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Complaint Calls as a Proxy for Perceived Quality: The Turkish Dishwasher Demand Estimation

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Abstract

The paper estimates dishwasher demand and supply in Turkey. The constructed Stackelberg type oligopolistic competition, with its strong testable implications is demonstrated to be consistent with a stable market composed of a leader firm and followers. The paper has an important contribution to demand estimation literature as well. The complaint calls rate for a product is offered and shown to be a valid proxy to help the problem of omitted variable bias due to the unobserved characteristics as perceived quality or after sale service quality. Elasticities calculated for each demand determinant can help durable good firms in emerging countries to use their investment and marketing resources more efficiently.

Keywords: Demand Estimation, Proxy, Complaint Calls Rate, Unobserved Characteristics, Durable Goods Market.

JEL classification numbers: D12, D21, D43

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Introduction

The paper estimates a labor saving appliance, dishwasher, demand in Turkey. In the estimation, for the first time in the literature, we use complaint call rate received by a firm's customer service as a demand determinant. This variable is used as a proxy for perceived quality of dishwashers of consumers. For a better understanding of the motivation, first, we will provide some background information on the Turkish dishwasher market based on the data provided by the highest share producer of the market.

The big firm of the market, which is also the first entrant, has a share more than 50%. Competitors have shares between 3% -13%. Big firm's share can be considered as stable across regions and time. The big firm has a very strong brand name in the durable goods market in the country. The big firm's domestic production approaches to 100%. Some followers produce domestically and others only import. For marketing purposes, by this industry, Turkey is divided into 10 different regions. This paper follows the same pattern. This also helps to increase variation for estimation purposes.

According to international standardization, 90% of the market has similar (A-) standards. Not surprisingly, there are no big price differences between firms for these similar standard machines. The machines, all of which have similar standards, are grouped as high-end, middle -end and low-end by the firms in the industry. Some of these machines have different features, electronic equipment, more programs etc. But all of them are qualitively similar (A-). Furthermore, share of low-end models in the market is close to 80%, and high-end models is close to 3% in Turkey. This composition is fairly stable across regions and time under investigation. Using all these evidence, we are going to approach the "dishwasher" in Turkey as a composite good. However, there is a significant variation among the complaint call rates of different regions. This makes us think that the perceived quality and/or after sale service quality are different, which might give way to different satisfaction levels, hence different future demand behaviors in different regions.

Durable Goods Demand Estimation

In durable good demand estimations, endogeneity of price due to unobserved characteristics has been a major problem. Most of the time, it is impossible to find data about perceived quality or after sale service quality of the products which might be important demand determinants. The lack of data about perceived and after sale service quality might be a cause of downward biased estimates for price in the demand equation. Actually Braeutigam and Pauly[1] showed that assumption about the exogeneity of these characteristics leads to biased estimates.

Different methods are employed to solve the unobserved characteristics problem in demand estimations. For example, the instrumental variable method offered by Wright[2] has been widely used in the literature for this purpose. However, the recent econometrics literature shows that issues like finding the proper instruments, assumptions about linearity, make the use of instrumental variables method questionable in some frameworks (For a full discussion on the topic see the paper by Angrist and Krueger Angrist, D. "Instrumental Variables and the

Search for Identification: From Supply and Demand to Natural Experiments", 69-85). To solve this unobserved heterogeneity problem, use of consumer reports on perceived quality data is also seen in the literature. Trandel[3], Crandall[4], have important papers in which they controlled for perceived quality using consumer reports. However, these reports, in the form of questionnaires, have the problems of size and self-selection. The random coefficient model of demand is also addressing this problem.[5] For this method, observing the market shares of all firms is obligatory. However, in this study all market data is provided by a single firm and we know the shares of this specific big firm and so the total of all others. Hence, with the data limitations, use of Berry, Levinsohn, and Pakes[6] method is not plausible for our analysis.

