
Modeling of the Deferred Demand on the Market of Household Appliances

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Abstract:

Purpose of the study. Development of a mathematical tool for assessing and predicting strategies of deferred demand on the market of household appliances.

Methodological basis of the study is the basic tenets of neo-Keynesian economic theory and methods of statistical analysis: the method of grouping and binary regression.

Information basis is analytical materials, expert opinions and statistical data of the Federal Service of State Statistics of Russia and the Republic of Bashkortostan. A survey was carried out by the example of the market of household appliances in the Republic of Bashkortostan. The study analyzed more than 800 questionnaires of consumers of household appliances.

The study results in the authors' definition of deferred demand as an economic category, provides main reasons for the transfer of part of the demand into deferred in the face of uncertainty, identifies factors that shape deferred demand on the market of household appliances; marks general and specific features of the market of household appliances in the Republic of Bashkortostan distinguishing it from the Russian market as a whole; a model of binary regression was built and tested; a strong correlation between the amount of deferred demand, price index, dollar exchange rate, unemployment rate and the index of consumer confidence was proved, which allows to predict the subsequent deferred demand for household appliances. The proposed study results represent a continuation and development of the study of consumer demand and behavior conducted by the authors in this field.

Key Words: *uncertainty, deferred demand, consumer behavior, savings, expectations, consumer confidence index, binary regression model.*

JEL Classification: *F10, F14, F17*

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Introduction

The strategy of household consumption and savings is undergoing significant changes under the influence of uncertainties. Keynes J.M. observed the motives of savings behavior; they remain relevant and are subject to further study in our time as well (Keynes, J.M., 1933, 2011). The experience-based decisions of consumers do not always fit in the well-known models (Friedman, 1957, Modigliani F, 1954, 1966).

It must be stated that the actual savings behavior of households begins to significantly deviate from the predictions of neoclassical models. The "buffer-stock" models lie at the heart of the processes of formation of deferred demand (Carroll, C. D., 1997, 2001), as well as ideas of the dependence (at least partial) of the savings behavior of people on their prior financial experience (Wahlund, R., 1996; Breckova 2016; Thalassinos *et al.*, 2012).

In particular, the most striking feature of the buyer behavior in Russia in the current crisis is not savings, but rather the maximum realization of the existing available funds, including on the market of household appliances. In this regard, it is important to study of the formation of deferred demand, which represents the demand shifted to the future on the one hand and determines the amount of savings in the present on the other hand.

Demand is a need supported by monetary or material resources. However, in the attempt to satisfy all their needs to the fullest extent, consumers often have to abandon them in the present in favor of future consumption. This refusal to satisfy the needs can be: consciously targeted, expressing preparation of satisfaction of the higher-level needs; forced, because there are no goods on the market in the needed amount, variety and quality (unsatisfied demand of the population); inertly unconscious – in the case of underdevelopment of the needs (Levin A.I. and Yarkin A.P., 1976; Okunev *et al.*, 2016; Tcvetkov *et al.*, 2015; Salimova and Makolov, 2016; Erastova, 2016).

Deferred demand is most often mentioned in terms of crisis and increase in the uncertainty as a consequence. Its study is associated with the study of the human savings behavior, the fall in sales of the enterprises and forecasting of the market development (Galimova, A.Sh., 2015, Chistohodov, A.Yu., 2007; Bashmakov *et al.*, 2015). The problem of the effective (really applicable rather than potentially possible) demand is often raised, because it influences production volumes and therefore level of employment (Lapaev, A.S., 2010).

Deferred demand is described from different sides. It can be defined as the demand for luxury goods, for which one has to save money (Oleynik N.S., 2013), or the purchase of goods or services coincides with a particular event (Solomatin A.N., 2000). According to the definition in the Great Economic Dictionary, demand is

deferred either if there is available money but no goods, or, conversely, there are goods but no money (1996). With a fairly wide use of the term, no commonly accepted definition has been developed either in the scientific or non-scientific literature, while those presented above have significant drawbacks. In the first case, the definition significantly narrows the boundaries of the use of the term, in the second case it is too broad, in the third case it is of considerable controversy (if the need is not backed up by solvency, it is not converted into demand).

