
CONSTRUCTION OF SEGMENT-BASED PRICE INDEXES IN TURKISH AUTOMOBILE MARKET AND ESTIMATION OF VARYING SEGMENT-BASED PRICE ELASTICITIES

Ahmet ÖZÇAM* Dilek SAĞLIK ÖZÇAM**

ABSTRACT

The Country of Origin effect being no longer as important in Turkey in the domestic automobile sector, this paper adopts a different disaggregation approach to estimating automobile demand in Turkey: segmentation based on types of automobiles. First of all, we can assert that during January 2006-September 2010, Hatch-Backs' price increases were higher compared to those of Compact-Sedans and Medium-Sedans pointing out to the changing pattern/nature of Turkish auto consumers' demand/preferences for autos using the Fisher index. Secondly, we investigated the extent of the temporary tax concession (decrease) given by the Turkish government to the producers/importers that was not passed completely onto the consumers during the global crisis in 2009. We concluded that at that time the demand elasticity was less than that of the supply. Finally, using the segmental price indexes that we have constructed, we were able to run a regression on combined set of equations model (LSDVM).

Key Words: Automobile Market, Segment-Based Price Indexes, Taxes, Estimation of Disaggregated Auto Demand, Disaggregated Price Elasticities

TÜRK OTOMOBİL PİYASASINDA SEGMENTE BAĞLI FİYAT ENDEKSLERİNİN OLUŞTURULMASI VE DEĞİŞKEN SEGMENTE BAĞLI FİYAT ESNEKLİĞİNİN DEĞERLENDİRİLMESİ

ÖZ

Ülke menşei etkisi Türkiye'de iç piyasada artık eskisi kadar önemli olmadığı için bu makalede Türkiye'de ki otomobil talebine farklı bir ayrıştırma yöntemi uygulanmıştır: otomobil tipleri. Bu makalede farklı segmentlerde ki otomobil fiyatlarıyla ilgili çok detaylı veri topladık. Öncelikle, 2006 Ocak- 2010 döneminde Hatch-Back (C2, B2) tipi otomobillerde fiyat artışı Compact-Sedan ve Medium-Sedan'lardan fazla olmuştur ve bu netice Türkiye'de değişen tüketici tercihlerini göstermektedir. İlaveten, 2009 küresel kriz döneminde Türkiye devletinin otomobil satıcılarına sağlamış olduğu geçici vergi indirimlerinin tamamıyla tüketiciye yansıtılmamış olması durumunu kendi segment tanımımız doğrultusunda farklılıklarını inceledik. Neticede, o dönemde piyasa fiyat esnekliğinin piyasa arz esnekliğinden daha az olduğuna karar verdik. En son olarak, segment bazlı fiyat endekslerimizi kullanarak

*Associate Prof, Yeditepe University, Department of Economics, aozcam@yeditepe.edu.tr

**Assistant Prof, Yeditepe University, Department of Business Administration, dsaglik@yeditepe.edu.tr

bütün segmentlerin denklemlerini birleştirerek LSDVM adı verilen bir regresyon analizi yaptık.

Anahtar Kelimeler: Otomobil Piyasası, Segment Bazında Fiyat Endeksleri, Vergi, Ayrıştırılmış Otomobil Talep Tahmini, Ayrıştırılmış Fiyat Esnekleri

INTRODUCTION

The automotive industry is the largest exporting sector in Turkey (\$ 17.5 billion) and has attracted substantial foreign direct investment. Parallel to the development of the vehicle production, Turkey's automotive parts sector which produces fuel injection systems, batteries, spark plugs, tires... grew strongly since the beginning of the new millennium. However, it is also important to note that the value-added of the automobile producing industry is not as large as the authorities of the Turkish government desire: about 65% of production is imported. About 2/3 of the new cars are imported from abroad into the Turkish market and approximately 1/4 is from outside EU. There are no import taxes on autos made in EU, but an import tax of 10% is levied on cars imported from outside Europe. However, the import tax is scheduled to be decreased by 1.5% each year in the future.

Every time the Turkish local market started shrinking, domestic auto producers (joint-ventures with big international firms like Renault, Honda, Hyundai, Ford...) tried to boost their exports and explore new foreign markets. Turkey's automotive sector was not terribly affected by the global economic and financial crisis perhaps mostly due to the temporary reduction in Special Consumption Tax (SCT) on automobiles during March-September 2009. However, the officials of the Turkish government were not satisfied with the fact that this tax decrease was not passed fully onto the auto consumers during the global crisis and fined certain companies presenting evidence that they behaved collusively (Özçam and Özçam, 2012-b; Özçam, 2014).

There have been voluminous *aggregate* and *disaggregate* studies analyzing automobile demand besides Turkey. The aggregated approaches generally estimated the price elasticity for new vehicles below unity whereas some studies found elasticity little over unity. Income elasticities in these aggregated approaches were found to be around 2. However, the disaggregated approaches (by types of automobiles) found that the demand for new vehicles was price and income elastic (McCarthy, 1996; Carlson, 1978; Verboven, 1996; Levinsohn, 1988). These results in the applied economics literature seem to be logical and consistent since we know from the theory that the price elasticity increases when we start to consider the demands of smaller groups in a given market.

As far as Turkey is concerned, this topic has not been widely explored and there have been only 2 studies on automobile industry in the last 18 years using rigorous econometric regression methods. Aslan and et. all. (2009) indicated that the price elasticity was around 2 using an aggregated data. Alper and Mumcu (2007) found that the price was inelastic using disaggregated data 1994-1997 for 3 automobile categories: domestically produced, imported from EU (European Union) and imported from other than EU. However, it is quite difficult to accept this result found in the Turkish automobile literature that the

price elasticity of demand at the disaggregated level (at segment basis) can be less than that of the demand at the aggregated level (the whole market) since it contradicts the theory. Therefore, we would like to point out to a further question and discussion regarding this issue: the possibility of *the demand curve to shift* during the business cycles.

Due to heavy direct foreign investment into Turkish automobile industry during the last decade, the Country of Origin effect (COO) seems to have become relatively unimportant in the Turkish domestic market as far as the cars of the big joint-venture local automobile firms and of the importers are compared (Özcam and Özcam, 2012-a). Therefore, it seems to be important to disaggregate according to other types of categorization. This paper takes a disaggregation approach to auto demand in Turkey from a different perspective: segmentation according to auto models (about 450 different types). We covered 4 important segments of the passenger cars: Compact-Sedan (C1), Compact-Hatch Back (C2), Entry-Hatch Back (B2) and Medium-Sedan (D1), each representing many models covering overall about 66% of all automobile sales in the Turkish domestic market. We note also that the Turkish Statistical Institute (TurkStat) takes a different segmentation approach from which is comprised of 3 categories: gasoline, diesel and above 2000cc., which differs from both those of COO effect and ours in this paper.