In this paper, considering the facts of the Turkish market and data limitations, we will suggest a different solution to this unobserved characteristics problem. For the unobservables as perceived quality of products, after sale service quality, or other similar efforts, use of the proxy 'complaint calls' is offered for the first time in this paper. Presumably, the unobservables as perceived quality, after sale service quality, will be inversely proportional to complaint calls received by a firm's customer service. Satisfied customers do not call customer service to say thank you, hence we assume the highest satisfaction if there are no complaints (Complaint call rate: 0%). With less satisfaction, complaint call rate rises up to 15% of the new machines sold in our data set. Hence, the complaint call rate is not truncated or censored realizations of random variable of unobserved perceived quality, it can rise to higher levels (up to 100%). The top two complaints about dishwashers are dishes are not clean enough and the machine is not efficient enough. Actually, machines sold in the different regions are very similar (A- standard), however variation in the complaint call rates shows us that, there is a difference in "perceived" quality and our proxy picks up the variation in perceived quality of dishwashers across time and regions. Considering the variation in the socio-economic levels of regions of Turkey, this difference does not come as a surprise. With this observation we will use complaint call ratio for a product received by the related firm's customer service as a proxy to the before mentioned unobservables (Complaint call data is aggregate and presumably people are more likely to complain about the product to the producer not to the reports. Complaint calls can be assumed to better reflect the after-sale service quality, as well). By the help of this proxy, the demand for dishwashers in Turkey will be estimated with a detailed socioeconomic analysis in the background. In the empirical part, the validity of the complaint call ratio as a demand determinant is shown.

Dishwasher Market Estimation

Following the literature and observing the socioeconomic structure of Turkey, we use; household income, education, women employment, price, retail electricity price as the demand variables. We follow the stream of using transitory income rather than permanent income for durable good demand estimation, which is led by Smith.[7] Keith[8] showed that women employment levels in a region affects the quantity sold of labor saving appliances. In Turkey, women (up to 83% of the households[9], generally do dishwashing and dishwasher sales, being a labor saving appliance, can be affected by women employment as well. Therefore, regional women employment ratio is included as a demand variable.

As shown by Park and Capps,[10] education is a key factor for explaining demand for labor saving goods. With education, a stronger belief about gender equality is generally observed and the likelihood of having labor saving goods increases. Hence, we include education as an explanatory variable. Dishwashers use electricity and water; so, we have the retail price of electricity in each region as a demand shifter. Since water prices differ significantly from city to city and even from town to town, there is no reliable quarterly data set for this cost across regions. The regional dummies are included for the regional differences that are not directly considered in the data set. Following the literature, real interest rate is added as a control variable as well.

For the supply side, as marginal cost variables, labor and capital are included. Goyal[11] uses wages, material, and fuel costs in the cost calculations. Following a similar methodology, we have labor cost, material cost and energy cost, which are provided by the producer as averages for each quarter. More detailed information about the production is kept confidential by the firms in the industry.

The Model

In addition to demand determinants that are explained in the previous part (household income, women employment, education level, interest rate and electricity cost) demand is expected to be affected also by the unobservables like perceived machine quality and after sale service satisfaction. Therefore,

$$q = a_1 X - b_1 P + v_{1+}\varepsilon_{01} \quad (1)$$

Here let X be a vector of all the demand shifters we mentioned above, P represents the real prices for the composite good "dishwasher" and v_1 the above mentioned quality unobservables, which are correlated with the price. On the supply side, we should mention that the leader firm is producing all kinds of home appliances in its production facilities that are located in different cities of the country. However, marketing and pricing decisions for each type of good are independent. For the supply side one has to consider the marginal cost structure of the producers. After the interviews with the leader dishwasher firm's production team in Turkey, for the relevant time period (2002-2009), constant marginal cost is safely assumed for the quantities we are interested in. For the given period, average capacity utilization is around 60%. For the quantity range produced, energy and material costs are fixed. Turkey has a very high unemployment rate, which is around 13% in this period. This makes production of different quantities easier, in the sense that, the plant can hire and fire workers, change the quantity of labor easily. It does not have to face increasing average wages with extra hours of labor as much as its correspondents in many other countries (Financial leverage ratio for the firms in the industry is between 50% and 70%. In addition, considering the existence of importing firms and capacity utilization rates around 60%, interest rates is safely assumed out of the MC functions for this 8 years model.).