Another characteristic of deferred demand is its realization in the future (Lapaev A.S., 2010). Given the above considerations, we propose the following definition of deferred demand. *Deferred demand is the need backed by solvency, the satisfaction of which is shifted in time in the future due to significant circumstances for the consumer. Significance* implies the need and prudence for the consumer to save money for a "rainy day", not completely formed need, or lack of goods in the right format for the consumer. (Dubovik, M.V. and Timiryanova, V.M. 2016; Firescu, V. and Popescu, J. 2015).

Information base of the study

We carried out the study of deferred demand by the example of the market of household appliances in the Republic of Bashkortostan. This market is divided into two segments. The largest market segment is the segment of large household appliances. It includes refrigerators, washing machines, freezers, dishwashers, stoves, etc. The segment of small household appliances includes kettles, vacuum cleaners, irons, etc.

The development of the market of household appliances is closely intertwined with the welfare of the population and dynamics of the country economic development. The specifics of the Russian market of household appliances were formed in the 90s against the backdrop of a huge deferred demand of the population for this type of goods (Karev A.V., 2016). The crisis in the sales of household appliances was observed in 1998. Later, the purchase of household appliances was postponed in 2009-2010, and some purchases are also postponed today.

After active sales at the end of 2014 caused by the desire of the population to save their money and buy goods at lower prices, the reports of the largest market player PJSC "MVideo" state drop in sales by 6.4% in 2015 compared to 2014. According to the retail chain, the overall decline in the market for large household appliances in Russia amounted to almost 15% in 2015, for small appliances – to 13%. The largest drop in demand was observed for kitchen appliances (Report of PJSC "Magnit", 2015). In 2016, this chain observed growth in total revenues in H1 by 19% compared to H1 of 2015, which indicates drop in sales in physical units, taking into account more than 20% growth in prices.

According to the agency GfK, the market of household appliances and electronics was described by considerable volatility in demand, the sales volume in August 2016 increased by 5% in rubles and decreased by only 1% in units of appliances (in July decline was by -4%), i.e. the recovery is observed (report "Russian consumer" of the research company "GfK", 2016).

The market of household appliances in the Republic of Bashkortostan, which we study, is part of the market of household appliances in the Russian Federation, but is somewhat different from it in its trends. Data analysis allows selecting several features. For example, in the period of 2000-2009, real incomes in the Republic of Bashkortostan grew stronger than the average in the Russian Federation, which influenced the higher indices of physical volume of retail turnover of certain household and electrical goods.

