The Brazilian Automobile Industry in the 1980s: the Lost Decade?*

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Summary: 1. Introduction; 2. The "world car" and the Proálcool; 3. Measuring quality change; 4. Quality innovation in the Brazilian autos; 5. Conclusion.
Key words: automobile industry; quality change; innovation; hedonic pricing.
JEL code: L62 e O31.

The 1980s was a difficult decade for the Brazilian economy. It was a period marked by both external and internal imbalances. The automobile industry was hard hit and the industry's performance during the period have been heavily criticized. This study presents evidence against the idea that the 1980s was a "lost decade" for the Brazilian automobile industry. While Brazilian auto makers have been lazy in terms of process innovation and productivity, the industry was not sleeping during this period. In fact, as we show, the pace of quality upgrading in Brazilian cars was astonishing.

A década de 80 foi uma década difícil para a economia brasileira. Este foi um período marcado por desequilíbrios externo e interno. A indústria automobilística foi atingida duramente e seu desempenho no período vem sendo altamente criticado. Este estudo apresenta evidências contrárias à idéia de que a década de 80 foi uma "década perdida" para a indústria automobilística brasileira. Embora as montadoras brasileiras deixaram muito a desejar em termos de inovação de processo e produtividade, a indústria não estava dormindo neste período. Como mostra este trabalho a velocidade do aumento da qualidade dos carros brasileiros foi impressionante.

1. Introduction

The 1980s was a difficult decade for the Brazilian economy. It was a period marked by both external and internal imbalances. As a result of the

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macroeconomic adjustment effort, Brazil's real GDP grew only 2 percent a year, on average, falling 4.4 percent in 1981, when industrial output fell by more than 10 percent. In 1984, the economy started to recover, but by 1990 per capita GDP had only regained its 1980 level.

The external adjustment was practically done by the end of the decade, but inflation was out of control. Starting with an annual inflation rate in 1980 of 52 percent, the decade ended with prices increasing by more than 1,700 percent a year. The second half of the decade witnessed a variety of stabilization plans, with inflation dropping sharply for a few months, in each case only to be rekindled soon after.[1]

The auto industry was heavily affected. Domestic vehicles sales, after peaking at one million units in 1979, fell to 580,000 in 1981. It averaged 614,000 units per year and ended at 762,000 in 1989. According to Thomas Kamm of *The Wall Street Journal*, during the 1980s the Brazilian automotive industry was, for all intents and purposes, dead to the world (April 20, 1994, first page and page A4). Brazilian-made cars were too dated by international standards, and their quality was being assailed by the end of the decade.

Labor productivity became stationary during the decade and energy consumption per assembled car increased from 12 to 20 kilowatts (see figure 1). According to Womack and others (1990, p. 269), by the end of the 1980s, Brazilian auto plants lagged "far behind the world pace in terms of productivity and product quality". James Brooke of *The New York Times* wrote that the Brazilian auto industry "was lackadaisical at best (April 23, 1994, first business page and page 26)". Fernando Collor de Mello, elected president in 1989, referred to Brazilian automobiles as horse carts, and suggested import competition as a remedy for the industry's lackadaisical behavior.

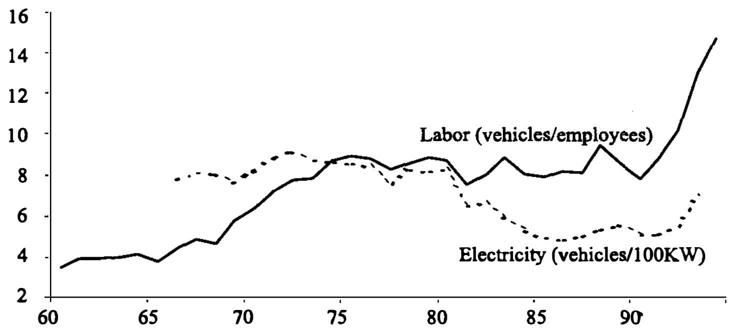
In spite of all the criticism, very few studies have tried to quantify the pace of innovation in the industry or its degree of lackadaisicalness. Fonseca (1996, 1997) calculated a quality change index for the Brazilian automobiles for the 1960-94 period. Surprisingly, the estimates showed that the 1980s were a period of rapid quality growth in the industry.

In this study, we further explore this controversial result. The next section reviews the new models and features introduced during the period and the alcohol-fueled engines project. In section 3, we reestimate the quality index

[1] *See (Abreu, 1990) for more details on Brazilian economic history in this period.*

and explore the downsizing bias, attributable to the significant reduction in car sizes following the oil shocks. Explanations for the main factors behind the rate of innovation in the 1980s are provided in section 4, followed by the conclusions.

Figure 1
Productivity measures
Brazilian automotive industry
1960-94



Source: Author's calculation based on Anfavea (1994, p. 49, 51 and 65).

2. The "World Car" and the Proálcool

The 1980s were the era of the "World Car" and of the ethanol-fueled engine. A decade marked by weak sales, it was nevertheless the stage of significant innovation in Brazilian automobiles. The first half of the 1980s was rich in new models. A total of nine new models appeared, not including station wagon versions. As new models were making their debuts old ones were retiring.

In the race to launch new models, Volkswagen (VW) came first, with the Gol in 1980. A domestic project, based on VW's European Scirocco, it was a small car and developed in response to the recent entrance of the Fiat 147. The following year saw a "3-volumes" version of the Gol, the Voyage.[2] Also in 1981, Ford launched its Del Rey, and the VW's Brasília (1973-81) and Dodge's Polara (1973-81) were retired.

Nevertheless, it was in 1982 that the Brazilian automobile market was shaken. The arrival of the General Motors (GM) Monza, the first "world car" produced in Brazil, brought the latest auto technology to the domestic market. GM's Monza (Ascona in Germany and Cavalier in the US), was followed by

[2] *A "3-volumes" car is a vehicle with three distinct compartment (engine-cabin-trunk).*

Ford's Escort in 1983, by Fiat's Uno in 1984, and by VW's Santana (Passat in Germany), also in 1984. Uno, Monza, Escort, and Santana, began production in Brazil, respectively, one, two, three, and four years after being introduced in Europe.

Fiat had previously ventured into the sedan market with the Oggi (1983), but in 1985, the Oggi was "killed" by its cousin, the Prêmio, a "3-volumes" version of the Fiat Uno. The rest of the decade was marked by a drought in new models, relieved only in 1989 with GM's Kadett.

