

HEDONIC PRICES INDEXES FOR NEW PASSENGER CARS IN PORTUGAL (1997-2001)*

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1. INTRODUCTION

The impact of quality changes on price indexes has become a major research topic. In fact, the Boskin Report (1996) suggested that mismeasuring the effects of quality change in a period of fast technical progress can lead to a substantial overestimation of inflation. As a consequence, the literature on the relation between quality change and prices has grown very rapidly. Recent studies in this area have addressed, for example, the effect of quality change on the prices of computers (Moch, 2001, and Pakes, 2002), housing (Bover and Velilla, 2002, and Hoffmann and Kurz, 2002), and passenger cars (Bode and Van Dalen, 2001, and Izquierdo, Licandro and Maydeu, 2001). An up-to-date summary of the main contributions to this literature can be found in Triplett (2000).

This study evaluates the effects of quality change on the price index for new passenger cars in Portugal for the years 1997-2001. The present work extends the pioneering study of Santos and Coimbra (1995) on this subject, which presents measures for the quality change for new passenger cars and quality adjusted price indexes for the period 1991-1994. However, the present study departs from the work of Santos and Coimbra (1995)

in a number of aspects. Besides the distinct time period considered, we have at our disposal a richer database and benefit from all the developments in the literature on this subject over the more recent years. Of course, there are also some differences that result purely from the different preferences of the authors. The remainder of this article is organised as follows: section 2 describes the data used, section 3 discusses the main results and, finally, section 4 concludes.

2. DATA

Cars are arguably the most complex consumer goods of today. Therefore, any hedonic study⁽¹⁾ of the price of new cars requires a huge amount of information on the characteristics of the car models available. This section describes the main features of the data available for this study.

The information used here comes from two different sources. The prices and characteristics of the new passenger cars available in the Portuguese market were collected by Marketing Systems GmbH⁽²⁾, a market research company which collects this sort of information both for the motor industry and for leading specialized magazines. The Marketing Systems files contain detailed information on the price and technical characteristics of about 1500 different versions of passenger cars available in the Portuguese market. The information on sales volumes was kindly provided by

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(1) Regression analysis to account for the effects of quality change.

(2) More information on this company can be obtained at <http://www.marketingsystems.de>.

Table 1

VEHICLE CHARACTERISTICS

General

Body type
Number of doors
Boot capacity

Technical

Fuel type
Engine capacity
Max. power
Max. power at (rpm)
Max. torque
Max. torque at (rpm)
Transmission drive (front/rear/full)
Maximum speed
Acceleration
Weight/power ratio
Fuel tank capacity
Fuel consumption urban
Fuel consumption extra-urban
Combined fuel consumption
Autonomy

Equipment

ABS
Steering wheel with height adjustment
Steering wheel with telescopic adjust.
Air-conditioning
Alarm
Immobilizer
Metallic paint
Driver air bag
Passenger air bag
Electric front windows
Electric windows front and rear
Electric door mirrors
Central door locking
Central door locking with remote control
Driver seat with lumbar adjustment
Driver seat with height adjustment
Driver seat with electric adjustment
Sport seats
Leather upholstery
Fog lights
Alloy wheels
Manual sunroof
Electric sunroof
Audio preparation
Radio with cassette player
Radio with CD player
Foldable back seats
On-board computer
Power assisted steering

ACAP, the Portuguese automobile trade association.⁽³⁾ The information on the prices and characteristics available for this study corresponds to data collected in the month of October from 1997

to 2001. Using the ACAP database, sales were registered for the months of September to November of the same years. In both cases, maker, model and version distinguish cars in the database.

Given that the information used was obtained from two different sources, it was necessary to match the two databases. This was a delicate process and great care had to be taken to ensure the correct matching. Fortunately, the ACAP files, besides identifying the different versions, provide the price and some technical characteristics of each version, and this made the matching somewhat easier. Of course, in some cases it was impossible to obtain a correct match and these observations had to be dropped from the sample. Despite this limitation, the data available corresponds to a total of 267 876 units sold in the period from September to November in the five years considered. This represents more than 90 per cent of total sales over this period. However, about 4 per cent of these observations were also lost due to incomplete data on the characteristics used in the final specification of the regression model. Therefore, the final sample used was somewhat smaller.

The full set of characteristics on which information is available in the Marketing Systems database is given in Table 1 and corresponds to those listed in Automotor, one of the leading specialized magazines.⁽⁴⁾ Although this is a very extensive set of characteristics, it is clear that it cannot possibly account for all the attributes the consumers consider when making their decisions. For example, there are subjective aspects that cannot even be measured. Therefore, there are always important factors which cannot be included in the construction of hedonic prices for cars.

A final point is worth mentioning. The data on prices available in this database correspond to prices recommended by the manufacturers and include both the value added tax and a specific tax on the sale of new cars. This tax is a function of engine capacity and is regularly updated. In their pioneering study of hedonic price indexes for new cars in the Portuguese market, Santos and Coimbra (1995) modelled the price of the new cars net of the tax on the sale of new cars, but including

(3) For more details, see <http://www.acap.pt>.