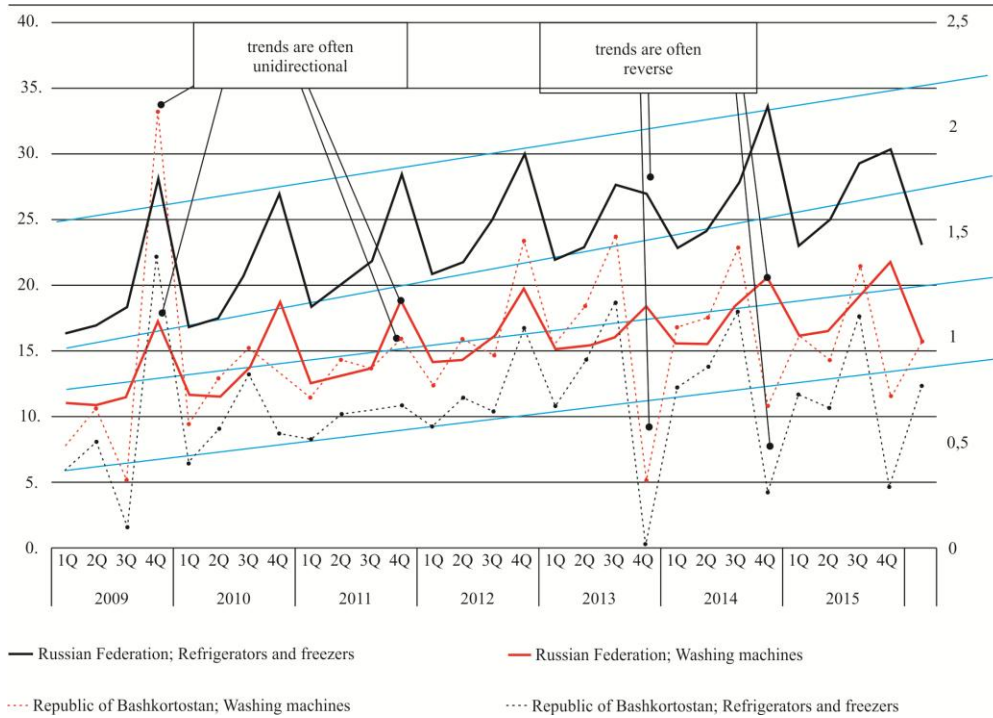
As a result, according to household surveys for the presence of articles of a cultural and social nature carried out by the Federal State Statistics Service, the residents of the Republic of Bashkortostan had more washing machines and refrigerators/freezers by 2008 by 19% and 14%, respectively, than the average in Russia. In addition, the value of the index of physical volume of retail turnover of certain household goods in the Republic of Bashkortostan in some periods significantly differs from the Russian average. The quarterly breakdown in Figure 1 shows that both the growth of consumption and its decline over the past three years have been ahead of the all-Russian figures by 1 quarter.

In itself, this cyclical nature indicates that there is deferred demand, which is realized with the appearance of favorable factors (for example, the appearance of extra money). During the period under study, we see situations in which the need was satisfied uniformly throughout the year, there was a preliminary realization of demand and postponement of purchases.

In fact, demand for household appliances in 2014, defined by many as excessive, resulted not only from the provisional realization of demand in an effort to keep savings, but also from the deferred demand accumulated in 2013-2014. To explain the choice of the strategies of behavior of consumers who postpone purchases, we have conducted a survey of more than 800 respondents.

As a result of the survey, it was determined that most of these people buy household appliances to replace broken ones (81.25% of respondents), 17.5% of respondents buy new household appliances due to the obsolescence of previous models, and only 1.25% – because of the desire to have a prestigious model. 37.5% of respondents noted that they currently postponed the purchase of some large household appliances, 31.8% postponed small household appliances. The group of 37.5% includes respondents who postponed the purchase of appliances both of the first necessity (to a lesser extent) and the less necessary appliances (to a greater extent).

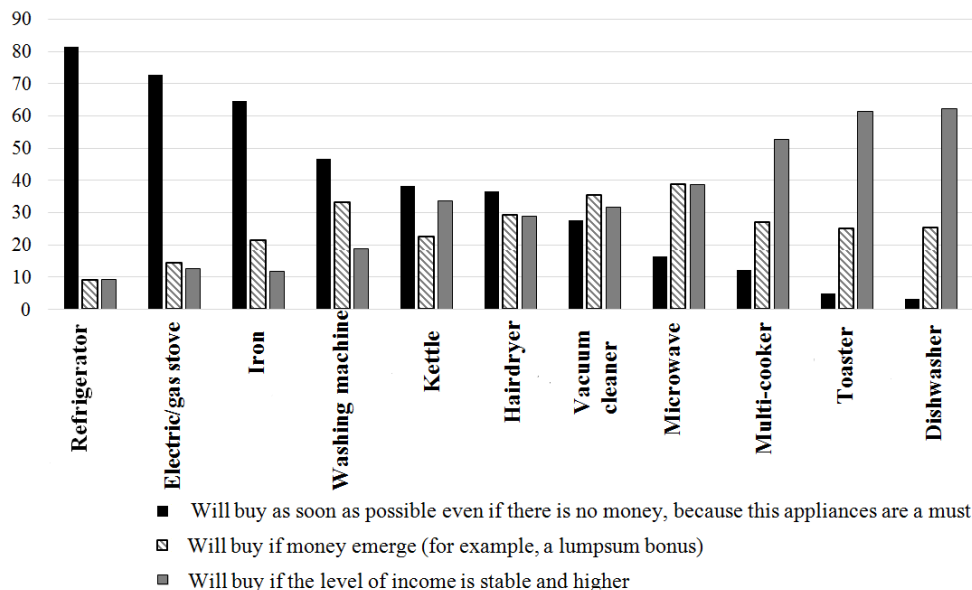
Figure 1. Dynamics of retail turnover of certain household and electrical goods in the Republic of Bashkortostan (right scale) and the Russian Federation (left scale), bln rub. (built by the authors using data from www.fedstat.ru)



