Lund said.

# # #

CHEVROLET VALUE COMPARISON

DIMENSIONS AND WEIGHTS	1977 Caprice Sedan	1962 Impala Sedan	1977 over (+) under (−) 1962
Wheelbase	116.0	119.0	−3
O.A. length	212.1	209.6	+2.5
Overhang—front	40.0	32.7	+7.3
—rear	56.1	57.9	−1.8
Tread —front	61.8	60.3	+1.5
—rear	60.8	59.3	+1.5
O.A. height	56.0	56.1	−.1
O.A. width	76.0	79.0	−3
Front—head (effective)	39.0	39.0	0
—leg (effective)	42.2	41.8	+.4
—hip	55.0*	63.5	−8.5
—shoulder	60.8*	58.7	+2.1
Rear—head (effective)	38.2	38.0	+.2
—leg (effective)	39.5	38.2	+1.3
—hip	55.3*	63.4	−8.1
—shoulder	60.8*	57.8	+3
Glass area	4363.2 Sq.In.	4195.6 Sq.In.	+167.6
Luggage (usable)	20.2 Cu.Ft.	19.0 Cu.Ft.	+1.2
Curb weight—lbs.	3716	3775	−59

*Not directly comparable to 1962 model because of industry changes to measuring methods enacted in 1975.

GENERAL

1977 Caprice Sedan	1962 Impala Sedan
Computer assisted design program for body and chassis —finite element models —plastic ⅜ scale models —electronic analyzer —wind tunnel tests	Conventional engineering design and laboratory test methods of that time.
Comprehensive 27-step design level corrosion protection program—extensive use of zincrometal and galvanized metal.	Conventional production and assembly applications of that time.

BODY

1977 Caprice Sedan	1962 Impala Sedan
Halo roof construction	Conventional
Very extensive acoustical insulation	Adequate insulation
Flow through ventilation	None

(*continued*)

Table 8A.2 (continued)

1977 Caprice Sedan	1962 Impala Sedan
Thin shell seat design for increased interior space	Conventional frame construction
Full molded foam seat cushions and backrests	Foam pads over conventional spring construction
Folding front seat center armrest	None
1-piece floor carpet extends fully under front seat	Separate front & rear carpets—minimal coverage under front seat
Simplified dash—improved sealing & noise reduction	Conventional construction
Ash tray lamp	Not available
Column mounted headlamp dimmer switch	Conventional floor mounted switch
Luggage compartment lamp	Extra cost
Wiring harness with bulkhead connectors	Conventional harness design with multiple individual connectors
1-piece formed headliner with polyfoam sound insulation	Vinyl headlining on lacing wires
EMISSION CONTROL SYSTEMS	
FEC (Fuel Evaporation Control System)	Not available
PCV (Positive Closed Crankcase Ventilation)	Positive Crankcase Ventilation
CCS (Controlled Combustion System)	Not available
CHA (Carburetor Hot Air)	Not available
EFE (Early Fuel Evaporation)	Not available
EGR (Exhaust Gas Recirculation)	Not available
UFC (Underfloor Catalytic Converter)	Not available
SAFETY	
Seat belts with pushbutton buckles for all six passenger positions. Two front combination seat and inertia reel shoulder belts for driver (with reminder light and buzzer) and right front passenger.	Seat belts available at extra cost. No shoulder belts available.
Adjustable front seat head restraints	Not available
Energy absorbing padded instrument panel	Extra cost
Safety steering wheel	Not available
Thick laminate windshield	Not available
Safety armrests	Not available
Contoured windshield header	Not available
Energy absorbing steering column	Not available
Passenger guard door locks	Not available
Safety door latches and hinges	Not available
Inertia seat back lock (coupes only)	Not available
Side marker lamps and reflectors	Not available
Parking lamps that light with headlamps	Not available
Four way hazard flasher	Extra cost
Lane change feature in turn signal control	Not available
Two speed windshield wipers with washers	Extra cost (single speed wipers without washers standard)
Day-night inside mirror (vinyl edged, shatter resistant glass, deflecting support)	Day-night mirror extra cost, safety features not available
Dual master cylinder brake system with warning light	Single circuit, no warning light
Starter safety switch	
Outside rear view mirror	Extra cost

Table 8A.2 (continued)

