Households Consumption Behavior in Russia: Estimates on Micro Data[1]

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Abstract

This paper investigates the household consumption behavior in Russia. The model assumes that household consumption can be described by both the Euler equation and the rule-of-thumb. Using panel data on households (Russian Longitudinal Monitoring Survey–Higher School of Economics [RLMS-HSE][3]) from 2000 to 2011, we obtain the estimates of the elasticity of intertemporal substitution and show that an essential part of households consume a constant share of their current income and do not solve optimization problem.

Keywords: household consumption**,** Euler equation, rule-of-thumb, elasticity of intertemporal substitution, RLMS-HSE
JEL classification: E21, C23

1. Introduction

Since the advent of the hypotheses of permanent income (Friedman, 1957) and life cycle consumption (Modigliani, Brumberg, 1954), a concept of consumption smoothing is widely used to describe household consumption behavior. This framework is based on the assumption that economic agents spread their spending over time to maximize the utility throughout the life. The first-order condition for this optimization problem is known as the Euler equation. The representation of agent preferences in the form of the Euler equation was proposed by Robert Hall (1978) and is widely used to describe the dynamics of household consumption.

The Euler equation represents one of the key blocks of dynamic stochastic general equilibrium (DSGE) models, currently one of the most popular tools of macroeconomic analysis (Corsetti,

[1] This study was carried out within Russian Foundation for Humanities Young Research Program (www.rfh.ru), research project No.13-32-01243

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[3] We thank the Russia Longitudinal Monitoring survey, RLMS-HSE, conducted by the National Research University Higher School of Economics and ZAO “Demoscope” together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology RAS for making these data available

Pesenti, 2001; Obstfeld, Rogoff, 1995, 1998; Smets, Wouters, 2003, 2007). A large number of empirical studies use utility function with constant relative risk aversion (CRRA) preferences. In this case, DSGE models allow identifying the impact of the elasticity of intertemporal substitution on the macroeconomic policy effectiveness (Gali, Monacelli, 2008; Parrado , Velasco, 2002).

The elasticity of intertemporal substitution is derived directly from the agent's optimization problem and shows how household consumption changes in response to anticipated changes in the real interest rate. Elasticity estimates are obtained for the U.S. economy using both aggregated and disaggregated data or micro data (Amemiya, 1985; Alan at al.,Alan, 2012; Altonji, Siow, 1987; Attanasio, Browning, 2009; Attanasio, Low, 2004; Attanasio, Weber, 1995; Hall, 1988; Runkle, 1991; Shapiro, 1984). Authors obtain positive estimates; however, most of them report values that are close to zero.

The estimation of household preference parameters is traditionally linked with several problems. First, the estimation on aggregated data can lead to biased estimates of the elasticity of intertemporal substitution, which is caused by the agents' heterogeneity (Attanasio, Weber, 1993). As a rule, to resolve this problem, authors use panel data, taking into account the specific characteristics of households. For the United States, empirical investigation is conducted on data from the panel survey of households (Consumer Expenditure Survey) by the Bureau of Labor Statistics (Alan et al., 2009; Alan, 2012; Attanasio, Low, 2004; Attanasio, Weber, 1995).

Micro data on household consumption suffer from appreciable measurement errors. Various solutions for this problem are applicable. A number of authors combine households in cohorts (Attanasio, Weber, 1995; Jacobs, Wang, 2004) or clusters (Grishchenko, Rossi, 2012) by demographic or individual characteristics, such as income, education, age, saving rate and so on. The main advantage of this method is that it solves not only the problem of measurement errors but also reckon with the heterogeneity of the economic agents. It was shown by numerous authors (see, for example, Browning (1999)) that preferences of microeconomic agents are nonhomogeneous and the concept of representative agent does not work in this case.

