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Regression Pattern Application in Quality Control

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Abstract: Consumer Price Index (CPI) has many application as scale of prices generality level change measurement in economical, especially in reduction of economic variable to real numbers. This index though its advantages, has various problems in formula definition, calculations and evaluation. One things that makes error in consumer price index, is quality change of got price goods through the time of getting price. Present investigation takes to qualitative reduction of consumer price index, applied object for personal computer. Main purpose of scientific and applied solutions is reduction of consumer price index.

Key words: Quality reduction, quality control, regression pattern, quality control

INTRODUCTION

One of the total problems in calculating the price indexes is to disregard qualitative changes in getting price of goods through the time. If this qualitative changes which appear on good price, was significant and temporary, above problem will be removed by embedding the new good instead of old one and calculate the price index according to new good. But if this qualitative change which often arise technological improvement in production process, was ongoing and eye catcher, the price time series was altered by ongoing replacement of goods. Generally, qualitative changes happen in family consumer bag about such goods as personal computers, audio and video instruments, automobile and etc. These ongoing changes make measurement error in price index calculation of each group of such goods. So breakdown of absolute effects can be effective to estimate prices level correctly and correct effects of personal computers quality change on price index using Hodanik regression model.

Application of new technology in goods production especially electronic goods in late decade causes to quality sizable change of these goods. Qualitative changes also affect finished prices and market prices of goods. Increase of product quality because of using newer technology and existing research cost and improvement, from one side increases the finished cost and from another side causes to reduce finished price because of time saving, consume material, energy and workers. To supply various models of a clear good such as personal computers which are produced by one or many producers often be accompanied quantitative changes among their goods.

In this investigation we try to find that part of price changes through specific time period (e.g., one year) which generally consists of good quality changes.

Then we take to estimate qualitative changes as separate using Hodanik regression model. Many methods were suggested for measurement of good and services qualitative changes which one of their most current is to use Hodanik regression model. In this study model basic variables are prices, characteristics of each good, various labels in market and a probability part which observe as follow:

$$LnP = (LnX)\beta + D\delta + U$$

Where, P vector is good price, X matrix shows characteristics of good, D matrix is dummy variable an dU vector is mode error. Less square error is used to estimate δ and β of above model.

Goods price index and consume services are the most important measurement tools of economic inflation as an evaluation scale of goods price change and families consume services. Basic applications and diversity of this index take it especial place in evaluations and economic planning. So in late years, accuracy of Consumers Price Index (CPI) measurement became important. By time passage, technological causes goods quality become better which effect of this qualitative improvement is appeared on goods price and this price change, changes good price index and finally total indexes. According to technological fast improvement, we expect this kind of changes have been continued. Often through the time, after a technological jump and price increase of a good by quality change, other price change of that good will be less than first step. Accordingly, relative weight of quality reduction effect on price oscillation will be more. So as for price index is a basic variable in economical analysis, its accurate calculation can help more suitable comment of situations and problems of Iran economical.

In this research information are collected from sellers of personal computers parts and other information resource such as newspapers and expertism magazines.

Quality change concept: Realizing quality change in goods could be difficult and often it's coming with mental aspects. Measured change in consumer price index in real price change and or change of received cash from customer, which consume goods quality aren't contemplated in that. Real price change doesn't correspond with change in quality. If we don't reduce quality improvement, overstate will happen in real price change averment, if a defect also happen in quality and we don't reduce that, so we will do understate in price change.

In good change, each difference like difference in quantity, physical combination, parts, packing size and good operation characteristics (speed, power, capacity, ...) was written as quality change. For industrial goods (e.g., television, computer, ...) each person contemplate a different concept of quality change as for its priorities which define a mental scale for quality change. Good multiple changes may be caused to positive or negative change in good quality and we must contemplate them as a total combination.

Methods of goods quality control: To remove problems consist of quality changes, saving goods quality, it is necessary that mental reduction in this index slakes. It means the price of that good take in each season. For providing consumer price index to reduce quality control problems, various scales such as good characteristics, good choice and exploration of quality change are contemplated.

Good characteristics: Realizing a good is step by step where change of characteristic which affect the quality of a good are analysed. But a good assessment for as much as especial attributions causes to discontinuity in getting price as maybe existed goods with that characteristics in markers rarely[1]. The most suitable realization must be how which continues getting price be admissible but should avoid price changes and non-clear quality.

Good choice: Choosing specific goods for consumer price index can reduce quality problems for which parts correlate to good displacing. Choosing goods which don't have eye catcher change in product and supply method, can help quality control. This do often choosing most existent label in shops to getting price.

Exploration of quality changes: Two methods be used for exploration and control of quality changes:

- Methods of price evaluation which do with revaluation of got price goods and comparing price and retails.
- Consult with retailers, producers and...