1977 Caprice Sedan	1962 Impala Sedan
CHASSIS	
Radial ply tires—fiberglass belted—FR78 × 15	Bias ply tires—fabric plies—7.50 × 14
Power steering	Extra cost
Front disc brakes, finned drum rear. Power standard	Drum brakes—front & rear. Power extra cost
Audible front brake wear sensors	Not available
Front ball joint wear indicators	Not available
15 × 6 wheels	14 × 5 wheels

Table 8A.3 **List of Changes and Added Features on Four-Door Chevrolet Sedans, 1948–85**

	List Price of Former Option Made Standard ($)
1948 Six-cylinder Fleetmaster:	
Thermal circuit breakers replace fuses.	
Three-position ignition switch.	
Precision replaceable main bearings.	
Increase in crankcase rigidity.	
Pressure cooling system.	
1949 Six-cylinder De Luxe 2100 Fleetline:	
Pushbutton door handles.	
Pushbutton starting motor control.	
Curved windshield—30 percent larger and two piece.	
Concealed fuel tank filler and vent pipe added.	
Deck lid—counterbalanced and keyless lock feature.	
Integral rear fenders part of quarter panel.	
Automatic dome light switches—two.	
Dash panel vents—ducts to front of car.	
Direct double-acting shock absorbers, front and rear.	
Center point steering linkage.	
Bonded brake lining—life approximately doubled.	
New 6.70 × 15 low-pressure tires and wide base rims.	?
New mechanical gear shift.	
Improved front suspension.	
Dual rear license lights.	
Foam rubber seat cushions.	
Integral exhaust pipe and muffler.	
Improved transmission.	
Rear window 70 percent larger.	
Larger radiator core.	
Wrap-around front bumpers.	
New windshield wiper assemblies.	
Ventipanes added to rear doors.	
Larger spark plugs—stronger shells.	
1950 Six-cylinder De Luxe 2100 Fleetline:	
External hood release.	
Larger exhaust valves.	
Box section roof rails—formerly channel design.	

(*continued*)

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
Improved fuel filler pipe.	
New front door seal.	
New carburetor—concentric float bowl design.	
Frame side rails strengthened.	
1951 Six-cylinder De Luxe 2100 Fleetline:	
Self-energizing brakes—duo serve.	
1952 Six-cylinder De Luxe 2100:	
Improved shock absorbers.	
Four-point engine mounts.	
New carburetor and automatic choke.	
1953 Six-cylinder 210:	
Built-in provision for backup lights.	
Improved body structure.	
Needle bearings replace bushings—Pitman arm.	
One-piece curved windshield.	
More rigid crankshaft.	
Strengthened engine structure.	
Key-turn starter control.	
Aluminum pistons.	
Cable drive windshield wipers.	
Swing-out front door hinges.	
Bypass added to cooling system.	
Wrap-around rear window area 41 percent greater.	
Direction signals.	?
45-ampere generator replaces 37 ampere.	
1954 Six-cylinder 210:	
Strap drive clutch—increased torque capacity.	
Rear door locks—"free-wheeling" type.	
Nylon inserts in rear springs.	
Muffler—30 inch replaces 16 inch; back pressure reduced; improved silencing.	
Engine—compression ratio increased to 7.5:1 from 7.1:1; horsepower increased to 115 from 108.	
Full pressure lubrication.	
Aluminum pistons offset pinned.	
New clutch—improved pressure plate.	
Improved transmission—use of needle bearings on countershaft; gears shot peened.	
1955 Six-cylinder 2100:	
New 265 cubic inch V-8 engine—first availability (an option).	
Twelve-volt electrical system.	
Panoramic wrap-around windshield.	
Cowl plenum chamber—vent system.	
Hotchkiss drive replaces torque drive.	
Spherical joint front suspension.	
Brake redesigned for better accessibility; passenger comfort; reduced weight.	
Tubeless tires—standard.	
Transmission—greater torque transmitting capacity; increased durability.	
Rear window visibility increased 21 percent.	
Frame—integrated front suspension; cross member lighter; more rigid frame.	
Torsion rod deck lid hinges.	
Suspended brake and clutch pedals.	