On the other hand, the consumer lost comfort and luxury with the exit of the Galaxie (1966-83) and the Alfa Romeo (1975-86). Other models that left the market were Corcel II (1977-86), Fusca (1960-86), Fiat 147 (1976-86), and Passat (1974-88). There was a complete renewal in the production lines, and by the end of the 1980s, there were only two representatives of the previous decade, the Opala (1968) and Chevette (1973), both from GM.

The wave of new models in the first half of the decade prompted Souza to write in 1985 that "today, [Brazilian cars] are among the best in the word" (1985:166; translated by the author)". The new models brought a wide range of innovations to the Brazilian market and, even during the drought, new features continued to be added to the vehicles.

Tables A.1 and A.2 present the evolution of selected characteristics and performance measures of Brazilian-made passenger cars from 1979 to 1990. As can be seen, the 1980s were a remarkable period. The performance variables (top speed, time to speed, and stopping distance) showed exceptional improvement. The behavior of the normalized variables also reflects the technological advances of the 1980s. WELENG, WBLENG and HP(.)CC suggest a significant augmentation in the number of features on the vehicles, internal room, and engine power, respectively.[3]

Features such as front wheel drive, front disc brakes, vacuum-assisted brake, double carburetion, and McPherson independent front suspension became standard in the industry. Also impressive was the increased use of vented front disc brakes, transverse engines, independent or semi-independent helicoidal rear suspension, and power steering. Augusto (1990) identifies several other important new characteristics added to Brazilian automobiles during

[3] *WELENG, WBLENG and HP(.)CC are normalized variables. We will return to this issue in the next section.*

the 1980s. Among them are, five-speed transmissions and electronic ignition, now standard in almost all available models.[4]

The automotive industry also focused its research and development effort on the development of a new technology: alcohol-fueled vehicles, one of the most important innovations of the decade. The National Alcohol Program (Proálcool) was instituted in 1975, with the goal of producing an alternative fuel to gasoline, thereby reducing the country's import bill, inflated by the increase in oil prices.

Ethanol-fueled cars began to be offered on a large scale in 1980. After a slow start, pushed by heavy subsidies and government pressure, the program took off. Initially, ethanol supply, corrosion, cool starting, and consumption were the biggest problems. As these problems were solved, consumers became more confident and, by 1983, alcohol-based automobiles already dominated the market (see table 1).

Table 1
Share of ethanol-fueled cars in total sales
Brazilian passenger cars
Domestic production 1979-94

Year	Share (%)	Year	Share (%)
1979	0.3	1987	94.4
1980	28.5	1988	88.4
1981	28.7	1989	61.0
1982	38.1	1990	13.2
1983	88.5	1991	22.1
1984	94.6	1992	28.5
1985	96.0	1993	26.7
1986	92.1	1994	12.2

Source: Author's calculation based on Anfavea (1995), p. 57 and 60.

Fuel consumption was still high compared to gasoline engines, but lower (subsidized) prices at the pump made up the difference. On the other hand, alcohol engines offer higher performance than their gasoline counterparts. Moreover, alcohol is a cleaner fuel than gasoline.[5]

[4] *See also Souza (1985) and Tunes (1989).*

[5] *For a recent comparison test between an alcohol- and a gasoline-fueled model, see Quatro Rodas, Jun. 1995, p. 46-7.*

However, by the end of 1980s the reduction of government incentives reduced the incentives on alcohol production and consumption. In 1990, there was alcohol shortage, definitely scaring the consumer away. The proportion of alcohol based new passenger cars fell to 61 per cent in 1989, and to 13 percent on 1990. In the first half of the 1990s, the gasoline would reign again.

Thus, during the 1980s, the Brazilian auto industry not only introduced a significant number of new characteristics in its cars, but also developed a new technology. Womack and others (1990) argue that Proálcool made the industry focus its "product-development energies on a technology that has found no market elsewhere in the world". Nevertheless, with the increasing interest world wide in reducing emissions, Brazilian know-how in ethanol-fueled engines may yet prove advantageous on the world market.

Another important episode in the history of the Brazilian automotive industry in this period was the creation of Autolatina. In 1986, Volkswagen and Ford announced negotiations to form a joint venture. Autolatina was founded the next year, integrating the Brazilian, and also the Argentine, subsidiaries of Volkswagen and Ford. The venture lasted from 1987 to 1994. During this period, the production of passenger cars in Brazil became concentrated in only three firms.

3. Measuring Quality Change

Innovation is verifiable but is quite difficult to quantify. For example, most would agree that a car with electronic fuel injection is superior to one equipped with a carburetor, but few can define *how* superior it is. Moreover, changes in product's quality generally occur in multiple dimensions. That is, several characteristics of the product may change simultaneously, making it harder to quantify the quality change. One way to approach this question is to construct a quality change index based on the hedonic pricing methodology. Fonseca (1996) constructs such index for the Brazilian automobile industry (see also Fonseca, 1997).

3.1 The hedonic pricing methodology

The hedonic pricing methodology was developed by Court (1939) and revived by Griliches (1961). Since then, the approach has been used frequently to estimate quality change in automobiles. Other important contributions are Triplet (1969), Ohta and Griliches (1976, 1980), Feenstra (1987, 1988), Gordon (1990), and Raff and Trajtenberg (1995).

The main assumption behind hedonic pricing is the "characteristics approach" to demand theory (see, for example, Lancaster, 1971). According to this approach, goods are defined as bundles of characteristics (qualities), and consumers have preferences over those characteristics. Thus, a consumer will decide not only whether to buy an automobile, for example, but which automobile best matches her preferences over the available characteristics.

The real world is full of examples of goods being sold with different added-on components, attributes, and sizes, that is, with different characteristics (qualities), in different varieties. Moreover, the reason that different varieties of a commodity sell at different prices must be due to differences in their sets of characteristics. Therefore it is reasonable to assume that, in equilibrium, there is a well-defined relationship between the price of a commodity and its characteristics.