Another approach to the measurement error problem is to use special econometric techniques. The Euler equation is usually estimated with the generalized method of moments (GMM). One may use the initial nonlinear equation or its linearized form. Attanasio and Low (2004) have found that the linearized form gives estimates that are more robust to measurement errors.

A large number of the empirical studies have not found evidence for supporting the theory of lifetime consumption optimization. Two reasons are offered for explanation. First, the access of economic agents to capital markets may be limited (the problem of bounded liquidity) (Zeldes, 1989); and second, agents may not be fully rational (the problem of myopic agents) (Runkle, 1991). Many authors emphasize that individuals are not able to perform complex mathematical operations for solving the problem of maximization of the utility. The economic agents' behavior is heuristic, and to make consumption decisions, they may use simple empirical rules (Winter at al., 2012).

Empirical rule, or rule-of-thumb, suggests that households make decisions about the current consumption, not taking into account future revenues and relying only on the level of current income. The results of the studies estimating the share of economic agents who use the rule-of-thumb are controversial. Some authors have reached the conclusion that the proportion of such households reaches 50% (Campbell, Mankiw, 1990; Hayashi, 1982); others claim that it is close to zero (Weber, 2000).

In this article, we assume that household consumption may be determined by both the Euler equation and the rule-of-thumb. This assumption allows estimating the elasticity of intertemporal substitution along with the proportion of households who base their decision only on current income.

To estimate the parameters of the model, we use disaggregated data on Russian households from the panel survey of the Russian Longitudinal Monitoring Survey–Higher School of Economics (RLMS-HSE) from 2000 to 2011. To solve the problem of measurement errors, we categorize households into cohorts and estimate the linear version of the Euler equation. We use GMM and account for overlapping observations and macroeconomic shocks. The set of instruments includes the lagged growth rates of consumption and income, along with a proxy variable for the real interest rate forecast. We present the results for credit rate and deposit rate, assuming that credits and deposits are the main financial instruments available to Russian households.

We find signs of rule-of-thumb consumption behavior along with optimal consumption behavior consistent with the Euler equation. The estimates of the elasticity of intertemporal substitution vary from 2.4 to 2.5, depending on interest rate choice. The estimated reaction of the logarithm of consumption to the change in the logarithm of current income is about 0.62. This result reflects the high share of rule-of-thumb households. Thereby, our findings support both hypotheses — consumption smoothing and rule-of-thumb consumption behavior.

The rest of the paper is organized as follows: in section 2, we present the model and empirical methodology; in section 3, we present the data used and the estimation results; in section 4, we present the conclusions.

2. The Model and Empirical Methodology

In this section, we present the theoretical model of consumption dynamics and make assumptions that are necessary for its estimation. In particular, we assume that households can choose the dynamics of consumption using both the Euler equation and the simple empirical rule (consume a constant part of current income).

2.1. The Model

To estimate the model parameters, we categorize all households into synthetic cohorts by demographic and financial characteristics. Therefore, the following equation describes the behavior of a representative household from a given cohort.

We assume that preferences are described by time- and state-separable CRRA utility function:

$$U_{i,t} = \mathrm{E}\left(\sum_{\tau=0}^{\infty} \beta^{\tau} \frac{c_{i,t+\tau}^{1-\sigma}}{1-\sigma} \mid \mathsf{F}_{i,t} \right), \tag{1}$$

where $U_{i,t}$ is the utility of the household i in the period t, $c_{i,t+\tau}$ is the consumption over τ periods, $\sigma > 0$ is the relative risk aversion coefficient, $0 < \beta \le 1$ is the subjective discount factor, and $\mathsf{F}_{i,t}$ is the information available at the time t.

The optimal consumption of the household in this case is described by the Euler equation:

$$\mathsf{E}\left(\left(\frac{c_{i,t+1}^{\text{opt}}}{c_{i,t}^{\text{opt}}} \right)^{-\sigma} R_{i,t+1} - 1 \mid \mathsf{F}_{i,t} \right) = 0, \tag{2}$$

where $R_{i,t+1} = 1 + r_{i,t+1}$ and $r_{i,t+1}$ is the real interest rate between periods t and $t+1$.