However, there is one feature behind these figures. The matter is that people have different attitudes to the issue of postponing the purchase of appliances of different categories. To explain this feature, we need to consider possible strategies of the person's behavior in case of appliances failure (occurrence of the obvious need to purchase the replacement). The responses were as follows.

Most people are not willing to postpone the purchase of a refrigerator, electric/gas stove and iron, while a dishwasher, a toaster and multi-cooker, in their opinion, can wait for more favorable conditions (Figure 2). These results of responses are consistent with the data of the longest time to which people are willing to postpone the purchase of appliances in the event of the need for it. In the category "Refrigerators", the mode was 0 month, the median was 1 month, the longest period specified in the responses was 15 years, "dishwashers" – the mode was 5 years, the median was 4 years, the longest period specified in the responses was 100 years (i.e. people are ready to completely abandon its purchase).

Figure 2. Distribution of strategies of respondents in case of appliances failure (occurrence of the obvious need to purchase the replacement) in 2016.



Source: Compiled by the authors based on the survey materials

Thus, we have identified two different strategies of deferred demand for household appliances of two categories, large and small.

Model of binary regression to assess the deferred demand on the market of household appliances

At the frequent study of aggregate demand and good elaboration of methodological tools for its modeling, we note the almost complete lack of deferred demand models, although the term "deferred demand" is often referred to both in theory and in practice. Considering different approaches to the study of aggregate demand, we noted that the researchers mainly applied simulation modeling and multiple regression (Alipkerova, N.V., 201, 5 Kuzina, O.E., 2013, Mityaeva, N.V., 2015; Erastova 2016). The binary regression method has been used relatively recently (Gao, Y., 2014). Since the buyer in fact makes a choice between two possible alternatives (postpone or buy now), we have chosen binary regression as a modeling tool.

Previous analysis showed different willingness to postpone purchases in the context of certain types of appliances: large ("refrigerator") and small ("toaster") (Dubovik M.V., Timiryanova, V.M. 2015). Thus, let's consider two strategies of deferred demand separately for two different groups of goods. The first relates to the goods the purchase of which is postponed less often (refrigerator) and the *second* relates to

the goods that often fall into the deferred purchases (toaster). Source data were obtained as a result of the survey of more than 800 respondents in the Republic of Bashkortostan.

Binary regression is dependency of an endogenous variable that takes only two values – 0 – "purchase is made" and 1 – "purchase is postponed" – from a set of factors. When building binary models, we used the normal distribution function (probit), (Lakman, I.A., 2013). The model has been studied on a computer in the Econometric Views 8 (EViews) environment.

Assuming that the dependent variable, which represents a postponement or purchase of goods, takes only two values, the probability that it will take an appropriate value can be expressed as a function of several factors:

$$\begin{aligned} P(Y = 1 | X_k) &= F(X_k \beta). \\ P(Y = 0 | X_k) &= 1 - F(X_k \beta). \end{aligned}$$

Thus, the likelihood that the person will postpone the purchase $P(Y = 1 | X_k)$ or, on the contrary, will make it $P(Y = 0 | X_k)$ depends on a set of variables (X_k), which can be both qualitative and quantitative. The set of parameters reflects the impact of changes in each factor on a finite probability.