Based on the assumptions above, it is possible to write the price of variety I of a specific commodity at time t as a function of a set of attributes X and some disturbance u. That is,

$$p_{it} = f_t\left(x_{1it}, x_{2it}, \cdots, x_{kit}, u_{it}\right) \tag{1}$$

Following previous works we will assume a semilogarithmic form, relating the logarithm of the price to the absolute values of the qualities. One advantage of this form is that the coefficients on the Xs will represent percentage changes in price due to changes in the related characteristic. In other words, we assume

$$\log p_{it} = a_0 + a_1 x_{1it} + a_2 x_{2it} + \cdots + a_k x_{kit} + u_{it} \tag{2}$$

Equation (2) can be computed for each period for which there are enough observations. An index of quality change can be defined from the estimated equations as follows:

$$q_{1i}^0 = \frac{\widehat{P}_{i1}}{\widehat{P}_{i0}} \quad \text{where} \quad \begin{aligned} \widehat{P}_{i0} &= f_0(x_{1i0}, \cdots), \\ \widehat{P}_{i1} &= f_0(x_{1i1}, \cdots) \end{aligned} \tag{3}$$

That is, the measure of quality change for variety I is a ratio between the price predicted, using estimated equation f_0, for the combination of attributes this variety had in period 0 and the price predicted for the combination of characteristics it had in period 1. In other words, the measure gives us the percentage change in price due to changes in characteristics, as predicted by the function f_0. To calculate a quality change measure for the "commodity" (the group of varieties), one can aggregate these q's using each variety's market share, for example, as a weight.

3.2 The variables

Most of the previous studies on hedonic pricing of automobiles rely on length or weight as proxies for quality. Length has been used as a proxy for comfort: a bigger car has more internal room, providing more comfort for the driver and passengers. Weight is supposed to represent features not accounted for by other variables included in the regression. A car loaded with features is heavier than a car without those characteristics.

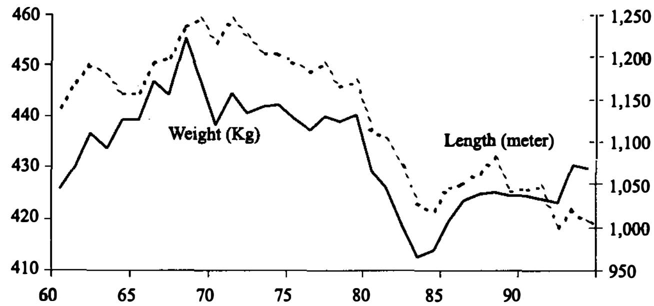
In general, it is assumed that the relationship between the desired characteristic (comfort) and its proxy (length) is stable over time. However, after the oil crises, the automobile industry innovated considerably. The new cars were smaller and lighter, but had basically the same comfort level and features as their ancestors. Thus, a study based on weight and length will underestimate the true quality change in the period.

During the late 1970s and early 1980s, new components affecting the relationship between length and comfort were introduced in Brazilian autos. The Fiat 147 was the pioneer in most of these new characteristics. It was a "small car on the outside but a big car on the inside", as Fiat used to advertise. This was achieved thanks to a transverse front engine combined with front-wheel drive, longer wheelbase, and a better design. Many of those characteristics were incorporated in other firms' new models during the 1980s.

The 1970s and 1980s also witnessed a significant reduction in the weight of automobiles, mostly motivated by the desire to increase fuel efficiency. According to Souza (1985), the increasing use of plastic resulted in an approximately 10 percent reduction in the weight of Brazilian cars between 1970 and 1985. Souza (1985) presents other examples, from the windshield to the engine, where the weight was reduced.

The downsizing trend prompted by the oil crises was relatively stronger in Brazil (see figure 2). The Brazilian market, already biased toward small cars, saw the death of the large-car market and of V-8 engines in the beginning of the 1980s. The Dodge Dart family left the market in 1981, when Volkswagen dismantled the Chrysler line.[6] The Ford Galaxie, then the only large car still produced in Brazil, left the following year. Since then, Brazilian consumers can find large cars only in the used car market.

Figure 2a
Length and weight evolution
Passenger cars (excl. S.W.)
Non-weighted sample: 1960-94



Source: Fonseca (1996, tabela A.2).

Figure 2b
Length and weight evolution
Passenger cars (excl. S.W.)
Weighted sample: 1960-94

Source: Fonseca (1996, tabela A.3).

Note that the reduction in size and weight is clear and profound when looking at the bundle of cars on the market (non-weighted sample, figure 2a). Nevertheless, the figures change when looking at the average car sold in Brazil (weighted sample,[7] figure 2b). Here, the downsizing process was more than

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[6] *Chrysler of Brazil was absorbed by Volkswagen in 1980.*

[7] *The data were weighted by the versions market share.*

offset by a demand shift. As the average weight of cars produced in Brazil fell, the average weight of the cars sold domestically increased. That is, as the size of the available vehicles fell, demand shifted from small to medium cars, and to more equipped (heavier) vehicles.[8]

To reduce the downsizing bias we will use a normalized variable WELENG (weight divided by total length) instead of weight. However, it should be clear that the bias would not be removed completely. For cars of the same length, innovations that reduce their weight will be counted as a quality downgrade. WELENG does account for the bias caused by the substitution of medium-sized for large-sized cars, and thus is a better proxy for better equipped vehicles than weight by itself.

Thus, two groups of equation have been estimated, one based on the variables SPEED and WELENG, and the other based on SPEED and WEIG. Note that the estimates produced by the second specification are important to comparison with previous studies.

This study uses the data set built by the author (Fonseca, 1996, 1997). The data set is desegregated down to the sub-model level and include price, specification, performance, and market share data, for more than 90 percent of the automobiles sold during the period. As presented in table 2, the data are composed of numerical and dummy variables. Dummy variables take value of one if the particular sub-model possesses the characteristic (as standard equipment) and zero if it does not.

3.3 Regression results

Hedonic pricing estimates the intersection of demand and supply curves. It allows us to estimate the implicit, or "missing", prices of characteristics using observed prices of differentiated products and their sets of characteristics. Thus, the implicit prices are determined by cost structure, technology and consumer preferences (tastes), factors that usually change over time.