Given all these facts and examples from the literature, we assume a constant marginal cost function for the producer.

Due to limited available data, the marginal cost function of the firm is designed as a function of input prices.

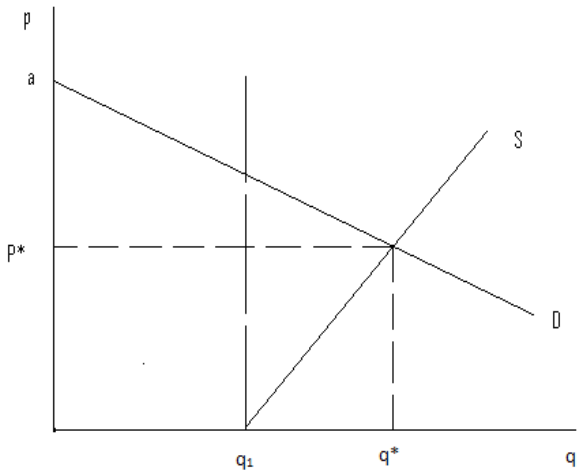
$$MC = c' = \alpha laborcost + \beta materialcost + \lambda energycost + \varepsilon_2 \quad (2)$$

The composite good dishwasher is supplied by a leader firm, which has more than 50% market share, and followers that have shares between 13% and 3%. There are many evidences that the top market-share firm is also the leader of the market. First, as the first entrant, it is always the brand that comes to a typical consumer's mind when he thinks about a dishwasher (Nielsen, consumer insight reports (1995-2009)). Many new technologies, like half-wash (2002), tech-touch (2008), fastest washing (2009) are all introduced by this company to Turkish market. Decrease in the energy consumption levels are also led by the big firm. Since prices of same quality machines by different brands are very close and share of the big firm is fairly stable around 50%, one can assume that the big firm is able to determine the quantity of sales in the market by its pricing decisions given market demand. Therefore, a Stackelberg type oligopolistic competition model is assumed.

In this model, considering competitors' response, leader firm sets its quantity. Competitors supply the remaining part of the demand in the market. Therefore, competitors' supply curve intersects with the market demand, and determines the equilibrium price and quantity. Graphically, the market conditions can be shown as in Fig. 1, where "q_1" represents the profit maximizing quantity of the leader firm, "D" represents market demand, "S" represents supply of the competitors, "q*" represents equilibrium market quantity and "p*" represents equilibrium market price (q^*- q_1 = quantity supplied by other firms)

Leader firm is trying to maximize its profits given its cost function and market demand. By this maximization, it decides a quantity to supply to the market knowing that the competitors will supply remaining demand. We assume that other firms have a supply function in the form of (Due to competitors' small shares and the model constructed accordingly, prices are indirectly set by the leader firm. The low power of small firms on the equilibrium price makes "price" exogenous for them):

Fig. 1: Stackelberg type oligopolistic competition



$$q_{-1} = mP + \varepsilon_1 \quad (3)$$

Considering total market quantity is the sum of the leader firm's and other firms' quantities we can write price as a function of big firm's quantity and other demand shifters:

$$P = aX - bQ + v_0 + \varepsilon_0 \quad (4)$$

$$P = aX - b(mP + \varepsilon_1 + q1) + v_0 + \varepsilon_0$$

$$\mathrm{P} = \left(\frac{\mathrm{aX} - \mathrm{bq}_1 + \varepsilon_0 + \mathrm{v}_0 - \mathrm{b}\varepsilon_1}{1 + \mathrm{bm}}\right)$$