In order to make our approach operational and to be able to run separate regressions, we constructed various price indexes like Laspeyres, Paasche, Fisher, Edgeworth... in these 4 segments and compared them. Moreover, a sales-weighted average of these indexes (an overall index) was compared with the official price index of automobiles of TurkStat (Turkish Statistical Institute). We were then able to differentiate between the price discounts offered by the auto producers/importers on segment basis during the global crisis in 2009. The model we used for estimation is Least Square Dummy Variable Model (LSDVM) and it allowed us to calculate some varying price elasticities of demand for autos in these 4 segments over time.

In Section-2, the theory of index numbers is briefly reviewed. Section-3 shows the constructions of various binary and chain price indexes of automobiles in Turkey. Section-4 discusses the tax issue, whereas in Section-5 we examine the estimation results and varying segment-based price elasticities and their relationship with the tax discounts. Section-6 concludes the paper and suggests some new topics for research.

1. THEORY OF INDEX NUMBERS

One of the oldest discussions about the index numbers considered a *constant* basket of goods comprising of 5 quarters of wheat, 4 hogsheads of beer and 6 yards of cloth in comparing the value of money (or purchasing power) for an Oxford student of 1707 versus an Oxford student of 1460 when a student grant was offered. It was observed that in 1707 a typical Oxford student's purchasing power of the grant changed substantially compared to his/her counterpart in 1460. The constant market basket in this traditional example was a first attempt to calculate the increase in the cost of living of a student and to make the necessary adjustment in the grant in order to keep the student's purchasing power the same. Later, the application of index numbers

covered many other more general areas like the rate of inflation, exports and imports quantities, PMI's (Purchasing Managers' Index, industrial and services) ... where keeping the composition of the fixed market basket over a long period was challenged.

In this broad context, it was believed that the meaning of the index number must have been clarified before all discussions about the "best" index formula, "correct weights" etc... could be meaningful. It seemed to be difficult to give such a definition on both empirical and theoretical grounds.³ Therefore, the *index number problem* was said to exist whenever a quantitative expression like a market basket was made up of individual measurements for which no common physical unit was present (Frish, 1936). In the case of automobiles today, even though a common individual quantitative measurement exists (# of automobiles) the automobiles differ in their qualities (heterogeneous or imperfectly substitutable products).

The theory of index numbers was also a theoretical ground for discussing economic theories like whether the increases in the money supply could increase all prices proportionately except for random fluctuations. Diewert (1993) explained that Jevons (1865) and some others like Bowley and Edgeworth had recommended the statistical approach in the explanation of such economic theories. Fisher and Walsh criticized the statistical method, even though their remarks were largely ignored by the profession. However, Keynes (1930) effectively destroyed the naïve statistical approach by showing that the hypothesis of approximate proportional change in all prices could not be claimed empirically. The price movements were not statistically independent.

There are many different approaches to the theory of index numbers including Laspeyres, Paasche, Fisher, Walsh... formulae, statistical approach, test approach, economic approach....which may be classified according to different philosophies. Since the theory of index numbers is well documented in many places elsewhere, our purpose here is to present a very brief overview of price measurements. In the next two sub-sections we will first review some of the *binary* or direct formulae which depend on the data for only two periods and then their *chain* versions which can be extended to over three or more periods.

1.1. Binary Indexes

Let P_{0t} be an index number that expresses the ratio between the price level at time t and the price level at time 0, the base point. P_{0t} depends on the prices $p_0^1, \dots, p_0^N, p_t^1, \dots, p_t^N$ and the quantities $q_0^1, \dots, q_0^N, q_t^1, \dots, q_t^N$ where N is the number of goods. The old Sauerbeck's index is the simple arithmetic mean of the price ratios:

$$P_{0t}^{SAUERBECK} = \left(\frac{1}{N}\right) \sum \frac{p_t}{p_0} \quad (1)$$

The well known formulae of Laspeyres and Paasche are

³ In this paper, we are discussing the price indexes rather than the quantity indexes.

$$P_{0t}^{LASPEYRES} = \frac{\sum p_t q_0}{\sum p_0 q_0} \quad (2)$$

$$P_{0t}^{PAASCHE} = \frac{\sum p_t q_t}{\sum p_0 q_t} \quad (3)$$

whereas the Fisher's "ideal" and Edgeworth's formulae are

$$P_{0t}^{FISHER} = \sqrt{P_{0t}^{LASPEYRES} P_{0t}^{PAASCHE}} \quad (4)$$

$$P_{0t}^{EDGEWORTH} = \frac{\sum p_t (q_0 + q_t)}{\sum p_0 (q_0 + q_t)} \quad (5)$$

Additionally, we can consider the geometric average index with constant weights which are independent of both time points 0 and t,

$$P_{0t}^{GEOMETRIC} = \frac{\prod (p_t^1)^{\alpha^1} \dots (p_t^N)^{\alpha^N}}{\prod (p_0^1)^{\alpha^1} \dots (p_0^N)^{\alpha^N}} \quad (\sum \alpha = 1) \quad (6)$$

There are certain tests against which all these formulae can be compared. The birthplace of the test approach was the casual observations of the early writers in index number subject on their favorite index number formulae.⁴ However, Jevons (1865) recognized that his unweighted geometric formula (eq (6) above) where weights are ignored gave index number comparisons between any two years that were independent of the base year. Edgeworth gave a better general explanation of this base invariance test (Diewert, 1993).

Frisch (1930) criticized the test approach to index numbers showing that three fundamental tests such as commensurability, determinateness and circular tests could not be satisfied at the same time. Moreover, if some tests were to be dropped, then there was no general agreement as to which subsets of tests should be kept.

1.2. Chain Indexes

⁴ There are certain tests against which all these formulae can be compared. Sauerback's formula satisfies only the commensurability (invariance with respect to unit of measurement) and the proportionality (if prices change by the same proportion, the index gives this proportion) tests. Laspeyres and Paasche satisfy the commensurability, proportionality and determinateness (index shall not be zero, infinite or indeterminate if an individual price or quantity becomes zero), but not the time (point) reversal test ($P_{0t} P_{t0} = 1$), nor the circular test ($P_{01} P_{12} = P_{02}$). Fisher's ideal formula considered also by Bowley, Walsh and Pigou, satisfies the point reversal test but not the circular test. The same applies to the Edgeworth's formula. On the other hand the geometric mean satisfies the circular test (for any set of 3 points for which the weights are the same). However, the main difficulty seems to allow constant weights in the case of comparisons between remote points. If such a consideration is taken into account, then we are back to choosing among formulae (1)-(5) (Frisch, 1936).