[8] *We will return to this issue in the next section.*

Table 2
Sample variables

Technical numerical variables

Variable name	*Technical specification*	*Unit*
SPEED	top speed	km/h
LENG	length	centimeter
WEIG	weight	kg
TRUNK	trunk capacity	liter

Technical dummy variables

Variable name	*Technical specification*
CARB2	double carburetion
INJE	electronic fuel injection
PSTE	power steering
BOOST	vacuum assisted brake system
DISCF	front disc brake
VENTF	front vented disc brake
DIMHE	independent, MacPherson, and helicoidal front suspension

Dummy control variables

Variable name	*Technical specification*
ALCO	fuel: ethanol
GAS	fuel: gasoline
POPU	"popular model"
L1, L2, L3	luxury levels 1, 2, and 3
DOOR4	four doors
HATCH	hatchback model

However, for periods not too far apart, characteristics' coefficients (implicit prices) may not differ significantly among periods. Here, one may pool the cross section data from the different periods. To account for this, we rewrite equation (2) in the following way:

$$\log\, p_{it} = \alpha_0 + \sum_{j=1}^{k} \alpha_j x_{jit} + \sum_{s=1}^{s} \beta_s D_s + u_{it} \tag{4}$$

In specification (4), I denotes the commodity's variety, t denotes periods (years), s denotes years for which there is a specific "time" variable D, and X_{ji} represents the set of characteristics of variety I. Here, after testing for stability, we have decided to split the period in four sub-periods of three years each. In this way, each regression will have two time dummies, the number of periods being pooled minus one.

This functional form allows for changes in the intercept over time, but assumes that slopes are constant. That is, the effect of each characteristic on the commodity's price is assumed constant over the selected years. However, the introduction of time dummies allows the price to change among periods, even when the characteristics remain the same. The time dummies take the value one in their reference period and the value zero in all other periods.

Multicollinearity is bound to be an issue in this kind of study. Luxury models are higher quality, and so possess most of the quality characteristics. Thus, one should expect a high correlation among the variables in the sample. Two points should be made here. First, of course it would be nice if the explanatory variables of a regression model were linearly independent. However, to exclude variables with this goal in mind is to negate the model's fundamentals. Moreover, excluding variables may create specification problems, since one may be omitting a relevant variable. Additionally, it is worth recalling that the least squares estimator will remain the best unbiased estimator of the parameters. As Greene points out (1993:270), the problem with multicollinearity is that "best" is not very good.

Second, a consequence of multicollinearity is that the individual shadow (implicit) price of a particular characteristic will not be well-identified. Although multicollinearity affects the estimates of an individual variable's coefficient, it does not affect their combined effect on prices. In this study, we are not particularly interested in the implicit price of a specific characteristic. The goal is to estimate the fitted path, that is, the effect of the whole set of characteristics (quality variables) on price. Thus, with respect to the main purpose of this study, multicollinearity is not a problem at all.

In an attempt to improve the results of this study, we have decided to weight the data. The rationale for this is that sometimes a manufacturer may set the "wrong price", given the quality of its vehicle. Not accounting for such deviations from the "right price" may bias our conclusions.[9] To minimize this bias from mistakes and idiosyncrasies in manufacturers' pricing policies, we have weighted the data by the market share of each sub-model. Thus, the procedure used to estimate the hedonic equations is weighted least squares, with market share as the weight.[10]

Table 3 presents the results. Comparing the two groups of equations, it can be seen that the year-dummy coefficients remained the same and the coefficients on the characteristics variables changed slightly. The fit of these regressions is very good. Given high inflation, the use of current prices produces R-squared statistics very close to 1. The annual change in prices is captured by the year-dummies, and those changes were above 100 percent during the 1980s. Accounting for the inflation by using constant prices results in lower R-squareds, but the regressions are still able to explain 90 per cent or more of the variance in the logarithm of car prices in most cases.[11]

4. Quality Innovation in the Brazilian Autos

Using the coefficients from table 3, we built two quality change indexes, weighted and non-weighted as defined by equation (4). Both indexes are displayed in figures 3 and table 4. Note that as expected, the index based on specification 1 is, in most cases, smaller than the one based on specification 2. However, as shown in figures 3, using either specification gives the same basic results.

A comparison of these results with similar estimates for the U.S. automobile market shows that the quality of the average Brazilian-made car has improved proportionally more than the quality of the average car sold in America. Feenstra (1985) calculated a quality index for the American made small cars and Japanese imported small cars sold in the US market during the first half of the 1980s. According to Feenstra, the quality of the American automobiles rose by an annual average rate of 1.1% between 1979 and 1984. The

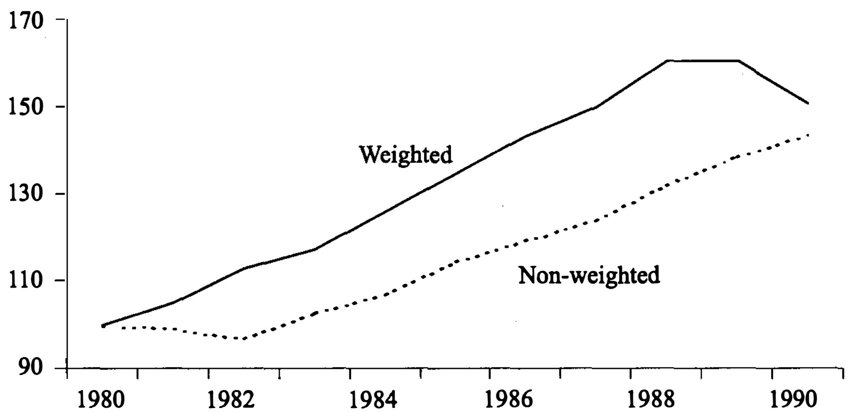
[9] *Graphing the squared residuals (of a non-weighted regression) against market share showed evidence that observations with smaller market share tend to produce estimates with a higher deviation from the true price.*

[10] *For more details on the estimation process see Fonseca (1996, Ch. 2; 1997).*

[11] *The use of different price series affects the "constant" term, year-dummy coefficients, and the goodness of the fit, or more specifically, the R-squared statistic. But it has no significant effect on the estimated characteristic coefficients. As we are interested in changes on price due the characteristics (quality) variables, it makes no difference which price series is used.*

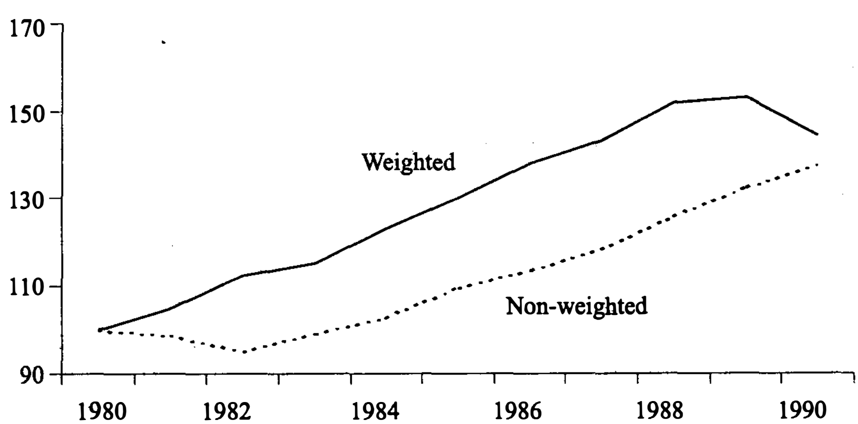
Japanese automobiles sold in the US presented a better performance rising by an annual average rate of 3.5% between 1979 and 1985.