(4) More information on this magazine can be found at <http://www.automotor.pt>.

the value added tax. In the present study, it was decided to consider the price including all taxes since variations in taxation rules are an important source of price variation in this period. Naturally, it would be preferable to have data on true transaction prices, but that would require a very different and much more expensive information gathering method.

3. HEDONIC PRICE INDEXES AND MAIN RESULTS

The method that is most often used to construct hedonic price indexes is the so-called dummy variable method, which consists in using data for several periods to estimate a model where the dependent variable is the natural logarithm of the price and which includes as regressors car quality indicators and period specific dummy variables. Using this approach, approximate estimates of the quality adjusted price variations are given by the estimates of the coefficients on the period specific dummies. However, this approach is only valid if the regression coefficients are constant for all the time periods considered, which implies that the value of the characteristics remains constant as time passes and technology evolves (see, Pakes 2002). Even if only two adjacent years are used in the estimation, this assumption can be violated if the product is changing rapidly and yearly data is used. Fortunately, it is not hard to generalise the dummy variable method to relax the coefficient stability restriction. In fact, estimating the hedonic regression model only for the base year, the estimated parameters can be used to evaluate the goods sold in a later period at the price of the base year. This approach is similar to the well known Oaxaca (1973) decomposition, which in this case is used to decompose the total variation of the average price in a part resulting only from the changes in the characteristics of the products sold and a pure price variation.⁽⁵⁾

As it is often the case, in this study the best regression results were obtained with models in which the dependent variable is the logarithm of the price. Since regressions of this type are only compatible with price indexes based on geometric means (see Reis and Santos Silva, 2002), all the

hedonic indexes estimated here are effectively based on geometric price averages.

Using these log-linear regressions, quality corrected price indexes were constructed according to three different methodologies: the usual dummy method, using both pooled and adjacent years data, and the method based on the Oaxaca (1973) decomposition. In view of the poor performance of the models estimated using more than one year of data, the Oaxaca-type quality adjusted price index based on the year-by-year⁽⁶⁾ regressions were preferred.

Because the data available are not a sample of prices of cars actually bought but rather it was constructed using list prices reported by the manufacturers, the market shares have to be used as weights to obtain an estimate of the average price of new cars sold in a given period.⁽⁷⁾ When weighted averages are used, the hedonic price indexes can be computed as usual if the hedonic regressions are estimated by weighted least squares. The values of the weights used in the estimation were computed as the total sales for each model during the months of September to November of a given year, divided by the total sales of the models considered during the same period.

To obtain quality corrected indexes it is necessary to choose the set of characteristics to be included in the regression. This is a vital process because the results largely depend on the set of characteristics considered. As described in the previous section, the characteristics included in the data set used here are those detailed in a specialized magazine, and therefore should be reasonably representative of the attributes consumers look for when choosing a new car. Although the set of variables on which data is available is relatively complete and provides detailed information on the equipment of the vehicles and on their technical specifications (see Table 1 of the previous section for details), there are important characteristics that are not included in this list. For example, the styling of the car and its built quality are certainly important factors for the consumers that are not available in this study and are in general difficult to measure. In order to partially compensate for

(5) For further details see Reis and Santos Silva (2002), section 2.

(6) The estimated parameters were used to evaluate the goods sold in one period at the price of the previous year (base year).

(7) See Machado and Santos Silva (2001) for further details.

Table 2

DEFINITION OF THE REGRESSORS USED

Name	Definition
CntrlLock	1 if has central door locking
CntrlLockR	1 if has central locking with remote control
Lumb	1 if driver seat has lumbar adjustment
EltrcSR	1 if has electric sunroof
PwrS	1 if has power assisted steering
Comp	1 if has on-board computer
AirCon	1 if has air-conditioning
Immob.	1 if has immobilizer
ABS	1 if has ABS
Leather	1 if has leather upholstery
TlscpcAdj	1 if has steering wheel with telescopic adjustment
EltrcW	0 if no electric windows, 1 if front only, 2 if front and rear
Fog	1 if has fog lights
Cassettes	1 if has radio with cassette player
CD	1 if has radio with CD player
Tank	Logarithm of fuel tank capacity
Cons	Combined fuel consumption
TransF	1 if front transmission drive
CC	Logarithm of engine capacity
Diesel	1 if fuel type is diesel
Pwr	Maximum power
MaxS	Maximum speed
Accel	Acceleration
Boot	Boot capacity
Doors	1 if has four or five doors
BR	1 if break
CO	1 if coupé
CA	1 if cabrio
RO	1 if roadster
OR	1 if off-roader or sports utility vehicle
MPV	1 if multipurpose vehicle
D	1 if German
S	1 if Swedish
J	1 if Japanese
K	1 if Korean
USA	1 if from the United States
E	1 if Spanish
East	1 if from an East European country
UK	1 if from the United Kingdom

the lack of these variables, a set of dummies indicating the country of origin of the manufacturer were added as regressors.⁽⁸⁾ This set of dummies may also help to reduce the conditional dependence between observations corresponding to cars produced by the same manufacturer. The list of variables included in the final specification, as well as information on the form, in which they enter the model, is presented in Table 2.⁽⁹⁾ It should

(8) As in Santos and Coimbra (1995), a single dummy was used for all Eastern European countries.