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
Telltale lights replace ammeter oil gauge.	
Recirculating ball-nut steering gear.	
Automatic transmission indicator mounted on instrument panel.	
Concentric gearshift control.	
New hood lock—improved hinges and catch.	
New rear axle housing assembly—stronger; extra torque capacity; more durability.	
New rotary-type door lock.	
1956 Six-cylinder 2100:	
Full flow oil filter provisions.	
Electric temperature gauge and sending unit.	
Ribbed insulator spark plugs.	
Provision for precision head lamp aiming.	
Improved sealed beam head lamps.	
Bumpers—heavier and wider.	
Frame—stronger.	
Self-cancelling directional signals—standard.	13.08
Improved parking lamps.	
Battery—capacity from 50 to 53 amps per hour; increased durability; guarantee increased from 21 to 36 months.	
Engine—provisions for full-flow oil filter; high lift camshaft; improved carburetor deicing.	
New clutch drive disc.	
Improved tail lamp.	
1957 Six-cylinder 2100:	
Improved rear suspension.	
Rear wheel bearings larger—higher capacity.	
Wheels—14 × 5; larger bead seat; improved cornering.	
Tires—7.50 × 14 replace 6.70 × 15; wider; lower pressure.	?
Bumpers stronger.	
New starter—fully enclosed; greater efficiency; current requirement reduced 36 percent.	
Improved ventilation—substantial increase in air flow.	
More rigid chassis frame.	
Brakes—improved lining and shoe mechanism.	
Windshield visibility increased 69 square inches.	
Head lamps redesigned with provision for air scoop.	
Improved clutch assembly—semicentrifugal.	
New gas filler vent—lessens spill; faster filling rate.	
Improved wiring harness and connectors.	
Improved seat cushions.	
1958 Eight-cylinder Biscayne:	
"X" frame—30 percent greater torsional rigidity; permits lower center gravity.	
Four-link rear suspension with coil springs.	
Two-speed electric windshield wiper.	?
Improved three-speed transmission.	
Improved clutch—new centrifugal feature.	
Foot-operated parking brake.	
283 cubic inch V-8 engine now standard.	
Redesigned front suspension and steering.	
New dual head lamp assembly—formerly single.	

(continued)

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
Windshield visibility—4 percent increase.	
Hood panel—inner panel added.	
Fan shroud added.	
New radiator—more effective cooling; "tube-on-center."	
Wrap-around bumpers.	
Propeller shaft—new two-piece with bearing.	
Rocker panels strengthened—inner and outer.	
1959 Eight-cylinder Bel Air:[a]	
Acrylic lacquer—better luster retention; greater stain resistance.	
Dry-type air cleaner more efficient—replaces oil bath cleaner.	
Tyrex tires—longer wearing; improved rayon; 7 percent greater tread life.	
Windshield area increased 53 percent.	
Rear window area increased 15 percent.	
Brakes—improved cooling; 17 percent increase effective lining.	
Frame design change—improved rigidity.	
Improved rear suspension—tie rod added.	
Wheels—short spoke disc wheels replace full spoke disc wheels; improves brake cooling.	
Improved steering mechanism.	
1960 Eight-cylinder Impala:	
Double stroke parking brake.	
Tires—improved Tyrex cord; 12 percent greater tread life; better traction; less squeal.	
Economy Turbo-Fire 283 cubic inch V-8 engine.	
Corrosion-resistant muffler.	
Full-flow oil filter.	?
Improved front seat back.	
Improved braking—less pedal pressure; proportioning of pressure between front and rear.	
Frame—redesigned at "X" member to decrease tunnel; added rear suspension cross member.	
1961 Eight-cylinder Impala:	
Parallel-acting windshield wipers.	
Concentric fuel filler neck.	
Removable instrument console.	
Five-position ignition switch.	
Luggage space increased 15 percent.	
More durable front wheel bearing—tapered roller.	
Straight element windshield glass replaces compound curved glass.	
1962 Eight-cylinder Impala:	
Front fender skirt—corrosion prevention.	
Two-ply tires standard.	
Heater and defroster standard.	69.00
Luggage compartment lamp.	2.25
Heavier bumpers and reinforcements.	
Stronger seat belt attachment.	
1963 Eight-cylinder Impala:	
Washed-dried body rocker panels.	
Self-adjusting brakes—new.	
Delcotron replaces conventional generator.	
Amber directional signals.	
Permanent coolant—antifreeze.	5.00