Therefore, the big firm is maximizing the following total profit function ($C(q_1)$ representing the total cost function of the big firm):

$$\Pi = \left(\frac{aX - bq_1 + \varepsilon_0 - b\varepsilon_1}{1+bm}\right) q_1 - C(q_1) \quad (5)$$

$$\left(\frac{\partial \pi}{\partial q_1}\right) = \left(\frac{aX + v_0 - 2bq_1 + \varepsilon_0 - b\varepsilon_1}{1 + bm}\right) - c'(q_1) = 0$$

After necessary adjustments and replacing c' in the first order condition above, with the marginal cost function assumed before we have;

$$aX + v_0 - (1 + bm)c'(q_1) + \varepsilon_0 - b\varepsilon_1 - (1 + bm)\varepsilon_2 = 2bq_1$$

$$q_1 = \left(\frac{aX + v_0 - (1 + bm)c'(q_1)}{2b}\right) + \varepsilon_3 (6)$$

That is, we are able to write profit-maximizing quantity of the big firm as a function of the demand and supply variables and unobservables as in (6). So according to this paper's construction, one should note (1) as the market demand function, (3) as the total supply function of the competitors, and (6) as the supply function of the leader firm. We should also emphasize that, the model has an implication to test. According to the model, parameters of shifters (X) in leader firm's supply function have to be half of the parameters of shifters (X) in the market demand function.

Data

To estimate the model, two data sets are used. The leader firm of the dishwasher sector mainly provides data regarding the supply side. This is a confidential data set. The leader firm in the dishwasher market divides the country into 10 different regions for marketing and service purposes. We have quarterly sales of the leader firm and total sales of its competitors in each region. (Leader firm's quantity and its own share on the market are in the data set. Hence, we are able to calculate the total sales of the competitors from data provided by the leader firm.) The time period of the study is from 2002 to 2009. Quarterly data is used. For all the analysis in this paper, we follow the regional division concept (The country is divided into 10 regions.) of the leader firm. Regional data is aggregated from the city data where necessary.

On the demand side, we have complaint calls data about leader's products in each region, quarterly (2002-2009). Complaint call data here is a ratio, which is the number of complaint calls per new machines sold in each region for each quarter. Since some time is needed for the complaints to diffuse to people to affect demand, in the estimation, two period lags of this data will be used. Firm's confidential data set has quarterly data on average real input prices: labor cost (hourly wage), energy cost (an index used for industrial electricity (30%) and natural gas costs (70%)), material cost (an index used for plastic and iron costs). All the items in the cost data (including the labor cost) are industry specific. Note that the firm has one plant at the capital of the country. Therefore, these input prices are not regional. For possible regional differences, regional dummies are included.

For income, we constructed a measure for each region by multiplying the number of households in each region by the purchasing power of an individual in that particular region. With this construction, we are able to consider the fact that dishwasher demand is expected to be controlled by number of households but not by the actual population.

For education level, there are many choices that can be included. Ratio of people who are college attendants is chosen. The purchase decisions of these kinds of labor saving appliances are generally based on the consensus of household members. That is why we include general education ratio but not only for men or women. In addition, we believe, this consensus is affected more with higher levels of education. For this reason, we included the percentage of college attendants in each region. TurkStat provides all number of households, real purchasing power (real GDP/population) woman employment, education level and real interest rate figures (For the years between 2002 and 2006 instead of actual population figures, only projections prepared by TurkStat are available. For that period, the projected numbers are used in the estimation. The most recent provincial income data is from 2001. The projections with a uniform growth rate (national growth rate) are used to calculate regional purchasing power levels. Number of cars per person, which is available for each city yearly, is used as an alternative income indicator as well (80% correlation). They give very similar results, hence the reported estimates use the projected purchasing power figures). This databank provides data for each city. Regional data is constructed by using the city data, and by using population weights where necessary.

Finally, on the demand side we have real residential electricity cost in kw/h terms provided by OECD. Since electricity cost of previous periods will be considered in the purchase decision of today, average of the last three periods is going to be used in the estimation. Name of variables and their descriptions are also provided in Table 1(Summary statistics about the non -confidential data, used in this study, are provided in the appendix).