(9) Besides the variables included in this table, the final model also includes the products of the engine capacity (CC) by the fuel type dummy (Diesel) and by the combined fuel consumption (Cons).

Table 3

ESTIMATES OBTAINED USING THE OAXACA DECOMPOSITION

	Year-on-year rate of change		
	Quality	Price	Total
1998	4.72	0.94	5.71
1999	6.12	1.08	7.26
2000	5.97	0.77	6.78
2001	2.60	0.60	3.21
Average	4.84	0.85	5.73

Table 4

CONSUMER PRICE INDEX

Year-on-year rate of change

	Official data		Hedonic estimates	
	CPI new cars	CPI total	Price index for new cars	Adjusted total CPI
1998	1.72	2.78	0.94	2.72
1999	1.88	2.34	1.08	2.28
2000	2.42	2.87	0.77	2.75
2001	2.76	4.35	0.60	4.20
Average	2.19	3.08	0.85	2.98

be noted that the parameter estimates obtained are not reported here since they are not of direct interest and are difficult to interpret (see Pakes, 2002).

Table 3 presents the Oaxaca-type decomposition of the variation of sample average prices into the pure price variation and an estimate of the change in quality of the new passenger cars sold.

The analysis of these results shows that quality of new passenger cars in the Portuguese market increased on average 4.8 per cent a year between 1997 and 2001.⁽¹⁰⁾ This quality improvement was particularly high in 1999 and 2000, reaching a variation of around 6 per cent.

It is also interesting to compare the estimated hedonic price index with the corresponding component of the CPI. Table 4 displays the official figures for the CPI and for its component corre-

(10) To give an idea of the importance of using weights in this sort of studies, it is interesting to notice that if the information on the sales volume was ignored, the estimate for the growth rate of the average quality would be just 1.6 per cent.

sponding to the sales of new passenger cars, as well as the hedonic estimates for this component of the price index and the adjusted values of the total CPI obtained using these estimates. It is remarkable that, despite being based on very different information and computed using a different methodology, the variation of the component of the CPI corresponding to the sales of new passenger cars is relatively close to the year-by-year hedonic price index, particularly for the first two years. However, for the last two years, the CPI clearly overstates the change in the price index for new cars. The difference between the CPI and the hedonic price index reaches a maximum of 2.16 in 2001 (1.34 on average between 1997 and 2001). In any case, and considering the values reported in Table 3, it seems clear that CPI managed to eliminate a substantial part of the impact of quality changes.

It is interesting to notice that in 1997 the methodology of the construction of the CPI was substantially revised (*Instituto Nacional de Estatística*, 1998). In particular, since 1997, the component corresponding to the acquisition of new passenger cars is computed using information on about 20 different models divided into three categories according to the engine capacity. In each class the best selling models were considered.⁽¹¹⁾ This methodology may have worked reasonably well until 1999, but the results for more recent years are less satisfactory. In fact, taking into account that the total weight of the price index for new cars in the overall CPI is about 7 per cent, the difference between this component of the CPI and the estimates of the hedonic price index for new passenger cars is not negligible. As Table 4 shows, this difference implies that there is an overestimation of the overall CPI of approximately 0.1 percentage points (.p.p.) on average, reaching a maximum of 0.15 p.p. in 2001. This suggests that with the current methodology it is perhaps necessary to regularly update the set of models whose price is considered in the construction of the CPI in order to account for the changes in the market shares of the different models.

4. CONCLUSION

The results of this study unequivocally show that average quality of the new passenger cars in the Portuguese market is growing at a fast pace and that this phenomenon has to be taken into consideration in the estimation of price indexes. Naturally, the complexity of a study like the one presented here makes it impractical for statistical agencies to use these methods on a regular basis to account for the changes in quality when computing price indexes. Therefore, simpler methods are often preferred.

The results described in the last section suggest that the method adopted by the *Instituto Nacional de Estatística* in the construction of the CPI was reasonably successful in accounting for the quality change of new passenger cars. However, the growing divergence between the hedonic indexes computed here and the results for the CPI suggests that the method adopted in the construction of this index needs to be regularly updated. The results of the study indicate that the CPI component corresponding to the sales of new passenger cars may have been overestimated by as much 2.2 p.p. per year. This corresponds to an overestimation of the overall CPI by about 0.15 p.p. per year. Finally, it is also possible to conclude that the quality of new cars sold in Portugal increased on average 4.8 per cent per year between 1997 and 2001.

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