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
Positive crankcase ventilation standard.	5.00
Battery—44 amp replaces 53 amp.	
Horn blowing ring replaces buttons at outer spokes.	
Muffler aluminized.	
1964 Eight-cylinder Impala:	
Two front seat belts standard.	17.50
Front fender reinforcement—new.	
Plastic cowl kickpads replace pressboard.	
Seat belt anchors improved.	
1965 Eight-cylinder Impala:	
New body, trim, glass, and hardware.	
7.35 × 14 nylon tires replace 7.00 × 14.	
Improved front suspension.	
New Salisbury-type rear axle housing.	
New double-walled exhaust pipe.	
New molded hood insulator.	
New frame—perimeter type; all welded with torque box construction.	
Rear bumper—center face bar of heavier gauge steel.	
New relay-type steering linkage and gear.	
New link-type rear suspension.	
New propeller shaft—one-piece shaft replaces two-piece shaft.	
1966 Eight-cylinder Impala:	
Two rear seat belts.	12.00
Instrument panel pad.	17.00
Outside rearview mirrors.	4.25
Two-speed wiper and washer.	15.00
Padded sun visors.	6.00
Ignition switch—push-turn accessory position.	
Windshield strengthened—double thickness laminate.	
Brake lines—super terne-coated; increased thickness.	
Wrap-around taillight provides side visibility.	
7.75 × 14 tires replace 7.35 × 14.	14.00
Addition of no. 6 body mounts—right and left.	
Aluminum distributor housing replaces iron.	
Improved water pump.	
Door rubber seal added.	
1967 Eight-cylinder Impala:	
Nonglare inside rearview mirror—day/night.	4.00
Increased tire size—8.25 × 14 replaces 7.75 × 14.	14.00
Front seat belt retractors.	4.00
Hazard warning flasher.	11.00
Energy absorbing steering wheel.	
Energy absorbing steering column.	
Fusible link wiring harness.	
Stamped steel door hinges—replace malleable iron.	
Dual master cylinder brake system & warning light.	
Larger fuel tank—improved retention; new metering unit.	
Carburetor linkage—anti-hangup feature.	
Air cleaner—reduced height; smaller diameter.	

(*continued*)

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
Window regulator knobs—soft vinyl.	
Front and rear seat belts—new pushbutton belt buckles replace lever releases (less retractors).	6.00
Steering linkage improved—less effort.	
Exhaust pipe and crossover improved.	
New "energizer" storage battery.	
Head lamp housings eliminated.	
Breakaway rearview mirror support.	
Seat belt anchorages improved.	
Instrument cluster—printed circuit replaces wiring.	
Fiber optics—light ignition key hole.	
Seat back and latch—improved seat construction.	
1968 Eight-cylinder Impala:	
Exhaust emission control including PCV valve.	47.50[b]
Shoulder belts.	22.00
Front and rear center seat belts.	12.00
Depressed park windshield wipers.	18.00
Electric clock deleted.	(16.00)
Nonglare finish—horn button and spokes; windshield garnish molding.	
Dome light replaces two side roof rail lights.	
Bumper guards—front.	15.00
Instrument panel cover size increased.	
Rotary action glove box door lock.	
Hood insulator deleted.	
Protective vinyl insert—side moldings.	
Side marker lights—front and rear.	
Ignition buzzer alarm.	
Energy absorbing seat back.	
Larger V-8 engine—307 cubic inch replaces 283 cubic inch.	
Heavier radiator.	
1969 Eight-cylinder Impala:	
Windshield skid header.	
Cowl panel upper strengthened.	
Luggage compartment forward barrier.	
Side impact barrier added.	
Front door locking knobs moved forward.	
Head restraints standard (1/1/69).	16.00
Improved fuel tank security.	
New steering column—ignition lock on column; new ball-type energy absorbing provision.	
Upper level ventilation system.	15.00
Brake pipes—spiral wire protection.	
Engine—235 horsepower 327 cubic inch replaces 200 horsepower 307 cubic inch.	75.00
Variable ratio power steering.	
New double-cushioned chassis sheet metal mounts—two added; metal vibration noise reduction.	
Odometer—antireversing provision.	
Radiator and shroud mounting change provides improved air flow.	
1970 Eight-cylinder Impala:	
New bias-ply, glass-belted tires—G78 × 15 replace 8.25 × 14.	30.00