Following Campbell and Mankiw (1990), we assume that along with solving the underlying intertemporal optimization problem, households may use current income as a reference point for consumption. To introduce this issue, we use the simple rule-of-thumb, which is described by the following equation:

$$c_{i,t}^{\text{rule}} = \alpha y_{i,t}, \tag{3}$$

where $c_{i,t}^{\text{rule}}$ is the current consumption, which is determined by the rule of thumb; $y_{i,t}$ is the current income; and $\alpha > 0$ reflects the share of consumption in the current income.

Finally, we assume that the current consumption $c_{i,t}$ is a combination of the optimal consumption $c_{i,t}^{\text{opt}}$ and the rule-of-thumb consumption $c_{i,t}^{\text{rule}}$:

$$\frac{c_{i,t}}{\bar{c}_t} = \left(\frac{c_{i,t}^{\text{opt}}}{\bar{c}_t}\right)^{p} \left(\frac{c_{i,t}^{\text{rule}}}{\bar{c}_t}\right)^{1-p}, \tag{4}$$

where $\bar{c}_t$ is the steady-state level of consumption and $0 \le p \le 1$ reflects to what extent the household is rational. For example, $p = 1$ means that the current consumption coincides with the optimum consumption. On the contrary, $p = 0$ means that the consumption is completely determined by the current income. We present equation (4) in deviations from the steady state, first, to follow DSGE notation and, second, to show why we use geometrical (not arithmetical) mean. One can simplify this expression by dropping $\bar{c}_t$ and taking the natural logarithm of both parts of equation. This leads to a simple interpretation of p — it shows the reaction of the logarithm of household consumption to the change in the logarithm of optimal consumption. Accordingly, $1-p$ shows the reaction to the change in the logarithm of rule-of-thumb consumption, or the logarithm of current income.

In the case of cohorts, a different interpretation of equation (4) can be offered. Following Attanasio and Low (2004), we can divide households into two types: optimizers (choose the optimal consumption) and nonoptimizers (based solely on the rule-of-thumb). In this case, p refers to the proportion of optimizers in each cohort.

Using equations (4) and (3) to get the optimal consumption level and substituting it in equation (2), we get

$$\mathsf{E}\left(\left(g_{i,t+1}^{c} \right)^{-\frac{\sigma}{p}} \left(\frac{\bar{g}^{y}}{g_{i,t+1}^{y}} \right)^{-\frac{\sigma(1-p)}{p}} R_{i,t+1} - 1 \,|\, \mathsf{F}_{i,t} \right) = 0, \tag{5}$$

where $g_{i,t+1}^{c} = c_{i,t+1}/c_{i,t}$ and $g_{i,t+1}^{y} = y_{i,t+1}/y_{i,t}$ are the growth rates of consumption and income, respectively, $\bar{g}^{y}$ is the steady-state growth rate of income, $\bar{g}^{c}$ is the steady-state growth rate of consumption, and $\bar{R}$ is the steady-state interest rate.

Using Taylor expansion around the steady state, we obtain a linear approximation of equation (5):

$$\mathsf{E}\left(\tilde{g}_{i,t+1}^{c} - \frac{p}{\sigma}\tilde{R}_{i,t+1} - (1-p)\tilde{g}_{i,t+1}^{y} - B \,|\, \mathsf{F}_{i,t} \right) = 0, \tag{6}$$

where $\tilde{g}_{i,t+1}^{c} = g_{i,t+1}^{c}/\bar{g}^{c} - 1$, $\tilde{g}_{i,t+1}^{y} = g_{i,t+1}^{y}/\bar{g}^{y} - 1$, and $\tilde{R}_{i,t+1} = R_{i,t+1}/\bar{R} - 1$—deviations from the steady-state values of variables, and B depends on the model parameters and steady-state values. When estimating the model, we assume that the steady-state values of interest rate and growth rates of consumption and income are constant over time, which means that B is also a constant.