Introduced by Marshall (1887), the chain index method results from a multiplication of a series of indexes which taken together cover a whole interval from 0 to t. It is adapted to time series data where the points are ordered in a sequence, and not to geographical data. Let P_{0t} be any index formula for direct comparison between two points like those in equations (1) to (6) above. Then the chain index \bar{P}_{st} between any two points s and t, is defined as

$$\bar{P}_{st} = \frac{P_{01}P_{12}\dots\dots\dots P_{t-1,t}}{P_{01}P_{12}\dots\dots\dots P_{s-1,s}} = P_{s,s+1}P_{s+1,s+2}\dots\dots\dots P_{t-1,t} \quad (7)$$

where 0 is the base period, and if s=0 then the denominator of the second term in (7) is simply one. Any chain index satisfies the point reversal test and the circular test no matter which binary or direct formula is used in the sequence. If a direct formula meets the circular test, then there is no difference between the chain index and the direct index (Frisch, 1936).⁵ If a direct index does not satisfy the circular test, then the divergence between the chain index and the direct index will often drift systematically. Sauerbeck and Laspeyres indexes will drift upward whereas Paasche will drift downward.

The Cost of Living Advisory Committee recommended the introduction of chaining into the U.K. Retail Price Index in 1962 instead of a base-weighted index (Craig, 1969). The committee concluded that such an index would provide an accurate measurement of changes over short periods without invalidating long-term comparisons of retail price movements. However, Allen (1963) stated that, “if the nature of the available data makes it necessary to adopt the chain method in practice, it must be remembered that the resulting index number is not identical with, though it may not differ greatly from, that obtained by direct comparison”.

In Section-3 below, we will construct separate price indexes for 4 segments of the Turkish automobile market and calculate also a weighted price index comprising these 4 segments.

2. SEGMENT-BASED PRICE INDEXES OF AUTOMOBILES IN TURKISH DOMESTIC MARKET

2.1. Data

Table-1 below shows the automobile sales (in quantity) in Turkey from 2006 to 2011, in total and in 4 segments: Compact-Sedan (C1), Compact-Hatch Back (C2), Entry-Hatch Back (B2) and Medium-Sedan (D1). This segmentation is constructed by the Association of Automotive Distributors (AAD) in Turkey. The total auto sales decreased in 2008 due to the global crisis. After recovering their earlier levels in 2009, they kept increasing in 2010 and 2011.

⁵ The chain method was given an attractive logical justification by Divisia who started from what he called the law of circulation of money which stated that the relative change in the aggregate value of all goods and services exchanged in a market in a given period of time was equal to the relative change in the level of prices multiplied by the relative change in the level of the quantities of the commodities sold (Forsyth and Fowler, 1981).

Table-1: Total Automobile Sales (In Quantity) and Sales At C1, C2, B2 and D1 Segments

	2006	2007	2008	2009	2010	2011
Compact-Sedan (C1)	77,330	94,626	85,253	90,874	122,878	151,205
Compact-HB (C2)	42,933	38,643	35,142	45,124	72,165	89,198
Entry-HB (B2)	95,277	78,173	59,878	73,715	108,821	119,044
Medium-Sedan (D1)	29,296	25,600	21,596	31,022	41,404	52,900
TOTAL SALES	373,219	357,465	305,998	369,819	509,784	593,519
Coverage of 4 segments out of Total Sales	66%	66%	66%	65%	68%	69%

Source: Association of Automotive Distributors in Turkey.

We constructed price indexes only in these 4 segments since collecting price data on about 450 models in overall 42 segments were practically impossible.⁶ The sum of sales in these aforementioned 4 major segments represented approximately 66% of total automobile sales in Turkish domestic market. The price data were collected from othaber, autoshow and autocar magazines and compiled.

2.2. Construction Of Standard (Binary) And Chain Price Indexes For 4 Automobile Segments

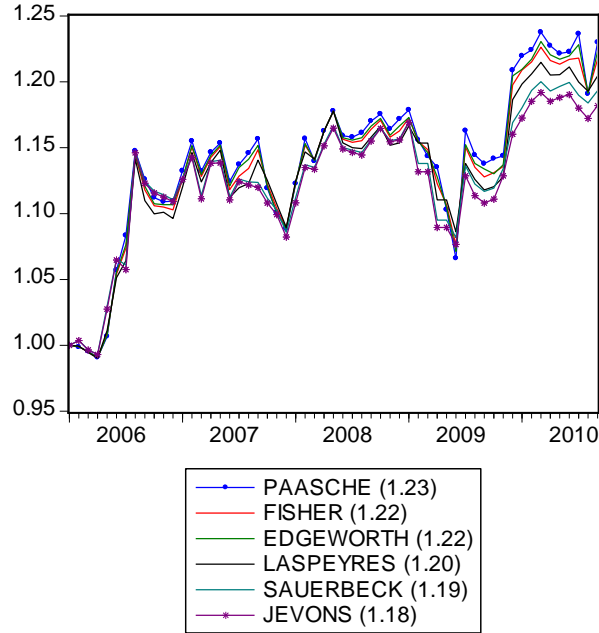
In Figure-1 below, six standard price indexes that were explained in Section 2-1 above are shown in the Compact-Sedan (C1) segment from January 2006 to September 2010. The values of all indexes are equal to 1 in the base period (January 2006). It is interesting to observe that these standard price indexes moved in the same direction over this period and fluctuated very closely together even though their formulae are quite different. For example Sauerbeck's formula and Jevons' unweighted geometric formula do not use the quantities at all and Laspeyres uses the quantity information only from the base period.

HYPOTHESIS-1: The divergences between the Standard Prices indexes like Laspeyres, Paasche, Fisher, Edgeworth, Sauerbeck and Jevons become larger as we apart from the base period over time.

We notice relatively larger divergences among indexes starting from the end of 2009 and this divergence becomes more marked in 2010 even though they keep fluctuating together in the same direction till the end of our sample. Over this period the price increases were: Paasche 1.23, Fisher and Edgeworth 1.22, Laspeyres 1.20, Sauerbeck 1.19 and Jevons 1.18. We find approximately a difference of 5% in price increases (0.23-0.18) between the Paasche index (the highest) and the Jevons index (the lowest) at the end of this period.

⁶ The models used in various segments are as follows: Compact-Sedan (C1): (Fiat-Linea, Renault-Fluence, Ford-Focus, Volkswagen-Jetta, Honda-Civic, Opel-Astra, Toyota-Corolla); Compact-HB (C2): (Citroen-C4, Opel-Astra, Ford-Focus, Volkswagen-Golf, Renault-Megane, Peugeot-308); Entry-HB (B2): (Ford-Fiesta, Opel-Corsa, Volkswagen-Polo, Renault-Clio, Peugeot-206, Hyundai-i20, Fiat-Grande Punto, Toyota-Yaris Terra) and Medium-Sedan (D1): (Toyota-Avensis, Ford-Mondeo, Peugeot-407, Renault-Latitude Laguna, Volkswagen-Passat). The % representations of these models in their segments are 76%, 75%, 82% and 50% respectively, computed from January-2006 to September-2010.