In this study, a function of the normal distribution (Probit) was chosen as a function, according to which the probability that the person will postpone the purchase $P\{Y = 1\}$ is defined as follows:

$$\begin{aligned} P\{Y = 1\} &= F(Z), \\ F(z) &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-t^2/2} dt, \\ Z &= \beta_0 + \beta_1 X_1 + \dots + \beta_k X_k. \end{aligned}$$

To evaluate the fitting of the models for the actual data, the McFadden coefficient of determination R^2 , Prob (LR statistic), log likelihood and Hosmer-Lemeshow test were used.

By analogy with the model proposed by a group of scientists from China and the Netherlands, who determined the reasons to postpone the car purchase (Gao, Y. *et al*, 2014), we proceeded from the fact that the decision on deferred demand of the person is associated with their social profile. 12 factors were selected from the questionnaire on the basis of expert assessments: gender, age, education, occupation, income of respondents, wealth, place of residence (urban/rural), marital

status, number of family members, presence of minors in their families, exercise of occupation (work/other), availability of savings. The selection of statistically significant variables in the models was made using the "Step-by-step exception" method (Backward).

Results of the computer experiment

The conducted calculations allowed selecting four most important factors for each models. For example, it was established that the person's income does not directly affect their buying decision. This confirms the idea of Caballero R.J. who drew a conclusion in the process of studying the savings behavior that consumption weakly responds to unanticipated changes in revenues, but much stronger responds to their anticipated changes (Caballero, R. J., 1988). More important is in which group of welfare the person includes themselves. Both of these questions were included in the questionnaire. According to the data of such major research centers as WCIOM and Levada-Center, we have identified the following groups of consumers rating their wealth as follows:

- (1) - we barely make two ends meet. We don't have enough money even for food;
- (2) - we have enough money for food, but buying clothes is already a problem;
- (3) - we have enough money for food and clothes, but buying a refrigerator, TV and furniture is a problem for us;
- (4) - we can easily buy a refrigerator, TV, furniture, but have no money for more;
- (5) - we can afford almost everything: car, apartment, country house, and more.

Gender, occupation and education of respondents were also not significant in the model.

The final **model of deferred demand for large appliances** – "refrigerator" – included the following factors:

- age (X_1),
- welfare (X_2),
- place of residence (X_3),
- number of family members (X_4).

For all parameters, the p-values of the coefficients (Prob) are close to zero, therefore the null hypothesis that the coefficient at a given factor is equal to zero can be rejected at any sufficiently low significance level. McFadden determination coefficient R^2 is 0.422. Prob (LR statistics) is low (it was 0.00007), which is less than the significance level α , so the model is significant. The criterion of likelihood (Log-likelihood = -42.307) indicates a good fitting of the model for the input data. The Hosmer-Lemeshow test indicates a fairly accurate description of the real data (Prob. Chi-Sq(8)=0.5371).

The calculation resulted in a constructed model, which allows estimating the probability of postponing the purchase:

$$Z = 2.015675 + 0.020072X_1 - 0.665564X_2 - 0.703706X_3 - 0.328960X_4$$

$$P(Y = 1 | X_k) = F(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-t^2/2} dt,$$

(K = 1, 2, 3, 4)

If $P < 0.5$, it can be assumed that an event (postponing of the purchase) will not occur; otherwise the event is anticipated – the purchase will be postponed.

For example, the likelihood that the purchase of a refrigerator will be postponed by a person 50 years old, living alone in a rural area and with level of income 2 (enough money for food, but buying clothes is already a problem) is 91.2%, from group (3) is 75.6%, i.e. the event will not occur. In turn, the likelihood that the purchase of a refrigerator will be postponed by a person 25 years old, living in the city with a family of three (for example, a young married couple with a child), i.e. from group (3), is 12.1%, that is, the event will occur, and the purchase will not be postponed.