Problems of quality control: Some problems of quality control is appointed as follow:

- Quantitative
- Disguised quality changes
- Changes in product method or material parts
- Design changes
- Packing changes
- Gifts with bought good
- Fashion changes
- Compulsive price changes and exist of product overall costs

Methodology of quality reduction: To argue about methodology of quality reduction, first we must clear history of methodology. To simplicity, we assume persons favorite and goods: choice scale were clear. According to this assumption, as prices show the value of a good, we can understand that quality reduction of price index is a way to measure a good by contemplating characteristic unites for similar goods. Here, characteristics are factors which represent quality. present good is a unite which consisted of those characteristics. Now this question exist that quality concept of a good or service how appears in various steps of price indexes estimation and changes that?

First, under the competitive conditions, corporations buy row material to produce and equipment to investment. So for price indexes of inputs which shows goods and services price in their putting step, often in point that product similar curve (which gets from using various combinations of inputs of a good as product size and its characteristics is equal through this curve) and cost similar curve (which consists of buying equal cost of a good) contact, prices are constant. When the price of a good change, this change causes to transfer of product similar curve. So transferred similar curve, must return to its previous place by equal characteristic unites. This is such a quality reduction. It means that product size must be constant to observe price changes. For production price indexes which related to step where corporations product good, prices are appointed where product possibility curve (which shows produced similar goods by corporations to characteristic unites) and cost similar curve contact. In this case quality reduction points to good reduction to characteristic unites for remaining on that product possibility curve.

From standpoint of price statistics collection, quality reduction has important to close price change trend to price real trend. If quality change doesn't separate from price index change, errors accumulate and in blue moon a basic divergence will happen between index changes and real prices. Error statistics cause to mistake change of economical real conditions. So if prices reduction which is caused from technological innovation doesn't calculate in price indexes, in stand moon price changes trend will not be real, and many of variables such as economic growth rate will estimate less than real number.

Additional, in late years, quality reduction took importance more than statistic research of price indexes. There are two reasons for this. First, we except price reduction effects continues, but the weight of quality reduction effect is increasing on price oscillations. Second, in late years, the number of cases which in them studied goods changed, increases.

Problems of quality reduction

- Difference between characteristics concept in economical principal and real assortment.
- Problems of information and data collection.
- Problems of characteristics realization.

Various methods of quality reduction: As follow some methods of quality reduction and Hodanik regression method which used in this investigation will be explained, are pointed:

- Direct comparison method
- Unite price comparison method
- Overlap method
- Product cost method
- Imputation method
- Hedonic regression method

Hedonic regression method: This method estimate the price of quality characteristics of goods. This method considers goods as a independent collection of different functions. For new and old goods, price calculates characteristics capacity. Achieved results consist of the gap between the price of new and old goods. In this method we estimate price change from quality change which this change is reflexed in converting a old good to new good.

Different models from a specific good can be conveyed from a few characteristics such as size, power, equipment and etc. By using this method the problem of new good entrance and technical changes will be decreased. Because new models will be made from different combinations of old characteristics.

This method can show a logical relation between price and various characteristics. For example the characteristics of monitors should contain price, screen size and flat screen technology.

This method compares this price with data collected about characteristics and by using regression averages calculates the amount of each characteristics. So each change in good's characteristics can be recognized by comparing new prices with this change. This method is really useful for goods which technical changes happen with quick progress. Difference between real price and price change can be considered as a price change results from quality change. The most important characteristic of this method is that personal opinion, mind do not interfere in that and the scale of assessing data quality efficiency rate is based on statistics methods.

Ways of price sampling: To achieve price index with high accuracy, we can use sampling statistic ways, but often as for follow limitations, it's so difficult to achieve suitable sample:

- To achieve various accurate estimations of society call for allocating the sample unites to various good levels which are available, rarely.
- Because the information of new manufactories or ideal assorted variable are not available, sampling frame, generally is defective.
- Reply percents don't forecast. And it's possible to make doubt about indexes accuracy and or affect the changes of measured price.

As for above limitations, statisticians try to choose the best sample by sampling theories and the most suitable practical ways. They analyse effective factors which make a matter in sampling results.

Some of these limitations such as probable reply rates, data quality and taking price resources levels depend on frame and sampling applicable conditions.

Totally, there is direct relevance among price indexes applications, its sampling coverage amplitude and essential conditions of sampling frame. Generally, price indexes are counted as total index of inflation rate and or reducer of national accounts. If we develop coverage amplitude of price indexes to economic activities, inflation rate analysis and conversion of constant price to production value must be more profitable. So sampling frame must be consisted of extensive horizon of economic activities in good product. Also, sampling frame must updates by new manufactories entry and shuted manufactories.

When be decided about price index coverage, we can provide sampling design which consist of appointment of sample capacity, number of assortments, appropriation size and etc. While required statistic information resources be extensive, we can observe acceptable estimations of various using probable sampling.