Figure-1: Comparison of Standard Price Indexes in Compact-Sedan (C1) Segment



In Figure-2 below, the *chain* versions of the same indexes are shown again in the Compact-Sedan (C1) segment. Over the same period, the price increases were: Laspeyres_Ch 1.25, Sauerbeck_Ch 1.22, Edgeworth_Ch 1.21, Fisher_Ch 1.20, Jevons_Ch 1.18 and Paasche_Ch 1.16 at the end of the period.

In Section 2-2 above, we argued that the Cost of Living Advisory Committee in U.K. concluded that a chain index would provide an accurate measurement of price changes over short periods without harming their long term comparisons (Craig, 1969). Even though the chain index was not identical with its standard version, it did not differ greatly from it (Allen, 1963).

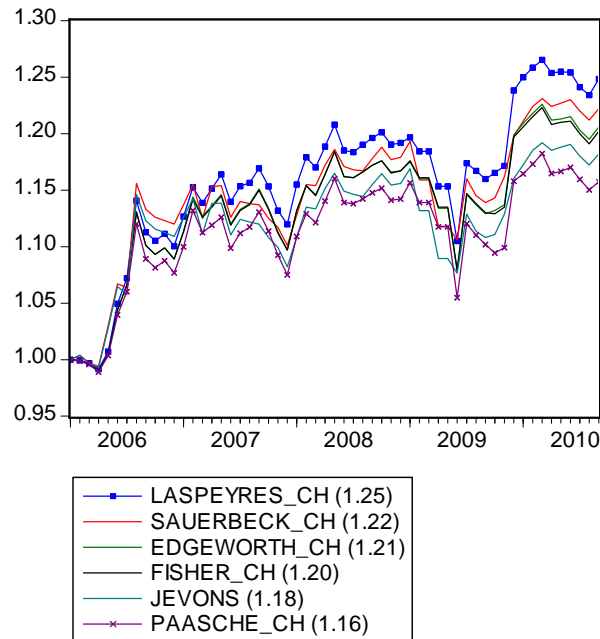
HYPOTHESIS-2: The result of the chain version of a price index does not differ substantially from that of its standard counterpart. However, the divergences among the chain versions may be more than those among the standard versions especially as we apart away from the base period over time.

Jevons' index is the only one whose chain version is the same as its standard version due to its construction and therefore each indicated an 18% price increase over this period. The results for the Edgeworth, Fisher and Sauerbeck chain indexes are quite close when compared with their standard counterparts. However, the results for the Laspeyres and Paasche chain indexes differ more compared to their standard versions. The Laspeyres_Ch (1.25) was substantially higher than its standard version (1.20), whereas Paasche_Ch (1.16) was substantially lower than its standard version (1.23).

The range of price increases among the chain versions corresponded to an approximately 9% difference in price increase (0.25-0.16) between the Laspeyres_Ch index (the highest) and the Paasche_Ch index (the lowest). Therefore, we found that the range of difference in increases in price (9%)

among the chain versions of the price indexes was greater than that of the standard formulae (5%). The divergences among the chain indexes were quite visible this time much earlier starting from the middle of 2006 as shown in Figure-2 below.

Figure 2: Comparison of Chain Price Indexes in Compact-Sedan (C1) Segment



Hence, we can conclude that the divergences among the chain indexes were greater than their standard counterparts in our case. A logical explanation is as follows: even though the chain indexes may represent price movements better since they make comparisons at each time period with the previous time period in a multiplicative fashion taking the changes in quantities over time, they fluctuated more since their formulae encompassed these quantity movements which may be large as time goes by. For example, whereas the standard Laspeyres formula uses the quantity information from the base period (fixed market basket) its chain version takes into account the compositions of quantities from the previous period at each point in time.

The results with respect to differences in the Compact-Hatch-Back (C2) segment are quite similar (not shown). Again, the standard indexes fluctuated very closely together at the beginning of this period and a noticeable divergence among them started to be visible after the end of 2009. Over the same period (from Jan-2006 to Sept-2010) the price increases were: Laspeyres 1.32, Fisher, Edgeworth and Paasche 1.30, Sauerbeck 1.27 and Jevons 1.26. This range of price increases corresponded to an approximately 6% difference in price increases between the Laspeyres index (the highest) and the Jevons index (the lowest).

In the Compact-Hatch-Back (C2) segment, the *chain* versions of the same indexes showed again more divergence compared to their standard counterparts starting from the beginning of 2007 (not shown). Throughout the sample period, the price increases were: Laspeyres_Ch 1.34, Sauerbeck_Ch 1.30, Edgeworth_Ch 1.28, Fisher_Ch 1.27, Jevons_Ch 1.26 and Paasche_Ch 1.19. This range of price increases corresponded to an approximately 15% difference between the Laspeyres_Ch index (the highest) and the Paasche_Ch index (the lowest). Again we can argue that divergences among the chain indexes were greater than their standard counterparts in this particular automobile segment as well.

The results in the Entry-Hatch-Back (B2) segment are again quite similar with respect to fluctuations. However, the price increases differed less: Laspeyres, Paasche, Fisher and Edgeworth 1.27, and Sauerbeck and Jevons 1.24, with a range of only 3% price increase (0.27-0.24). In the Medium-Sedan (D1) segment, the price increases were: Paasche 1.21, Edgeworth 1.17, Fisher 1.16, Sauerbeck 1.15, Jevons 1.13 and Laspeyres 1.11 with a range of 10% price increase (0.21-0.11).

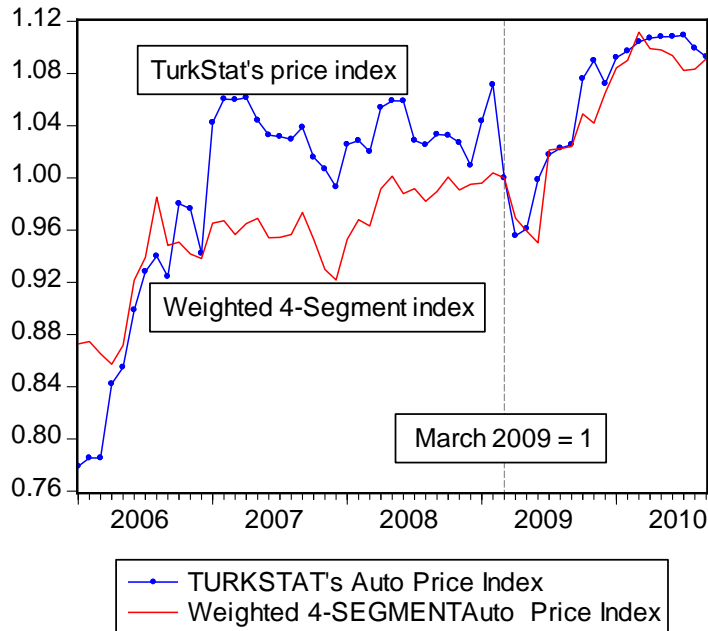
2.3. Comparison Of Our Weighted Automobile Price Index Using The 4 Segments With The Turkstat's Official Automobile Price Index

In this sub-section we will compare our *overall auto price index* using all 4 individual indexes at segment basis weighted by the quantities of these 4 segments with the TurkStat's (Turkish Statistical Institute) official auto price index representing the whole market of automobile of gasoline type. In Turkey, TurkStat updates both the coverage and the weights of the items representing the market basket of a typical consumer once a year (in December) and uses a chain Laspeyres method in calculating the Consumer Price Index (CPI) for the following year. There are 3 automobile price series included in TurkStat's typical market basket comprising 477 items in total.⁷ TurkStat's method in finding the prices of automobiles consists of getting in touch with the firms whose sales are the highest. The determination of weights of prices is based on the sales figures of these firms. In resolving the price of the *right automobile*, the features of the models (horse power, shift system, air bag, cd player...) are also taken into account.