Figure 3a
Quality change indexes
Brazilian automobile industry
Equation 1 (Speed — Weight)



Source: Author's calculation.

Figure 3b
Quality change indexes
Brazilian automobile industry
Equation 2 (Speed — Weleng)



Source: Author's calculation.

Table 3
Regression results: 1980-1990

Period:	80-82	80-82	83-85	83-85
Equation:	1	2	1	2
Dep. variable:	LPRICBR	LPRICBR	LPRICBR	LPRICBR
Number obs.:	263	263	286	286
Adj. R-squared:	0.982	0.981	0.963	0.959
SSR:	2.55	2.71	10.08	11.12
Explanatory Variables:	Coefficients (t-stat.)	Coefficients (t-stat.)	Coefficients (t-stat.)	Coefficients (t-stat.)
C	3.93**	3.54**	5.99**	5.42**
	(36.7)	(22.0)	(29.7)	(22.8)
L1	0.082**	0.089**	0.037	0.048
	(4.60)	(5.01)	(0.70)	(0.85)
L2	0.115**	0.131**	0.185**	0.213**
	(2.85)	(2.81)	(3.27)	(2.97)
L3	0.239**	0.260**	0.387**	0.427**
	(9.24)	(7.32)	(8.39)	(8.19)
DOOR4	0.058	0.064	0.046	0.074
	(1.37)	(1.55)	(0.88)	(1.43)
HATCH	-0.007	-0.073*	-0.031	-0.144**
	(-0.29)	(-2.32)	(-0.87)	(-4.26)
ALCO	-0.023	-0.033	-	-
	(-1.31)	(-1.72)	-	-
GAS	-	-	0.045	0.040
	-	-	(1.18)	(0.94)
SPEED	0.0027**	0.0025*	0.0029	0.0041
	(2.96)	(2.55)	(1.12)	(1.44)
WEIG	0.0011**	-	0.0015**	-
	(6.72)	-	(5.92)	-
WELENG	-	0.659**	-	0.843**
	-	(6.10)	-	(4.61)
CARB2	0.062*	0.084**	0.034	0.050
	(2.14)	(2.87)	(0.49)	(0.69)
PSTE	0.176*	0.199**	-0.008	0.012
	(2.52)	(2.87)	(0.14)	(0.75)
DIMHE	0.161**	0.111**	0.223**	0.168*
	(5.36)	(4.15)	(3.68)	(2.41)
BOOST	0.121**	0.170**	-	-
	(4.31)	(6.51)	-	-
VENTF	-0.029	0.014	0.290**	0.308**
	(-0.82)	(0.41)	(4.39)	(4.43)
Y81	0.82**	0.816**	-	-
	(49.5)	(50.2)	-	-
Y82	1.65**	1.64**	-	-
	(89.6)	(87.1)	-	-
Y84	-	-	1.03**	1.02**
	-	-	(20.5)	(19.1)
Y85	-	-	2.18**	2.16**
	-	-	(67.4)	(52.7)

*Significant at 95%. **Significant at 99%. t-statistics are in parentheses.
See Table 2 for variables descriptions.

Table 3
Regression results: 1980-1990

Period:	86-88	86-88	88-91	88-91
Equation:	1	2	1	2
Dep. variable:	LPRICBR	LPRICBR	LPRICBR	LPRICBR
Number obs.:	227	227	262	262
Adj. R-squared:	0.990	0.989	0.997	0.997
SSR:	4.52	4.90	3.40	3.32
Explanatory Variables:	Coefficients (t-stat.)	Coefficients (t-stat.)	Coefficients (t-stat.)	Coefficients (t-stat.)
C	9.21**	9.03**	13.3**	12.8**
	(25.7)	(24.6)	(36.4)	(31.0)
L1	0.020	0.023	0.086**	0.088**
	(0.72)	(0.79)	(3.64)	(3.70)
L2	0.128**	0.123*	0.139**	0.129*
	(2.81)	(2.46)	(2.74)	(2.51)
L3	0.257**	0.262**	0.118	0.177*
	(5.71)	(5.85)	(1.49)	(2.35)
DOOR4	0.012	0.042	0.005	0.005
	(0.44)	(1.43)	(0.17)	(0.16)
HATCH	-0.063	-0.129**	-	-
	(-1.78)	(-3.47)	-	-
ALCO	-	-	-0.071**	-0.075**
	-	-	(-3.19)	(-3.34)
GAS	0.099*	0.104	-	-
	(2.09)	(1.77)	-	-
SPEED	0.0043	0.0049*	0.0146**	0.0157**
	(1.90)	(2.04)	(6.17)	(7.21)
WEIG	0.0011**	-	0.0006**	-
	(6.16)	-	(3.70)	-
WELENG	-	0.448**	-	0.376**
	-	(4.32)	-	(3.33)
CARB2	0.012	0.048**	-	-
	(0.24)	(0.96)	-	-
INJE	-	-	0.374**	0.357**
	-	-	(4.34)	(4.07)
PSTE	0.173**	0.215**	0.287**	0.322**
	(3.04)	(3.53)	(5.04)	(5.90)
DIMHE	0.274**	0.211**	0.144**	0.091**
	(6.19)	(4.79)	(6.53)	(4.31)
VENTF	0.212**	0.233**	0.117**	0.105**
	(6.03)	(6.52)	(4.16)	(3.81)
TRUNK	0.0003	0.0006*	0.0008**	0.0011**
	(1.23)	(2.26)	(5.70)	(8.08)
Y87	1.47**	1.46**	-	-
	(45.1)	(42.6)	-	-
Y88	3.33**	3.32**	-	-
	(98.2)	(97.0)	-	-
Y89	-	-	3.84**	3.84**
	-	-	-181	-1851)
Y90	-	-	5.21**	5.22**
	-	-	-172	-173

As shown in table 4, the quality of the Brazilian autos sold in the domestic market between 1980 and 1985 increased by an yearly average rate of 5.4% (specification 1, weighted index), well above the figures calculated by Feenstra. The rate fall to 1.9% when considering the cars offered on the market (non-weighted index), but remains above the US made cars' rate.