Since probit models are nonlinear models, the estimated coefficients in these models have interpretation that differs from the interpretation of the coefficients in the linear regression model. The marginal (limit) effect of the explanatory factor X_k is calculated as the partial derivative of X_k using the following formula:

$$\frac{\partial P}{\partial X_k} = F'(Z) \frac{\partial Z}{\partial X_k} = \left(\frac{1}{\sqrt{2\pi}} e^{-\frac{Z^2}{2}} \right) \beta_k$$

When the age of the person is increased by one point, the likelihood of postponing the purchase of a refrigerator will increase by 0.52%; in case of moving from village to city, the likelihood of refusal from a refrigerator will decrease by 18.2%. In case of transition from group (1) in terms of welfare into group (2), the likelihood of postponing the purchase of a refrigerator decreases by 17.2%. Number of family members negatively affects the decision of postponing the purchase of a refrigerator (-8.5%). Indeed, when living alone, one can arrange the meals without the need for a refrigerator (buy products for 1 day, eat out). In other cases, the need in a refrigerator increases.

For the model of deferred demand for small appliances, let's call it "toaster", the following factors appeared significant:

- age (X_1),

- welfare (X_2),
- exercise of occupation (X_5),
- availability of savings (X_6).

For all parameters, the p-values of the coefficients (Prob) are close to zero (Table 1).

Table 1. Obtained values of estimates of the parameters of the Probit model

Variable (X_k)	Refrigerator		Toster	
	Coefficient (β_k)	Prob.	Coefficient (β_k)	Prob.
Age	0.020072	0.0724	0.112594	0.0395
Place of residence: city (1), village (0)	-0.703706	0.0415	-	-
Welfare	-0.665564	0.0032	-1.022941	0.0447
Number of family members	-0.328960	0.0287	-	-
exercise of occupation: employed (1), unemployed, retired, student, etc. (0)	-	-	-1.420392	0.0483
Savings behavior: always have savings (1), formed periodically (2), formed in a crisis (3), not formed (4)	-	-	-0.397965	0.0914
C	2.015675	0.0557	4.053791	0.0511

The McFadden determination coefficient R^2 is 0.535. Prob (LR statistics) is low (it was 0.00364), which is less than the significance level α , so the model is significant. The criterion of likelihood (Log-likelihood = -15.44) indicates a good fitting of the model for the source data. The Hosmer-Lemeshow test indicates a fairly accurate description of the real data (Prob. Chi-Sq(8)=0.9755). The calculation resulted in the following model of deferred demand:

$$Z = 4.053791 + 0.112594X_1 - 1.022941X_2 - 1.420392X_5 - 0.397965X_6,$$

$$P(Y = 1 | X_k) = F(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-t^2/2} dt.$$

Similarly to the first model, the value of likelihood $P < 0.5$ means a postponement of the purchase, i.e. non-occurrence of the events; otherwise, it is assumed that the purchase will occur.

The likelihood that the purchase of a toaster will be postponed by an employed person 50 years old, prone to make savings and with the level of income from group (3), is 100%, i.e. the purchase will be postponed. For people of older generation, the toaster is really less interesting than for the young, and the feasibility of its purchase at low income is rather weak. In turn, the likelihood that the purchase of a toaster

will be postponed by an employed person 25 years old, not prone to make savings and with the level of income from group (5), is 10.4%.

Marginal (limit) effect of the explanatory factor “age” was 2.9%. In case of the transition from one group to another in increasing welfare, the likelihood of postponing the purchase of a toaster will decrease by 26.4%. In case of changing the status from unemployed to employed, the likelihood of postponing will decrease by 36.7%.

Conclusion

The conducted analysis of the presence of articles of a cultural and social nature in households showed that the trends of development of the household appliances market in the Republic of Bashkortostan are somewhat different from the all-Russian. The observed variations in the turnover of household appliances indicate the formation of deferred demand in some periods. The household survey showed that 37.5% of the population postponed buying some appliances in 2016.

At the same time, there are several strategies of deferred demand, depending on the types of appliances. To evaluate the selected strategies, a model using binary regression was build, which allowed to identify the main factors significant for deferred demand for large and small units of appliances and to build the corresponding buyer's strategies. Assessing the internal motivations of buyers and external macroeconomic factors, it is possible to build a forecast of the development of the market of household appliances. The currently observed decline in living standards of the population and the rise in unemployment will contribute to the formation of deferred demand, the reverse trend is the increase in the number of urban residents, which leads to an increase in realized demand for appliances.

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