In Figure-3 below, TurkStat's official auto price index is shown along with our weighted index calculated in this paper based on 4 segments. The base period (month) is taken to be March 2009 in order to display the similarity between these 2 indexes after this date (March 2009). Since TurkStat's automobile price series was expressed in nominal terms, we divided this series by its March 2009 value of TL 31,908 in order to obtain 1. The sample correlation coefficient was found to be 0.84 between the TurkStat's series and our weighted index over the whole period.

⁷TurkStat uses a different disaggregation approach than presented in this paper. They started publishing the prices of gasoline automobiles (Code = 0711301) since 2003 and the prices of diesel automobiles (Code = 0711101) since 2006 and the prices of automobiles above 2000 cc (Code = 0711401) since 2011 as items of CPI basket.

Figure 3: Comparison of Our Weighted Automobile Price Index Using the 4 Segments with The Turkstat's Official Auto Price Index



Even though there is not a perfect match between these two indexes over the whole sample period, it is important to observe that they moved quite closely to each other after March 2009. They increased approximately at the same rate almost every single month from March 2009 to September 2010 (TurkStat's index: 9.28% and ours: 9.11% at the end of the period).

There may be at least 4 reasons for the difference before March 2009:

i) Our 4 segments represented about 66% of total auto sales in the Turkish domestic auto market (Table-1 and Footnote 6).

ii) Moreover, TurkStat's method is quite direct and attempts to find the right type of automobile (for example of gasoline type) by considering the ones that are sold the most whereas our method considers the total quantities of automobiles in each of these 4 segments and takes a quantity-weighted average of the individual (segment based) price indexes.

iii) We used TurkStat's price series of cars using gasoline only in order to be able to make a comparison for a longer period of time. Our prices of auto models consisted of those cars of both gasoline and diesel type.

We believe that it was instructional to make such a comparison between an overall official index and an index compiled differently based on major segments. For example, both of them pointed out to the decrease in auto prices during the first half of 2009 when the global crisis was felt strongest in Turkey.

A further aim of ours in this paper is to use disaggregated price data in investigating individual demand curves in these 4 segments in the regression analysis in Section 5 below.

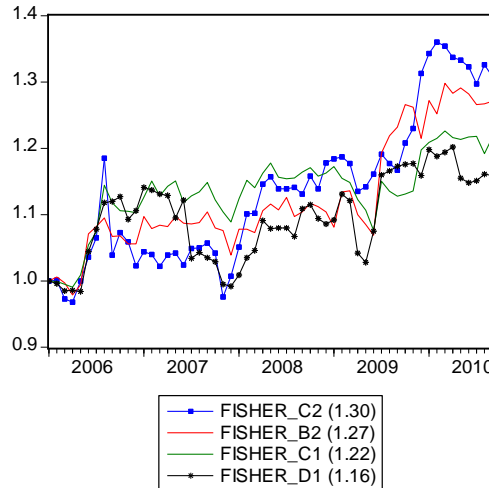
2.4. Differences In Price Increases In 4 Segments Of Auto Market

HYPOTHESIS-3: *If one is interested in finding out the changing pattern/nature of Turkish auto consumers' demand/preferences for autos, the traditional price indexes like Fisher, Laspeyres, Paasche.. convey better information compared to a simple unweighted nominal price level.*

As discussed in Section 3-2 above, the price increases were not uniform across 4 segments. As shown in Figure-4 below, the price increases were realized as: C2 (1.30), B2 (1.27), C1 (1.22) and D1 (1.16) using the ideal Fisher index. We see that the price increase in autos of C2 type (1.30) were much higher than that in autos of C1 type (1.22) when compact cars were compared.

However, it is important to note that Figure-4 shows the quantity-weighted price increases and not a simple unweighted nominal price level for a certain segment of cars. For example if we calculate a simple unweighted average for C1 and C2 type at the end of the period (September) we find TL 36,811 (C1) and TL 32,051 (C2) respectively and C1 type automobiles seem to be more expensive. However, this kind of simple averaging ignores the quantities that are sold in the market. On the other hand, taking the quantities as weights into account and considering the quantity-weighted average price levels of automobiles in these 2 segments (compact cars) our further calculations showed that C1 type autos were more expensive than those of C2 types but only at the beginning of the sample (January 2006). We adjusted the weights to add up to 1. Averaging the car prices again by quantities, at the end of our sample (September 2010) actually C2's turned out to be more expensive than C1's in compact category. This seemingly contradictory result stems of course from the fact that the price increase for C2 type autos (30%) was higher compared with that for C1 types (22%) calculated by the Fisher index.

Figure 4: Price in Creases in 4 Auto Segments Using Ideal Fisher Index



Moreover, we can assert that during this period Hatch-Backs' (C2 and B2) price increases were higher compared to those of Compact-Sedans (C1) and Medium-Sedans. This result shows the changing pattern/nature of Turkish

auto consumers' demand/preferences for autos, and is quite important from the suppliers' decision making process. Therefore, we maintain Hypothesis-3 above.

3. THE GLOBAL CRISIS OF 2009 AND THE TEMPORARY DECREASE IN SPECIAL CONSUMPTION TAX (SCT)

March 2009 happens to be the beginning of a policy of decrease in Special Consumption Tax (SCT) implemented by the Turkish government for automobiles below 1600 cc to support the domestic automobile market against the likely negative effects of the global crisis which had started being felt relatively strongly in 2009:Q1. The tax concessions were offered differently in the following two periods: a decrease of 16% (=1.37/1.18 from 37% down to 18%) from March 16th to June 15th and a decrease of 7.8% (=1.37/1.27 from 37% down to 27%) from June 16th to September 30th. So, the government allowed a sudden big reduction in tax during the first 3 months, but cut it in the second period and applied about half of it during the following 3 and half months.