Table 4
Quality change in Brazilian automobiles
1980-90

Year	Equation 1 Speed-weight		Equation 2 Speed-weleng	
	Non-weighted (%)	Weighted (%)	Non-weighted (%)	Weighted (%)
1980	-5.5	1.9	-5.1	2.2
1981	-1.4	4.8	-0.9	4.8
1982	-3.6	7.0	-2.3	7.8
1983	4.1	2.4	5.9	3.7
1984	3.6	6.9	4.4	7.5
1985	6.9	6.1	6.7	6.8
1986	3.6	5.9	4.3	6.3
1987	4.0	3.9	4.0	4.9
1988	6.4	6.1	6.2	7.0
1989	5.5	0.8	5.3	-0.1
1990	3.8	-5.7	3.6	-6.2

Period	Whole period (%)		Annual average (%)		Whole period (%)		Annual average (%)	
	NW	W	NW	W	NW	W	NW	W
1980-85	10	30	1.9	5.4	14	35	2.7	6.2
1985-90	25	11	4.5	2.1	26	12	4.8	2.3
1980-90	37	44	3.2	3.7	44	51	3.7	4.2
1980-89	32	53	3.1	4.8	39	60	3.7	5.4

Considering the whole period (1980-89), the quality of the average car offered on the Brazilian market (non-weighted index) increased by an annual average rate of 3.1 percent, according to the index based on the equation 1

(WEIG). This rate rises to 3.7 when accounted for the weight bias (equation 2, WELENG). When considering the quality of the average car sold in Brazil (the weighted index), the average annual improvement is 4.8 percent (equation 1) or 5.4 percent according to equation 2 (see table 4).

However, it is importante to have in mind that these quality change indexes are of no use if we want to compare the quality of an average Brazilian car with an average American car. The only comparison possible is of the quality evolution in the two markets, that is, the proportional change in car quality. The index says nothing about absolute quality level. Nonetheless, as illustrated by table 5, the 1980s saw a rate of quality improvement never seen before in the industry.

Table 5
Quality change in Brazilian automobile

Period	Non-weighted index (%)		Weighted index (%)	
	Whole period	Annual average	Whole period	Annual average
1960-65	10.8	2.1	1.4	0.3
1965-70	19.4	3.6	15.1	2.8
1970-75	14.0	2.6	10.7	2.1
1975-80	2.0	0.4	7.5	1.5
1980-85	14.0	2.7	35.0	6.2
1985-90	26.3	4.8	11.9	2.3
1990-94	26.4	6.0	2.6	0.7

Source: Fonseca, (1997, table 4, p. 90).

Note that the index based on the non-weighted sample illustrates quality change in the set of automobiles *offered* in the market, while the index based on the weighed sample yields the quality evolution of the average domestically-produced car *sold* in the Brazilian market. The distinction is important. It allow us to identify quality change driven by changes in demand versus those driven by supply-side factors. For example, a significant higher rate of change in the weighted index suggests a shift in demand towards higher quality vehicles. In the same way, if the average quality of domestic cars sold in Brazil is increasing and the average quality of the cars available to sell is constant, one may conclude that consumers are shifting their purchases towards higher quality automobiles.

Thus, there is evidence that a change in demand was behind the quality increase during the 1980s. The evidence is stronger during the first half of the decade, when the weighted index rose by an annual average of 6.2 percent against 2.7 percent of the non-weighted index (see table 4, equation 1). Examining figures 3 and table 4, we see that, during the first three years of the decade, as the quality of the average offered vehicle declined, the quality of the average car sold increased by more than 15 percent.

The shift in demand towards higher quality models is attested to by table 6. The share of small cars fell from 59 to 30 percent between 1980 and 1990, reaching 25 percent in 1986. The medium segment was completely replaced by the medium-large one, although the large segment disappeared from the market. Consumers, albeit still concentrated in the small and medium-small car markets, moved to bigger cars inside those segments.

Table 6

Segment share in the Brazilian passenger cars excluding station wagons 1980-89

Year	Small %	Small-medium %	Medium %	Medium-large %	Large-medium %	Large %
1980	58.7	8.7	25.0	-	7.2	0.5
1981	46.8	19.7	21.6	5.2	6.3	0.4
1982	39.3	25.4	23.4	6.4	5.3	0.2
1983	35.7	30.4	18.3	12.2	3.5	-
1984	33.3	32.9	7.2	24.3	2.3	-
1985	30.7	34.5	4.5	27.0	3.3	-
1986	25.2	33.1	9.3	29.5	2.9	-
1987	28.2	37.3	3.2	27.9	3.5	-
1988	29.2	37.4	1.1	27.5	4.8	-
1989	30.4	38.4	-	27.3	3.8	-

Source: Fonseca (1996, table A.1).

Note: Small: Fiat 147, Chevette Hatch, Brasília, Fusca, Gol e Uno; small-medium: Polara, Chevette, Voyage, Oggi, Prêmio, Escort e Kadett; medium: Corcel II, Passat e Monza; medium-large: Del Rey e Santana; large-medium: Alfa Romeo 2300 e Opala; large: Dodge Charger, Dodge Dart, Galaxie, LTD, Lebaron e Magnum.

In 1983, the Fusca lost its crown as the most sold car to the GM Chevette (a small-medium model). More impressive, however, was the sales performance of the GM Monza. In the three following years (1984-86) the Monza became the first medium-sized car to earn the position of most sold car. From 1987 until the end of the decade, it lost first place to the VW Gol, albeit it remained the second in the sales raking. Although the Gol helped Volkswagen and the small-car segment to again dominate sales, it was a much better automobile than the 1960's Fusca.