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
Increased wheel size—14 to 15 inches.	8.00
Lights—front parking from class B to A; class A reflexes added to side markers; rear lights from class B to A.	
Improved window regulators—vertical tube guide.	
Exhaust emission control—TCS added in conjunction with CCS.	
Yielding windshield pillar molding.	
Improved body sound insulation.	
New 350 cubic inch engine replaces 327 cubic inch.	
New interlock front engine mounts.	
Improved exhaust system—welded connections and brackets.	
Hood stop pins added.	
New ignition lock—detent accessory position.	
1971 Eight-cylinder Impala:	
Turbo-Hydra-Matic transmission.	205.00
Evaporative emission control.	35.00
Power disc brakes.	61.00
Increased wheel size—15 × 5 to 15 × 6.	
Improved rear lamp reflectors.	
Wheel opening moldings—deleted.	
Single horn replaces dual horns.	
New side terminal battery.	
Improved body mounts—front impact.	
Improved frame—longer; "C" section side rails replace box section; gauge increased.	
Remote hood latch release.	
Bumpers strengthened—gauge increased; rear brackets heavier.	
Emission control—engine adopted for low lead and other emission control improvements.	
Double shell roof construction.	
Thinner windshield glass—visibility increased 11.6 percent.	
New underbody—larger panels; less welding; improved sealing.	
Improved windshield wiper—longer blades and arms; new drive and linkage.	
Improved body ventilation.	
Rear window visibility increased 43 percent.	
New door glass weather seal.	
New molded full-foam—front seat and back; rear seat cushion only.	
Improved body wiring harness.	
Improved front suspension.	
Improved rear axle assembly.	
Steering linkage new—incorporates forward steering.	
1972 Eight-cylinder Impala:	
Three-point seat belt and warning system.	
Front and rear bumper reinforcement—GM 2.5 mph barrier.	
Floor pan construction simplification.	
Emission control—TCS reinstated replacing CEC; new idle stop solenoid.	
Alternator—integral diode set.	
Shoulder belt mounting provisions—rear passengers.	
Body ventilation system—improvements and simplification.	
Exhaust pipes and crossover—gauge increase.	

(continued)

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
1973 Eight-cylinder Impala:	
Doors—right and left side impact improvement.	
Frame transmission crossover—heavier gauge.	
Interior trim—flammability.	
Bumpers—front 5 mph impact; rear 2.5 mph impact; enersorbers added to front; rear reinforced.	
Addition of brake proportioning valve.	
Exhaust emission control—addition of AIR and EGR; TCS deleted.	
Simplified evaporation emission control.	
Enclosed bushing engine mounts.	
Alternator—addition of integrated voltage regulator.	
1974 Eight-cylinder Impala:	
Ignition interlock front seat—three-point belt restraint system.	
Front and rear bumpers—5 mph barrier impact; 3 mph corner impacts; enersorbers added rear.	
Roof crush resistance.	
Accelerator control—secondary linkage return.	
Emission control—addition of TVS to EGR.	
Serviceable CV universal joint.	
1975 Eight-cylinder Impala:	
Underfloor catalytic converter system.	
Tandem-type power brakes.	
New brake hoses.	
Speedometer numerals changed.	
Threaded fuel filler cap.	
Improved corrosion resistance.	
Moldings—changed to bimetal sandwich.	
Stationary vent window.	
Frame—gauge increase.	
Front suspension lower control arm front bushing.	
Steel-belted radial tires HR78 × 15—standard.	157.10
1976 Eight-cylinder Impala:	
Hydraulic brake system.	
Exterior protection—new front bar, changed bumpers.	
Check valve at fuel inlet filter.	
1977 Eight-cylinder Impala:[c]	
Exhaust recirculation valve, distributor spark advance curve and carburetor recalibrated.	
Fuel tank—reinforcement and attachment revised.	
Front seat restraint system redesigned.	
Corrosion resistance improved.	
Engine electrical diagnostic connector.	
Acoustics improved.	
Air conditioner compressor changed to cycling clutch orifice tube.	
Four cylinder air conditioning compressor.	
1978 Eight-cylinder Impala:	
Fuel evaporation control.	
Restraint system—front seat portion revised.	
Brake system—active carbon filter added; brake pressure switch from nylon.	
Improved corrosion resistance.	
Bright metal roof drip moldings—standard.	17.00