Estimation

In this part, we are going to estimate the following demand and supply system for dishwashers.

$$q_{i,t} = aX_{i,t} + \beta P_{i,t} + \phi Dummy_{i,t} + v_{i,t} + \varepsilon_{1i,t} \quad (I)$$

$$q_{-1i,t} = mP_{i,t} + \vartheta Dummy_i + \varepsilon_{2i,t} \quad (II)$$

$$q_{1i,t} = \delta X_{i,t} + \lambda MC_t + \Upsilon Dummy_i + \varepsilon_{3i,t} \quad (III)$$

Here with (I) the market demand will be estimated. Since we have a Stackelberg kind of oligopolistic model and firms have different places in the market; the market supply is going to be estimated separately: (II) as other firms' supply and (III) as the leader firm's supply.

The existence of the unobservables like after-sale service or perceived machine quality might be creating a problem of endogeneity in the system that will be estimated. With the used Stackelberg kind of oligopolistic model, price does not directly appear in the supply function of the big firm. In addition, since small firms have not much market power, price works more as an exogenous variable in the supply equation of small firms. According to the model construction and the conditions of the market, endogeneity of price due to reasons other than unobserved quality should not create a major problem. However, existence of omitted variables about quality is still expected to create bias for the estimated coefficient of price in the demand equation. ($Cov(P,v) \neq 0$)

To cope with this omitted variable bias, the complaint call rate is used which is represented with "call" in the estimation as a proxy for the unobservables that are represented with "v" in the demand function. We assume that the unobservables as perceived quality of machines,

and after-sale service quality in a region, will be inversely proportional to the complaint calls received by a firm's customer service hence will make a good proxy for these demand unobservables. That is call can now be included in the vector of control variables for demand (*X'*) and the new market demand function to be estimated can be written as (as (And note that eq. III will be estimated as: $q_{1i,t} = \delta X_{i,t}{}' + \lambda MC_t + YD_i + \varepsilon_{3i,t}{}'$ (III')):

$$q_{i,t} = \alpha X_{i,t}{}' + \beta P_{i,t} + \phi \text{Dummy}_i + \varepsilon_{1i,t}{}' \quad (I')$$

To get the best estimates and understand the endogeneity problem with its offered solutions better, different techniques are employed. First, we start with IVREG (I) - OLS (II) - OLS (III) triple (Here, we assume $u_{i,t}, \varepsilon_{i,t}, v_{i,t}$ are independent). To get rid of the endogeneity, "price" is instrumented with energy cost and labor cost. Apparently, those costs affect price but not quantity demanded, directly (Since pricing of industrial and residential electricity is independent in Turkey and the share of electricity is low in the energy cost index (70% natural gas, 30% industrial electricity) we assume the use of energy cost as an instrument for price is valid. In addition, labor cost provided is industry specific.). To understand the validity of the proxy, complaint call rate, the demand equation is estimated with and without using complaint calls as a control variable. The unobservable " $v_{i,t}$ " is included in the error term when complaint calls is not used as a control variable.

Then same equations are also estimated without incrementing, using the OLS. Estimations are made with and without the use of complaint calls as a control variable again. Comparison of the estimates (especially the estimates of price) and use of the Hausman test will allow us to have a better idea about the endogeneity problem due to unobsorvables and its possible solutions.

In the data set, we have call rates only for the leader firm. However, considering the leader firm's extremely powerful brand name, its fairly stable shares in the investigated time period, similarity of rates across firms for the single observable year and observing how people generalize this brand's products to all the products in the market; call rate in the data is taken as a shifter for market demand when it is used as a control variable. Average of the last three periods for electricity cost and two period lags for complaint calls are used for the estimation of the demand in period "t".

Results

When the model is estimated without call rates by the IVREG, and the OLS, we get the estimates provided in Table 2. When IV and OLS results are compared, with the rejection of the hypothesis that coefficients are not significantly different by Hausman test and simply observing the estimates (demand) that are not close to each other, it can be said that using instruments helps to deal with the endogeneity problem due to unobservables.