The change in the pattern of demand is also reflected by the entrance of Volkswagen, in 1984, into the medium-large (and luxury) segment with the Santana. This mid-large model, surprisingly, reached fifth place in the 1986 sales ranking. Also, with an eye on the "luxury" market, GM released a new version of the Monza, the Monza Classic, in 1986.

A common explanation for the quality evolution in the models of the 1980s was that the Brazilian consumer had became more demanding (see Quatro Rodas, Dec. 1986, p. 92-97 and Augusto, 1990). Heinz Gundlach, president of Volkswagen of Brazil, stated in 1990 that "The consumer changed his pattern. Today he is more demanding, seeking novelties and eagerly awaiting the evolution of the product" (Augusto, 1990:41; translated by the author)".

Other factors driving this behavior were the effects of the recession and income concentration on the demand for automobiles. From 1980 to 1983, per capita GDP fell 11.7 percent and the Gini coefficient increased from 0.530 to 0.534.[12] Although per capita GDP barely recovered during the second half of the decade, the income distribution continued deteriorating until the end of the 1980s (see IBGE, 1990 and Bonelli and Ramos, 1994).

The recession and the redistribution of income toward the rich affected the demand for new cars. Not only did the number of vehicles sold per year fall significantly, but the universe of consumers became further biased towards higher income groups. Thus, it is natural to suppose that demand would shift in the direction of higher-quality models.

Additionally, with lower overall demand, competition among the automakers became intense. However, the economic environment provided strong incentives for non-price competition. The auto market was very concentrated and the Brazilian government regulatory framework used to tie prices adjustment to firms' cost structure. Furthermore, as suggesting by Scherer (1984, ch. 12),[13] in a very concentrated market, increasing competition tends to speed

[12] *Figures for the Gini coefficients refer to the period 1979-83. (see Ramos, 1990, ch. 2.).*

[13] *Originally published in* American Economic Review *57 (June), 1967.*

up the innovation process. The Brazilian auto industry appears to support this hypothesis.

5. Conclusion

This study presents evidence against the idea that the 1980s was a "lost decade" for the Brazilian automobile industry. It is true that the period was a disaster in terms of sales and productivity. And, as the flatness in labor productivity indicates, firms may indeed been quite "lazy" in process innovation.

Such behavior is understandable given the environment faced by this highly concentrated oligopoly. Sales stagnated, prices were controlled by the government based on the industry's cost structure, and high inflation allowed firms large gains in the financial markets. With the economic uncertainty of the period, one should expect lower incentives to increase productivity.

However, these facts did not translate into negligence of product innovation in the industry, as many have stated. In fact, it appears that the recession pushed firms to offer higher quality vehicles. The competition among them was in the realm of product differentiation, including quality improvement.

Most of the innovation in the Brazilian auto market was through adoption of features already introduced in other markets by the parent firms.[14] Although the introduction of some features still requires further research and development, the process of adoption is generally less troublesome. Thus, an extremely high rate of quality improvement may be a sign of initially low quality, with considerable ground to be covered until the domestic car catches up with its sibling in the developed world. This study cannot determine how distant the Brazilian cars were from foreign cars in quality. This is an important issue to be explored in the future.

In any case, this work shows that the quality innovation process sped up during the 1980s, reaching rates never reached before. Most important, the industry was not dead at all. The high rate of product innovation makes it difficult to believe that, by the end of the decade, vehicles made in Brazil resembled "horse carts."

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[14] *Note that there are still cases of features first introduced in Brazil. The ethanol-fueled engine is the most important example, but there are others. For example, the Ford Corcel was the first Ford in the whole world to come with a 5-speed transmission (Souza, 1985, p. 166).*

A second important finding was the driving force behind the quality innovation process. We have presented evidence that the quality innovation was triggered by a demand shift. A combination of recession, income redistribution in favor of the rich, and more demanding consumers resulted in a shift towards higher quality vehicles.

It is important to note that the quality change was not just a shift in demand. The shift was merely an inductive factor. That hypothesis could be true for the first three years of the decade. As noted, during that period, the quality of the average car offered in the market decreased. However, the remaining years witnessed a significant increase in car quality. Even after 1985, when the introduction of new models ceased, vehicle quality kept rising. Better engines were introduced as well as new features.

In short, while Brazilian auto makers have been lazy in terms of process innovation and productivity, and while it may be true, as many have argued, that Brazilian cars in 1989 were of lower quality than their foreign siblings, the industry was not sleeping during this period. In fact, as we have shown, the pace of quality upgrading in Brazilian cars was astonishing.

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Table A1
Characteristics of Brazilian passenger cars (excl. S.W.). Non-weighted sample: 1979-90

Variable	Unit	Year											
		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Average													
LENG	cm	447	438	435	430	423	422	426	427	429	432	426	426
WBAS	cm	257	252	251	247	245	246	247	248	249	249	249	250
WEIG	kg	1.132	1.066	1.047	1.002	966	974	1.008	1.032	1.038	1.041	1.036	1.036
TANK	liter	61	59	59	56	59	60	62	63	62	66	63	62
TRUNK	liter	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	360	370	363	343	336
DISP	cc	2.480	2.194	2.072	1.733	1.669	1.700	1.851	1.887	1.925	1.901	1.913	1.901
HPS	hp (SAE)	108	96	94	85	86	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
HPA	hp (ABNT)	n.a.	n.a.	n.a.	71	72	76	83	87	90	89	92	93
WBLENG		0.5777	0.5783	0.5773	0.5765	0.5789	0.5850	0.5823	0.5825	0.5818	0.5784	0.5864	0.5889
WELENG	kg/cm	2.499	2.404	2.377	2.314	2.275	2.301	2.354	2.404	2.411	2.403	2.427	2.427
HPSCC	hp/cc	0.0458	0.0454	0.0469	0.0500	0.0521	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
HPACC	hp/cc	n.a.	n.a.	n.a.	0.0421	0.0438	0.0455	0.0463	0.0478	0.0488	0.0482	0.0497	0.0499
DISWEI	meter/kg	0.0303	0.0336	0.0338	0.0345	0.0354	0.0345	0.0331	0.0320	0.0310	0.0308	0.0301	0.0299
SPEED	km/h	148	145	145	145	149	152	154	157	155	157	159	160
ACCE	sec	18.2	19.1	18.8	18.8	17.0	15.8	15.3	14.5	13.9	13.7	13.0	12.5
DIST	meter	32.0	34.0	33.8	33.4	33.6	33.0	32.6	32.2	31.7	31.6	30.7	30.5
Proportion of new cars with													
DOOR4	%	35.2	30.7	33.3	27.8	35.0	35.6	30.1	29.7	29.2	35.7	34.9	29.9
ENGF	%	88.9	88.6	89.6	92.4	98.1	99.0	98.8	98.6	100.0	100.0	100.0	100.0
TRACF	%	25.9	40.9	47.9	60.8	76.7	77.2	78.3	75.7	80.6	77.4	84.9	87.6
TRANS	%	7.4	8.0	7.3	13.9	27.2	39.6	37.3	33.8	43.1	36.9	50.0	51.5
CARB2	%	59.3	47.7	46.9	46.8	61.2	63.0	60.2	71.6	81.9	78.6	86.0	83.5
INJE	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	4.1
PSTE	%	11.1	15.9	15.6	10.1	5.8	5.9	7.2	10.8	11.1	19.0	19.8	22.7
BOOST	%	50.0	58.0	64.6	78.5	89.3	89.1	91.6	90.5	94.4	100.0	100.0	100.0
DISCF	%	96.3	95.5	95.8	94.9	98.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0
VENTF	%	14.8	1.1	0.0	2.5	11.7	8.9	16.9	18.9	26.4	46.4	57.0	61.9
DISCR	%	3.7	2.3	3.1	2.5	1.9	2.0	2.4	2.7	0.0	0.0	0.0	2.1
DIMHE	%	22.2	29.5	29.2	34.2	57.3	67.3	62.7	58.1	65.3	65.5	82.6	85.6
THELI	%	0.0	4.5	7.3	12.7	38.8	48.5	44.6	43.2	50.0	47.6	66.3	74.2