Table-2 below gives the % price discounts of automobile companies (from 4% to 9.1%) and the lengths of periods (like 3-4 months) these discounts were being offered. Especially the segments C2, B2 and C1 represent autos below 1600 cc. The % of tax decrease given by the government (16%) during the first 3 months does not seem to have been passed *completely* on to the auto customers even though TL (Turkish Lira) appreciated against EURO from 2.22 in March-2009 down to 2.07 in July-2009. TurkStat's official gasoline type auto price index indicates an overall 4% decrease in auto prices from March to May 2009. We also know from Figure-3 above that our quantity-weighted price index by 4 segments moved very closely with TurkStat's index during this period. However, now we are able to differentiate the price decreases given by firms *on segment basis*. The smallest discount (4%) was offered to C2 type car purchasers and the biggest discount (9.1%) to D1 type car customers. It is interesting to note that even though most of C2, B2 and C1 cars are below 1600cc, the price discounts in these segments were not as large as those in D1 segment on the average.

HYPOTHESIS-4: During the global crisis, in the Turkish domestic automobile market the elasticity of supply of firms was greater than that of the demand of consumers.

We calculate roughly the average tax reduction given by all firms to be 6.8% $(=(4+5.9+8.2+9.1)/4)$ which is 42.5% $(=6.8/16)$ of 16%. Therefore we can conclude that the market price elasticity of supply at that time was greater than that of the demand. Even though the firms were caught with huge inventories at the end of 2008, these inventories were depleted much sooner than expected. It is of course very difficult to tell how much more the auto sales would have improved if the market conditions (elasticities of market supply and demand curve) allowed the tax reduction to have been passed completely onto the consumers as the government officials had expected. Helping the producers was of course important during that difficult time, since it was the main intention of the fiscal policy in the first place. However, later the Turkish Antitrust authorities looked into the matter more carefully and investigated

whether firms behaved collusively and gave substantial fines (millions of \$'s) to some firms.

As a conclusion we can assert that during the global crisis the portion of SCT decrease given by the Turkish government passed onto the Turkish auto consumers was about 42.5 % and short-lived (only 3-4 months as opposed to the government's tax concession of about 6.5 months) pointing to the price elasticity of demand being less than the elasticity of supply. It seems that the usual market conditions prevailed as in the economics theory and the discussions between the Turkish government and the auto producers/importers should perhaps have taken into account the utility maximizing of individuals in free markets (Özçam, 2014).

Table 2: Peak and Troughs of Price Indexes in 2009 GLOBAL Crisis (Segments' Fisher Indexes and Turkstat' Index

Segment	PEAK PRICE	TROUGH PRICE	PRICE DISCOUNTS OF FIRMS (% and LENGTH OF PERIOD)
C2	1.187 (February 2009)	1.135 (April 2009)	4% (THREE MONTHS)
B2	1.136 (March 2009)	1.069 (June 2009)	5.9% (FOUR MONTHS)
C1	1.173 (January 2009)	1.076 (April 2009)	8.2% (FOUR MONTH)
D1	1.131 (February 2009)	1.028 (May 2009)	9.1% (FOUR MONTHS)
TurkStat	31,908 (March 2009)	30,663 (May 2009)	4% (THREE MONTHS)

It is obvious that real GDP dropped during that period and the price elasticity of demand must have increased ceteris paribus (See Section-5 below on varying price elasticities). We turn now to the question of estimation of segment-based demand curves in Section 5 below.

4. ESTIMATION OF DEMAND FOR AUTOMOBILES IN TURKEY USING DISAGGREGATED (SEGMENT BASED) DATA

In this paper we would like to emphasize the fact that the price elasticities may change over time and therefore we use a linear model where the elasticities are allowed to be different depending on both the price level *along the demand curve* and *the position of the demand curve* perhaps due to mostly the business cycles. On the other hand, a Cobb-Douglas type demand function which we did not prefer would have kept the price elasticity constant. The Cobb-Douglas function has the advantage in estimating the constant elasticity easily by using logarithms. With a view to accommodating the shifts in the demand curve due to other variables (real interest rate, real amounts of credits...) also besides income (business cycles) which must affect the price elasticity together with the autos' own price along the demand curve we chose a linear model where the price elasticity was permitted to fluctuate over time.

VARIABLES:

a) Dependent variable: AUTO SALES: automobile sales (in quantity).

b) Independent variables:

- RPRICE: Real automobile price index (Auto price index stacked for 4 segments in a single column divided by CPI (Consumer Price Index), 2003=100).
- RGDP: Real GDP at constant 1998 prices.
- RINT: Real interest rate on vehicle credits (Nominal interest rate (in %) divided by the rate of annual change in CPI (inflation)).

- RCRED: Real new vehicle Credits in TL (New vehicle Credits divided by CPI (2003=100)).
- DUM-SCT: A dummy variable taking the value of 1 from February 2009 to September 2009 representing the temporary decrease in Special Consumption Tax (SCT), and 0 otherwise.
- DUM-C2, DUM-B2 and DUM-D1: Dummy variables taking the value of one if the auto type falls in the specified segment (C2, B2 or D1) and 0 if it is otherwise, with C1 segment autos being the base category.
- RGAS: Real price of gasoline (Gasoline prices in TL divided by CPI (2003=100)).
- NIP: Non-institutionalized population over 15 years of age.
- LEAD-IND: Leading indicators index of Central Bank of Turkey (CBT).
- CCI: Consumer confidence index of CBT.
- REE: Real effective exchange rate of CBT.
- TREND: Time trend variable.

Table 3: Estimation of Disaggregated Auto Demand Using Data from 4 Segments Dependent Variable: Auto Sales (in quantity)

INDEPENDENT VARIABLES	MODEL 1 (Heteroskedasticity-robust Standard Errors)	MODEL 2
Constant	21,742 (0.01**)	12,713 (0.00**)
TREND	-55.84 (0.001**)	-34.29 (0.003**)
DUM-C2	-2,241 (0.78)	-
DUM-B2	9,542 (0.32)	-
DUM-D1	-335 (0.97)	-
RPRICE	-2,435,445 (0.04**)	-1,810,106 (0.00**)
RPRICE*DUM-C2	1,701,350 (0.19)	903,946 (0.01**)
RPRICE*DUM-B2	891,652 (0.52)	962,211 (0.00**)
RPRICE*DUM-D1	1,600,546 (0.18)	1,431,175 (0.00**)
RGDP	0.001 (0.00**)	0.0009 (0.00**)
RGDP*DUM-C2	-0.0009 (0.04**)	-0.00056 (0.01**)
RGDP*DUM-B2	-0.0008 (0.08*)	-
RGDP*DUM-D1	-0.0012 (0.00**)	-0.00083 (0.00**)
RINT	-304 (0.01**)	-239 (0.00**)
RINT*DUM-C2	-58.45 (0.64)	-
RINT*DUM-B2	-309.2 (0.03**)	-248 (0.00**)
RINT*DUM-D1	162.65 (0.16)	-
RGAS	-292,389 (0.31)	-
RGAS*DUM-C2	110,406 (0.71)	-
RGAS*DUM-B2	98,686 (0.77)	-
RGAS*DUM-D1	252,952 (0.36)	-
RCRED	0.1446 (0.14)	0.1084 (0.00**)
RCRED*DUM-C2	-0.1445 (0.13)	-0.1014 (0.00**)
RCRED*DUM-B2	-0.021 (0.84)	-
RCRED*DUM-D1	-0.1421 (0.13)	-0.0788 (0.01**)
LEAD-IND	7.33 (0.49)	-
REE	-27.37 (0.31)	-
DUM-SCT	769 (0.09*)	1,069 (0.01**)
AUTO SALES(-1)	-0.094 (0.31)	-
<i>AdjustedR²</i>	0.74	0.69
<i>Akaike criterion</i>	17.498	17.473
<i>Schwarz criterion</i>	17.935	17.699
<i>No of Obs.</i>	227 after adjustments	228

Notes: The number in parentheses are the p-values. ** indicates 5% significance level and * indicates 10% significance level.