Problems of price sampling ways: There are some problems for extension of received results from price sampling to national level, such as:

- Because of choosing the samples purposively, sample ratio which extracted from probable sampling ways has more biased.
- In non-probable choice ways can not calculate the accuracy of statistic estimations.
- Sampling capacity for a good or specific industry changes through time. Often an economic activity or an industrial good grows of comes down rather than base year.
- Often the frames don't encompass new goods through the time, but this problem can be solved by changing of manufactories samples.
- Perhaps sampling frame was old and or didn't consist of specific groups of society. This sampling increases the amount of errors which drives non-replying.

Important points in price sampling: Below factors affect on sampling design and its results:

- Using price indexes for received reduction or inflation measurement
- Index geographical cover as national or local
- Monthly or seasonal price indexes
- Prices collection such as basic, producer, wholesaler or customer prices
- Choosing sampling pattern according to price index priority of industrial activities or products.
- Providing aside indexes for export or internal market prices

Samples accuracy: Whenever probable sampling ways are used, sampling error can be characterized by the maximum of acceptable level for each published index. It means that at first various estimations for index components are appointed using archetypal sizes. Then samples are collected and variances are calculated. This samples can be optimized according to new variance information. However, on stream variances calculation and sampling errors are so difficult.

Also, on stream, there are such a change between cost and accuracy. High level of accuracy, is a level which has maximum of sample content, if we will extract these samples. In these cases, often sample capacity was assessed by costs and acceptable error level was constrained to us. It is necessary to remember that the society which sample is collected from that, must be assignable and be decided about completion or review in sampling frame.

Total data analysis: As for prenominate matters in price sampling argument for price collection of personal computers, particular way of this investigation is as follow:

- In this investigation manufactory choice was purposively and so probable sampling didn't accomplished, rather with accomplished analysis about wholesalers' market share, be tried to recourse manufactories which firstly agreed with cooperation and second, be had maximum possible data through analysis period. Hereof we can point to Data Pardazie Iran and East Iran.
- In this investigation assessment accomplish for price index qualitative reduction using Hodanik method, so as for cost argument and accessibility to resource of studied society, wholesalers of personal computers are in Tehran.
- In this investigation practice price of sale which collected as follow from wholesalers (Data Pardazie Iran and East Iran) and also some retailers of Tehran market was used. In this method, all kinds of price assuagement in practice price of sale received attention, so price qualitative reduction will be absolute affect assuagement and so on.
- As for that achieved data from publications resource have practice and theorical matters to use in Hodanik regression model, so this prices just were used as a testifier and didn't use in regression model. In other way newspaper data merger and prenominate information resources have problems as a theoretical.

Data collection resources related to personal computers: Information of collected price about personal computers of this design were anaclitic time period 1999 to 2002 and totally information achieved from two resources as follow:

Wholesalers: In part of wholesalers, price information caught from two companies; Data Pardazie Iran and East Iran. Thirty six cases of computer monthly price list of 1999 upto 2002 years caught at random from. Data Pardazie Iran company. Also, weekly price list of 1999 upto 2002 years caught from East Iran company.

Table 1: Numbers of computers sold through 1999-2002

Number	Year
117	1999
112	2000
135	2001
252	2002
616	Sum

Table 2: Main characteristics of sold computers through 1999-2002

Year	1999	2000	2001	2002
Speed (MHz)				
Minimum	300	333	500	533
Average	369	464	771	1392
Maximum	500	650	1500	2400
Standard deviation	65	86	210	383
First memory (RAM.MB)				
Minimum	32	32	64	64
Average	56	60	141	251
Maximum	128	64	256	512
Standard deviation	25	10	58	52
Hard disk (GB)				
Minimum	4	6	20	20
Average	6	11	26	42
Maximum	8	20	40	80
Standard deviation	1	3	9	8
Observations	117	112	135	252

Retailers: Totally 125 bills of sale computer for years of 1999 upto 2002 were gave by companies, but in Table 1 only numbers and years are presented. bills and price list are presented in Table 2.

Data analysis: Table 2 shows main characteristics of sold computers through 1999-2002. The considerable points about above information are, firstly, above characteristics are main characteristics but they aren't only characteristics which determine Hodanik function, rather than other characteristics such as monitor, processor and etc., play roll in it. Second, all observed characteristics in this table have verticality arrangement and this means that anticipated each consumers prefers more amount of that. Third, minimum contents, average and maximum of characteristics through studied period which shows characteristics quality increase and totally sold computers, increased. Fourth, characteristics variation rate in various years is significant variable.

As example CPU speed average in 2001 with sizable jump, increased from 771 to 1392 MHz in 2002. Also, capacity average of RAM increased from 60 MB in 2000 with 134% growth to 141 MB in 2001.