Source: Author's calculation.
Note: For variables descripiton see table A3.

Table A2
Characteristics of Brazilian passenger cars (excl. S.W.). Non-weighted sample: 1979-90

		Year											
Variable	Unit	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Average													
LENG	cm	410	410	413	414	412	412	413	415	412	411	409	403
WBAS	cm	241	241	241	241	240	242	243	244	243	243	244	243
WEIG	kg	887	891	895	905	907	921	937	960	959	971	973	950
TANK	liter	46	47	50	51	55	56	57	58	58	60	60	57
TRUNK	liter	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	345	344	337	300	280
DISP	cc	1.505	1.480	1.494	1.510	1.548	1.610	1.629	1.636	1.665	1.693	1.720	1.671
HPS	hp (SAE)	69	67	70	74	77	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
HPA	hp (ABNT)	n.a.	n.a.	n.a.	62	66	74	76	81	84	86	87	83
WBLENG		0.5888	0.5893	0.5855	0.5843	0.5853	0.5887	0.5897	0.5894	0.5929	0.5928	0.5981	0.6040
WELENG	kg/cm	2.154	2.165	2.163	2.183	2.198	2.229	2.262	2.308	2.323	2.359	2.378	2.354
HPSCC	hp/cc	0.0463	0.0454	0.0469	0.0490	0.0496	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
HPACC	hp/cc	n.a.	n.a.	n.a.	0.0415	0.0424	0.0457	0.0472	0.0494	0.0510	0.0515	0.0511	0.0495
DISWEI	meter/kg	0.0386	0.0389	0.0388	0.0380	0.0381	0.0361	0.0351	0.0339	0.0331	0.0325	0.0319	0.0329
SPEED	km/h	133	133	136	141	143	150	152	155	154	157	158	156
ACCE	sec	23.7	24.8	22.7	20.4	19.8	15.7	15.4	14.6	14.0	13.1	12.8	13.4
DIST	meter	33.5	34.1	34.2	33.9	34.1	32.8	32.4	32.1	31.4	31.3	30.7	30.9
Proportion of new cars with													
DOOR4	%	3.9	4.0	5.9	4.1	5.3	5.6	6.6	8.0	9.2	11.4	14.1	11.6
ENGF	%	57.4	66.4	77.1	85.3	87.8	89.7	92.4	95.9	100.0	100.0	100.0	100.0
TRACF	%	39.7	46.4	58.6	69.9	78.6	86.6	89.0	92.7	96.5	93.6	92.6	92.0
TRANS	%	13.8	13.3	10.2	16.6	21.6	38.1	40.8	42.1	47.7	40.4	49.0	54.3
CARB2	%	19.2	18.2	20.8	23.1	29.4	38.4	48.1	68.9	76.0	81.8	85.1	82.0
INJE	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1
PSTE	%	0.9	1.3	1.3	0.9	0.6	0.5	1.4	2.7	6.1	7.0	9.7	7.9
BOOST	%	20.5	25.7	45.2	67.7	82.2	84.9	81.5	84.3	88.7	100.0	100.0	100.0
DISCF	%	78.5	79.2	82.2	85.6	87.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0
VENTF	%	0.2	0.0	0.0	1.8	4.4	2.4	10.5	11.3	24.7	39.6	45.9	43.9
DISCR	%	0.3	0.3	0.2	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.9
DIMHE	%	28.9	34.6	39.4	52.0	54.4	67.5	69.6	74.7	78.9	78.9	87.9	91.0
THELI	%	0.0	6.7	15.7	29.0	38.5	53.5	53.5	55.3	61.3	66.0	74.9	71.9

Source: Author's calculation.
Note: For variables descripiton see table A3.

Table A3
Legend for tables A1 and A2

Variable	Description
LENG	length
WBAS	wheelbase
WEIG	weight
TANK	fuel capacity
TRUNK	trunk capacity
DISP	displacement
HPS	horsepower (SAE)
HPA	horsepower (ABNT)
WBLENG	WBAS/LENG
WELENG	WEIG/LENG
HPSCC	HPS/DISP
HPACC	HPA/DISP
DISWEI	DIST/WEIG
SPEED	top speed
ACCE	time to speed (0-100km/h)
DIST	stopping distance (80-0km/h)
DOOR4	four doors
ENGF	front engine
TRACF	front drive
TRANS	transverse engine
CARB2	double carburetion
INJE	electronic fuel injection
PSTE	power steering
BOOST	vacuum assisted brake system
DISCF	front disc brake
VENTF	front vented disc brake
DISCR	rear disc brake
DIMHE	independent, MacPherson, and helicoidal front suspension
THELI	semi- and independent helicoidal rear suspension
n.a.	not available