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
1979 Eight-cylinder Impala:	
Improved antitheft ignition lock.	
Thermac engine temperature sensor in air cleaner.	
Improved EGR system.	
New single stage two-barrel carburetor.	
Cold trapped ignition sparks.	
Corrosion resistance improved.	
1980 Eight-cylinder Impala:	
Air injection reactor.	
Electric choke.	
Two aluminum steel heat shields.	
Low dispersion acrylic lacquer paint.	
Reinforcement of each rear end frame.	
Solid bumper guard impact stripes.	
Improved door locking mechanism.	
4.4 liter—267 CID, two-barrel, V-8 engine (optional, part of reported car).	
Engine inlet manifold changed to aluminum.	
Automatic transmission with torque converter clutch.	
High-pressure compact spare and tire.	
Lightweight plastic tape drive window regulators.	
Two gas spring assists in rear compartment deck lid.	
Power steering pump rotor redesigned.	
Thickness of rear window reduced.	
Reduced weight front rubber floor mats.	
Smaller, lighter weight floor mats.	
Door impact bar design changed.	
Transmission support diameter reduced.	
Intermediate exhaust pipe diameter reduced.	
Smaller, high efficiency radiator.	
Steel-belted radial tire (P205/75 R-15) replaces the FR 78-15/B.	
Chassis changes due to tire change.	
Improved corrosion resistance.	
Removal of air conditioning system diagnostic connector.	
Side-lift frame jack.	
Removable body rear end finishing panel.	
Deluxe seat and shoulder belts—standard.	24.00
1981 Eight-cylinder Impala:	
Computer command control emission and fuel control system.	
Dual-lead oxidizing reducing converter.	
Computer-controlled exhaust gas recirculation valve solenoid replaces thermal vacuum switch.	
Additional oil separator baffles.	
Carburetor vacuum break—tamper proof.	
Electronic spark timing.	
Heater in-line water shut-off valve.	
Activated carbon element added to air cleaner assembly.	
Heat activated thermo vacuum switch.	
Improved carburetor sealing.	
ISO identifying pictures on controls.	
Vehicle Identification Number plate.	
Electronically controlled converter clutch.	
Rear wheelhouse deadener material changed.	

(continued)

Table 8A.3 (continued)

	List Price of Former Option Made Standard ($)
Engine inlet manifold changed back to cast iron.	
Reduced front brake drag.	
"Freedom II" battery (F-15) replaces "Freedom I."	
Improved corrosion resistance.	
"Resume speed" memory feature added to cruise control.	
Powertrain protection extended to 24 months or 24,000 miles.	
1982 Eight-cylinder Impala:	
Refinements of the emission control system.	
Changes in fuel evaporation control system.	
Improvement in corrosion resistance.	
New fluidic windshield washer system.	
1983 Eight-cylinder Impala:	
Two flexible plastic tabs sewn to rear seat covers.	
New engine design encloses alternator cooling fan.	
"Dish" reservoir added to fuel tank.	
Improved corrosion resistance.	
Instrument panel radio speakers upgraded.	
Engine electrical diagnostic connector removed.	
1984 Eight-cylinder Impala:	
Altitude sensing switch assembly/barometric pressure sensor.	
Exhaust gas recirculation valve recalibrated and vacuum reducer added.	
Housing pressure altitude advance solenoid added.	
Improved corrosion resistance.	
Improved fuel filter system.	
Refinements to engine compression and oil rings.	
Wheel trim covers—standard.	52.00
1985 Eight-cylinder Impala:	
Computer controlled exhaust gas recirculation system.	
Component parts of THM-2000 automatic transmission modified.	
New antenna.	
"All Seasons" tires size P205/75 R15.	

Note: This table is not explicitly discussed in the text of chap. 8, since the value of most of these changes are difficult to quantify. However, since this material has not been published anywhere else and provides a unique time series on the nature of quality changes throughout the postwar period, it is included here as an appendix.

[a]From 1959 to date, changes in a four-door Impala are noted. For comparability purposes prior to the introduction of the four-door Impala in 1959, four-door, middle-of-the-line vehicles were followed. The eight-cylinder engine did not become available until 1955, and only then as an option. The first V-8 model was introduced in 1958.

[b]Deduct $5.00 for PCV valve reported in 1963.

[c]In view of the significant change in the 1977 model Impala compared with the 1976 model, the BLS ruled that it would be impractical to determine the quality changes on the traditional basis. An acceptable alternative was to report only those quality changes that were clearly identifiable and unrelated to the weight and size reduction of the vehicle.