In Table 3, same estimations are done by IV and OLS with including complaint calls as a control variable. This time Hausman Test cannot reject the hypothesis and estimates are much closer. This shows us that the complaint call rate as a control variable helps to cope with the endogeneity problem arising from the unobserved heterogeneity in the estimation and can be offered as an alternative method, when IV is not appropriate to use to get rid of the omitted variable bias in the estimation. The remaining difference is possibly due to simultaneity.

This finding is important given the fact that weak instruments and non-linearity of the functions to be estimated create problems for the validity of IV technique and even it is valid,

the inclusion of the compliant calls rate brings safer estimates. When the BLP method is available, it can help as a product characteristic as well.

To increase efficiency, we estimate the model with system estimators, the 3SLS and the SUR as well. Taking into account the endogeneity problem, "price" is instrumented in 3SLS. The results without complaint calls are presented in Table 4 and with complaint calls are presented in Table 5. Even it is not as perfect as in IV vs. OLS case, again, the comparison of the results shows us that use of the complaint calls to correct endogeneity due to omitted variables works properly and give safe results.

Discussion on the testable implication

The implication of the model that the coefficients of shifters (X) in leader firm's supply function have to be half of the coefficients of shifters (X) in the market demand function is tested one by one and jointly. We tested that if the coefficients of the shifters in the market demand function are significantly equal to the two times of the coefficients of the shifters in the supply function. Constraints for income, call, interest and employment pass the test. Even we couldn't jointly accept the hypothesis implied by model, with simple observation we think that, parameters of X in the demand function are close to the two times of the coefficients of X in the leader firms supplied function, especially when the confidence intervals are considered. (Note that, income estimate in the demand function is 10.88 and in the leader firm's supply function is 5.51, call estimate in the demand function is -235 and in the leader firm's supply function is -131, interest estimate in the demand function is -312 and in the leader firm's supply function is -170.)

To test the validity of testable implications, we also estimate the system with the relevant constraints (forcing the relevant parameters in the supply function to be half of the corresponding parameters of the market demand function), results of which are given in the appendix part. Most of the coefficients are very similar in the before unconstrained and these constrained models (for example, for the demand function $interestu_u$=-325, $interest_c$=-323 $income_u$=10.88, $income_c$=10.8 (estimates with the SUR method), $call_u$=-208, $call_c$=-205 (estimates with the 3SLS method)). By all these, and the similarity of the estimates, we can conclude that the model's implications seem to be valid and the model constructed seems to be satisfactory for explaining the dishwasher market in Turkey.

Elasticities

In Table 6 and 7 elasticities that are calculated by constrained 3SLS and SUR are presented (the constrained model gives us the most significant results; hence we report the elasticities calculated using these estimations.). At a first glance, women employment's insignificancy is surprising. For example, women employment is relatively high in northeast Turkey when compared with similar income-education region (mid-east) but there is no relatively high demand for dishwashers in that northeast region (We tried the estimation with many different time periods. Not surprisingly, we get the best estimates without any lag or average usage. In this, we also suspected about the possible correlation between employment and education, and employment and household income. Correlations are 0.09 and 0.19 respectively. It is not as high as to take into account.)

Second point to note is the price elasticity of demand. Claiming dishwasher is not a popular good with its high price in Turkey, a price elasticity of demand of -1.20 is acceptable and very close to the numbers in the literature. Price elasticity of supply is 1.20 and not in contrast with the literature. Electric's insignificancy for demand estimation might be a point of concern too. But considering "retail electricity prices'" instability for the period under investigation, this doesn't come as a surprise.

However, education is a significant determinant for demand. It has a very high elasticity, which is close to 3%. It is not surprising in the sense that it brings "gender equality" into place

in the purchasing decisions of households. Therefore, households with higher education are more likely to buy dishwasher, which is mainly seen as a labor saving machine for a housework which is generally done by women (Up to 83% of the households)

The complaint calls are significant and has an elasticity close to -.1 that makes it one of the most important determinants of demand. It plays a similar role for the supply of goods as well (At this point, one might doubt whether there is a correlation between education and complaint calls, Correlation is -0.21, not too high to consider).