Our previous constructions of auto price indexes at disaggregated level allowed us to make estimation of segment-based demands using the Least Squares Dummy Variable Model (LSDVM). Therefore, AUTO SALES and RPRICE variables are formed by stacking information from all 4 segments: C1, C2, B2 and D1 using the monthly data from January-2006 to September-2010. There are 57 observations in each of these 4 segments making a single column of a total of 228 observations.

In Table-3 above, in the Model 1, all coefficients have the expected correct signs. For example all 4 price coefficients are negative whereas all 4 GDP coefficients are positive (when the differential slope estimates using dummy variables at segment basis are taken into account). The p-values in parentheses are calculated using White's Heteroskedasticity-robust standard errors since we used a panel data (having both cross-section and time dimensions).

To arrive to Model 2 we used a stepwise method in reducing the number of variables using Adjusted R^2 , Akaike and Schwarz criteria and t-statistics. All 3 differential intercept dummies were dropped. Whereas some of the slope differential dummies were kept for GDP, RINT and RCRED variables, all of the differential slope dummies remained for the RPRICE variable. Even though Adjusted R^2 decreased somehow from 0.74 down to 0.69, both Akaike and Schwarz indicated an improved fit.

4.1. Implied Price Elasticities Of The Disaggregated Approach

Now in Figure-5 below, we would like to show the evolution of the elasticities in the 4 segments based on the slope estimates calculated in Table-3 above (Model 2) using the following formula. For example for the base category (C1):

$$ELAS(C1) = \frac{dQ}{dP} \frac{P}{Q} = -2,435,445 * \left(\frac{C1_Price_Index}{CPI} \right) / \quad (8)$$

Estimated _Sales(Model2)

The formulae for the other 3 segments are similar when the differential price estimates are added to the base category (C1). The price elasticity using TurkStat's general price index is also exhibited in Figure-5. We observe that these 5 price elasticities altogether moved generally in the same direction during this period. The sample mean of the elasticity based on TurkStat's index (-1.96) is about at the middle of the sample means of the other elasticities based on our price indexes (Table-4 below). In Section 4 above, we found the price discounts passed onto consumers by auto firms to be 9.1%, 8.2% and 5.9% in the D1, C1, and B2 segments during the temporary tax decrease given by the Turkish government (Table-2). Incidentally, the estimated elasticities from Model 2 above are also ranked in the same order. They are -2.52, -2.36

and -1.26 respectively. In other words, the higher the price elasticity of demand facing the auto sellers, the bigger were the price discounts offered by them in view of a tax decrease by the government. This finding seems to present further evidence that a given tax decrease (subsidy in our case) by the government depends heavily on price elasticities of individual demands on segment basis.

Nevertheless, the segment C2 differs. This may be perhaps due to the elasticity of supply being different in these 4 segments (see Section 4 above and Ozcam, 2014). Incidentally, the price index of C2 type autos had the lowest correlation with that of TurkStat (only 0.46 (Table-4 below)).

Figure 5: Elasticities Calculated with Tuik, C1, C2, B2 and D1 Price Indexes

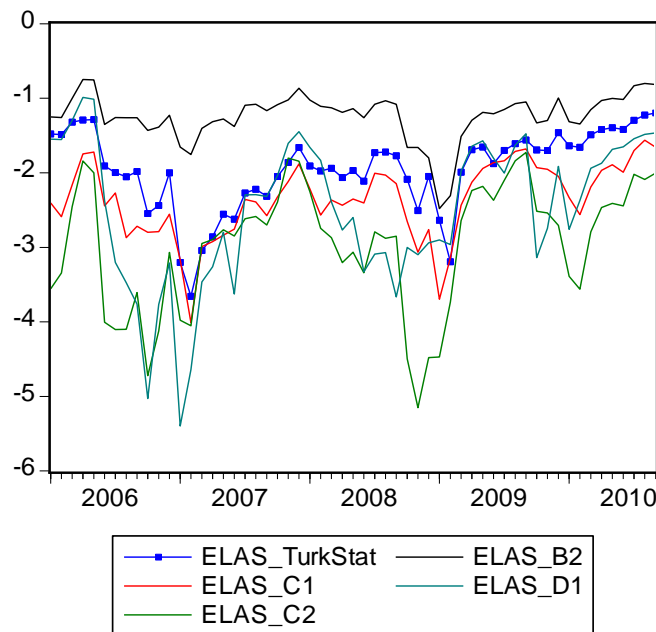


Table 4: Descriptive Statistics of Various Elasticity Measures

	ELAS_TurkStat	ELAS_C1	ELAS_C2	ELAS_B2	ELAS_D1
Maximum	-3.66	-4.01	-2.79	-2.81	-5.40
Minimum	-1.20	-1.56	-1.72	-0.75	-0.98
MEAN	-1.96	-2.36	-3.12	-1.26	-2.52
Std. Deviation	0.54	0.51	1.30	0.38	0.97
Correlation with ELAS_TurkStat	1.0	0.88	0.46	0.66	0.75

CONCLUSION

In this paper we have discussed 4 important issues regarding the Turkish domestic auto market:

a) We constructed price indexes for 4 segments of the Turkish domestic automobile market from Jan-2006 to Sept-2010 based on auto models since the Country of Origin (COO) effect seemed to be no longer important for Turkey. We observed that the price increases were not uniform among these 4 segments. For example, during this period Hatch-Backs' (C2 and B2) price increases were higher compared to those of Compact-Sedans (C1) and Medium-Sedans. This result showed the changing pattern/nature of Turkish auto consumers' demand/preferences for domestically available autos, and carries quite an important piece of information for the suppliers' decision making process regarding their inventories/sales.

b) There were many *aggregate* and *disaggregate* studies analyzing automobile demands in the applied economics literature. The market (aggregated) price elasticity was found to be smaller from each of those of its segmented parts whenever a disaggregated approach was adopted. This of course made sense on theoretical grounds. On the other hand, there have been only 2 studies on automobile industry in the last 18 years in Turkey using rigorous regression methods. Alper and Mumcu (2007) found that the price was inelastic (less than 1) using disaggregated data 1994-1997 emphasizing Country of Origin (COO) effect. Aslan and et. all. (2009) indicated that the price elasticity was around 2 (elastic) using an aggregated data. These results seem to stand contradictory since the overall price elasticity for the market cannot be smaller than the individual price elasticities making up the various segments of the whole market. Therefore, we thought that the possibility of varying price elasticities over time especially due to the business cycles shifting the demand curve for autos must have been discussed to be able to reconcile these studies. Alper and Mumcu's data (2007) covered a period which was much before (1994-1997) compared to Aslan and et.all's (2009) data which incidentally coincided with the global crisis.