Regressions: In this part Hodanik Price index of personal computers, was calculated for 1999-2002. Be suggested various methods for goods qualitative changes measurement which one of its most current is, using Hodanik linear regression classic pattern. In this study, pattern practical variable; prices, characteristics of each good, various labels in market and a random number, are as follow:

$$LnP_i = \alpha + \sum_{j=1}^{n} \beta_j LnX_{ij} + \sum_{k=1}^{k} \delta_k d_{ik} + u_i$$

In above pattern, P_i is good price, α is constant, X_{ij} is jth good index in ith period, d_{ik} is dummy variable and U_i is trouble part.

For Hodanik indexes application, at the first, it's necessary to choose basic functional form. So be examined many functional forms such as linear, semilog and logarithmic-logarithmic using residuals. Analysis and residuals test moreover shows existence or non-existence of variance dissimilar and self-adequacy, it's also usefull to appoint the pattern functional form (especially in section data)[2]. With study of regression pattern functional form using resent test in various time periods was indicated that the algorithm-algorithm form is significantly unsuitable. Linear form also shows less value in forecasting. In other side in linear form test opposite of algorithmic-linear form, second one was realized more suitable.

So in this investigation, below pattern used to estimate:

$$LPT_i = \alpha_0 + \alpha_1 LCPU_i + \alpha_2 LRAM_i + \alpha_3 LHD_i + \alpha_4 D_i + U_i$$

Which in that LPT is price logarithm, LCPU speed logarithm, LRAM main memory logarithm and LHD is hard disk logarithm and D is dummy variable. So all the regressions are consisted of three main characteristics of computers; speed of CPU, RAM initial memory, HD hard disk and also processor characteristic arrived at regressions as a dummy.

Above pattern was estimated using ordinary less square test. Table 3 shows main characteristic factors which used in Hedonic regression pattern in 1999-2002. As you see all factors in significant level is a significant percent. Factor mark of all variables through studied years (except secondary memory variable factors or HD hord disk in 2000 and 2001) was positive which is explanatory of proportional elasticity size or dependent variable. Sensibility in respect of changes of each independent variables. So observed factors explains amount of price sensibility in respect of changes of each one of computers total characteristics which is according to observed results, from 2000, speed variable has had most affect on bought computers price.

Table 3: Efficient of main characteristics and their standard error in Hedonic regressions

Variable	1999	2000	2001	2002
	12/16 (0/19)	12/89 (0/56)	12/21 (0/27)	12/34 (0/45)
Speed (MHz)	0/29 (0/04)	0/53 (0/11)	0/56 (0/06)	0/24 (0/05)
Initial memory (MB)	0/4 (0/01)	0/18 (0/07)	0/06 (0/04)	0/29 (0/04)
Hard disk (GB)	0/23 (0/03)	-0/46 (0/08)	-0/19 (0/03)	0/05 (0/09)

Table 3 shows the Efficient of main characteristics and their standard error in Hedonic regressions methods.

RESULTS

Application of new technology in goods product especially electronical goods in late decade is leaded to sizable changes in the quality of this good. Supply various models of an assignable goods (like personal computers) by one or many producers, often, accompany qualitative changes among their goods. In this investigation we tried to realize and measure which part of price changes in particular time series which is because of goof quality changes.

Collected data and information about personal computers were from 1999 to 2002 time series and were elicited from detail and total suppliers sale factors. Study of those data and information show that the minimum contents, average and maximum indexes increased in studied period which shows indexes quality increase and totally sold computers. Also, indexes change rate changes in various years. Also, change trends of each three indexes was opposite of personal computers total price. In other word personal computer was reducing.

In price index letter, be suggested various methods for goods qualitative changes measurement which one of its most current is, using Hedonic regression pattern. In this investigation with calculate the price Hedonic index of personal computers, be observed this reduction trend in studied period was decreasing as from 100 in 1999 catch up 68 in 2002 with a continuing reduction.

Additional, descending trend of this index was also decreasing as its change amount catch up 9% in 2002 from 17% in 2000.

DISCUSSION

- As for results of this investigation, be noted that quality change has many affects on calculated computers price index. As regards product technology change happen so quickly about other various products as such as furniture (like television, video, ...), Hedonic method usage is so essential for quality reduction of these products.
- As for results of statistics from cost and revenue of cities families of 2001 of Iran statistics center; costs of house and transportation form more that 50% of total cost of cities families, qualitative reduction of above items have the main roll in consumer price index reduction.
- As regards quality change of produced goods index are more realizable in producer price index, using Hedonic regression model for quality reduction in producer price index is more applicative.
- One of Hedonic regression method disuse arguments for goods quality reduction, is because there isn't any accurate statistics related to usable goods indexes. So we suggest, Iran statistics center must appropriation this good indexes in their questionnaire for communal usage of this method.

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