On the supply side, we observe insignificancy for material cost. This cost item in the data is provided by the firm and can be thought as an index for plastic and iron prices for the relevant year. In the unit price of iron, like many other metals, for the period under investigation, major fluctuations happened. For example in the year 2008 it hit to a record high level. Firms might respond to these by new production technologies. However, these new techniques, which may allow firms to alter their material usage structure, are kept secret by the industry (Change in input stocks might be another response by the firms, which is not observable.). In addition, there is a slight correlation between energy cost, and material cost (0.42).

Concluding Remarks

In this study, for the first time in the literature, the complaint calls rate is used as a proxy for the omitted variables like perceived and after sale service quality. The complaint call rate is found to be an important demand determinant and be advised to include in the variable set whenever possible.

The constructed model's validity is tested by its implication that coefficients of shifters (X) in leader firm's supply function have to be half of the coefficients of shifters (X) in the market demand function and evidence was found in favor of the model.

With the help of the new variable, the paper offers elasticity estimates for dishwashers in an emerging county; Turkey. Education level is found to be very significant factor for the demand of these kinds of labor saving appliances. Price elasticity of demand is estimated around -1.5. We can conclude from this that consumers are highly price sensitive for dishwashers in Turkey.

It is concluded that, the method to cope with unobserved perceived quality problem, offered in this paper can be used in different contexts. The constructed model is shown to work properly in stable leader firm-follower firms markets. Also the estimated elasticities can be used as a guide by durable goods firms for emerging countries for an efficient use of resources, in the investment and marketing efforts.

Appendix

Summary statistics about the non-confidential variables

Variable	Mean	Std. Dev	Min	Max
q	17658	11477	2703	53207
income	902	523	207	2248
emp	27	07.Şub	16	47
price	460	25	393	510
edu	9.62	2.32	5.	12
electric	10.54	1.00	8.6	12

Residuals

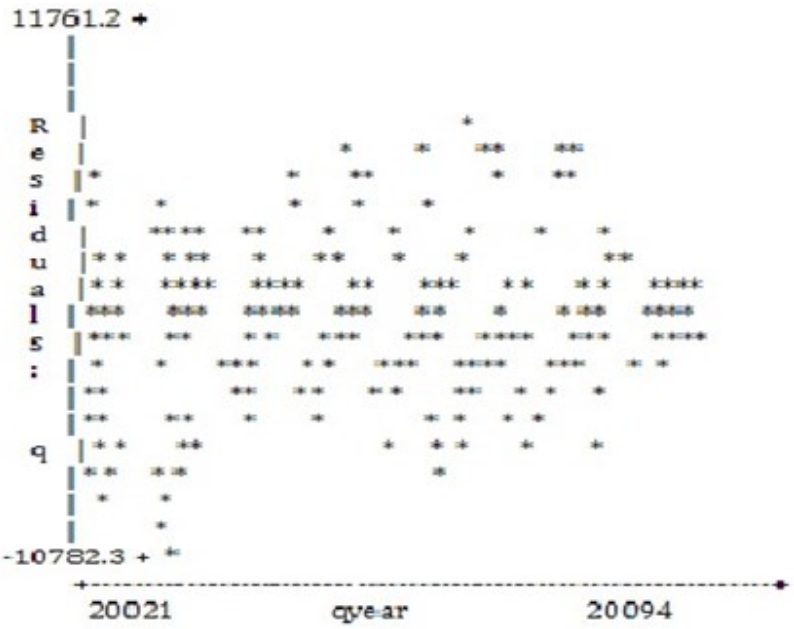


Fig.2: Time/Residuals

When the residuals from SUR demand estimation are plotted with time on the x-axis the graph above is observed. Heteroskedasticity doesn't seem to be a major concern.

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