This paper took a disaggregation approach to auto demand in Turkey from a different perspective: segmentation at auto models' basis. Due to the heavy direct foreign investment into Turkey to the automobile industry and joint-venture automobile firms producing for both domestic and foreign markets during the last decade, the Country of Origin effect (COO) seems to have become relatively unimportant in Turkey. Therefore, it was important to disaggregate according to other types of categories such as ours. We noted that TurkStat took a different disaggregation direction in automobile segmentation from ours in this paper, since they are concerned with the calculation of price changes after determining the right definition of automobile in gasoline, diesel or autos above 2000 cc categories.

c) We found that during the global crisis the portion of SCT decrease given by the Turkish government passed onto the Turkish auto consumers was about 42.5% and short-lived, pointing to the price elasticity of demand being less than to the price elasticity of supply. It seems that the usual market conditions prevailed and the discussions/disputes between the Turkish government and

auto producers/importers should perhaps have taken into account the utility maximizing of individuals in free markets and accepted as normal.

The Turkish government seems to prefer to keep the Special Consumption Tax (SCT) on automobiles above 2000 cc higher in trying to receive more revenues from the wealthier citizens and also for equity reasons. For example, in October 2011 the additional SCT rise was 25% for the autos more than 2000 cc compared to a 12.5% rise for 1600-2000 cc cars. There was no additional increase in SCT for autos below 1600 cc. However, later in September 2012, due to the widening of the Turkish government budget deficit, further indirect taxes (not on income) like SCT on auto below 1600cc, alcoholic beverages, electricity and natural gas...were implemented. The relative shares of consumers and producers of an advalorem tax increase on a product during the boom-bust periods of the business cycle taking the Turkish case as an example in a microeconomic theoretical framework are considered further in Özçam (2014).

d) Using the price indexes that were constructed, we were able to run a regression on a combined set of equations model (LSDVM) comprised of *stacked* prices and quantities of individual segments. The 4 price elasticities estimated from this model generally moved in the same direction and had high correlations with that of TurkStat. TurkStat's index evolved approximately at the middle of our 4 price indexes. Moreover, the price elasticities on segment basis that we obtained from the model seemed to agree in general with the price discounts offered by firms during the global crisis.

Some further topics of research are as follows:

i) Rather than a single income variable (real GDP) that we used for all segments in the automobile sector, micro data on consumers' income levels may be necessary. However, our notion of *varying elasticities* over time that we emphasized in this paper within the context of a linear model must be kept anyways even when micro level cross section data are used.

ii) The issue of after-sale services of sold automobiles in Turkey was not taken up in this paper. However, this fringe sector is known to be a very important income generating gate for the imported or domestically produced companies and requires much more attention in further research topics in discussing auto prices.

REFERENCES

- ALLEN, R. D., 1963. 'Price Index Numbers', *Rev. Int. Statist. Inst.*, 31, 281-306.
- ALPER, C. E., and MUMCU, A., 2007. 'Interaction between Price, Quality and Country of Origin when Estimating Automobile Demand: the Case of Turkey', *Applied Economics*, 39, 1789-96.
- ASLAN, I. Y., and et. all 2009. 'Itinerary on Automobile Trade in the next 10 years', Istanbul, Association of Automotive Distributors in Turkey, ch.11.
- CARLSON, R. L., 1978. 'Seemingly Unrelated Regression and the Demand for Automobiles of Different Sizes, 1965-75: a disaggregated approach', *Journal of Business*, 51, (2), 243-62.
- CRAIG, J., 1969. 'On the Elementary Treatment of Index Numbers', *Journal of the Royal Statistical Society, Series C*, Vol. 18, No.2, 141-152.
- DIEWERT, W. E., 1993. The Early History of Price Index Research, in *Essays in Index Number Theory*, Vol. 1, W.E. Diewert and A. Nakamura (eds.) North Holland, Amsterdam.
- FRISH, R., 1930. 'Necessary and Sufficient Conditions Regarding the Form of an Index Number which shall meet Certain of Fisher's Tests'. *American Statistical Association Journal*, 25, 397-406.
- FRISH, R., 1936. 'Annual Survey of General Economic Theory: The Problem of Index Numbers'. *Econometrica*, 4, No.2, 1-38.
- JEVONS, W. S., 1865. 'Variations of Prices and the Value of Currency since 1762', *Journal of Royal Statistical Society*, 28 (June), 294-325.
- KEYNES, J. M., 1930. *Treatise on Money*, Vol.1, London: Macmillan.
- LEVINSOHN, J., 1988. 'Empirics of Taxes on Differentiated Products: The case of Tariffs in the U.S. automobile industry', *Trade Policy Issues and Empirical Analysis*, Ed: R. E. Baldwin, Chicago: University of Chicago Press, 11-40.
- MARSHALL, A., 1887. 'Remedies for Fluctuations of General Prices', *Contemporary Review*. 51, 355-375. Reprinted as Ch. 8 in *Memorials of Alfred Marshall*, A. C. Pigou (ed.) London: Macmillan, 1925.
- MCCARTHY, P. S., 1996. 'Market Price and Income Elasticities of New Vehicle Demands', *The Review of Economics and Statistics*, 78 (3, Aug), 543-547.
- ÖZÇAM, A. and ÖZÇAM, D. S., 2012-b. "Construction of Price Indexes for different Segments of Automobiles in Turkish Market and Estimation of Varying Price Elasticities", 7th Annual International Symposium on Economic Theory, Policy and Applications, ATINER, 23-26 July 2012, Athens, Greece.
- ÖZÇAM, A., 2014. "Should Before or After Tax Equilibria Point Elasticities be Calculated When the Laffer Effect is Considered in a Micro Market?", *Journal of Economic Studies*, Issue 4, Accepted.
- ÖZÇAM, A., and ÖZÇAM D. S., 2012-a. 'A Review of Econometric Estimation of Consumer Demand for Automobiles and the Country of Origin (COO) Effects', *The Journal of Dokuz Eylül University*, 27 (1), 97-132.
- VERBOVEN, F., 1996. 'International Price Discrimination in the European Car Market', *Rand Journal of Economics*, 2, 240-68.