2.2. Empirical Methodology

Equation (6) allows using GMM to obtain the estimates of model parameters. Let us denote θ to be a vector of stacked values of σ, p, and B. Then moment conditions for GMM may be given as

$$\mathrm{E}\left(H_{i,t}(\theta)z_{i,t}\right) = 0, \qquad (7)$$

where $z_{i,t}$ is the $J \times 1$ vector of instrumental variables, index $i = 1, \ldots, N$ refers to the cohorts, index $t = 1, \ldots, T$ refers to the time periods, N is the number of cohorts, and T is the number of periods. The forecast error $H_{i,t}(\theta)$ is determined by

$$H_{i,t}(\theta) = \tilde{g}^{c}_{i,t+1} - \frac{p}{\sigma}\tilde{R}_{i,t+1} - (1-p)\tilde{g}^{y}_{i,t+1} - B. \qquad (8)$$

In several papers that test the Euler equation on data (Altug , Miller, 1990; Attanasio, Banks, Meghir, , Weber, 1999; Hayashi, 1987), the authors point out that the expectation in equation (7) is taken over time, not over households/cohorts. For example, for the simplest case, this means that the cross-sectional mean of forecasting error does not necessary equal zero at any point in time. That is why for sample counterparts of moment conditions, we use averages over time:

$$\hat{g}_i(\theta) \equiv \frac{1}{T}\sum_{t=1}^{T}\left(H_{i,t}(\theta)z_{i,t}\right). \qquad (7)$$

Let us denote $\hat{g}(\theta)$ to be a $JN \times 1$ vector of stacked values of $\hat{g}_1(\theta), \hat{g}_2(\theta), \ldots, \hat{g}_N(\theta)$. Then GMM estimates are

$$\hat{\theta}_{\mathrm{GMM}} = \arg\min_{\theta} \hat{g}(\theta)'\hat{A}\hat{g}(\theta), \qquad (10)$$

where $\hat{A}$ is a positive definite weighting matrix.

To obtain estimates, we use a two-step optimal GMM. In the first step, we use identity matrix as the weighting matrix. In the second step, we estimate the covariance matrix Ω of the moment conditions and use its inverse as the weighting matrix.

Estimation is based on yearly data (yearly growth rates and yearly interest rate) that are available with monthly frequency. There is an autocorrelation in moment conditions due to overlapping observations Therefore, we adjust estimates of Ω. using the Newey-West procedure

Macroeconomic shocks can also cause correlation in moment conditions for different cohorts, which are usually controlled by dummy variables for time periods (Altug, Miller, 1990; Attanasio, Low, 2004). However, moment conditions for each cohort separately are derived separately, which means that the score estimates of Ω accounts for the autocorrelation of this type by construction. That is the reason we do not use dummy variables for periods.

Assuming that the covariance between moment conditions is the same for all cohorts, we may improve its estimates. Let us denote $\hat{\Omega}$ to be an initial score estimate of Ω and $\hat{\Omega}_{ij}$ to be the block of $\hat{\Omega}$, which refers to the covariance between moment conditions for cohorts i and j. Then for the case $i < j$, the more effective estimate of that block is

$$\tilde{\Omega}_{ij} = \frac{1}{N(N-1)/2} \sum_{l=1}^{N} \sum_{m=l+1}^{N} \hat{\Omega}_{lm}, \tag{11}$$

because it considers average estimates for all possible combinations of cohorts.
For the case $i = j$, we get

$$\tilde{\Omega}_{ij} = \frac{1}{N} \sum_{l=1}^{N} \hat{\Omega}_{ll}. \tag{12}$$

For the case $i > j$, we get $\tilde{\Omega}_{ij} = \tilde{\Omega}'_{ji}$ on the grounds that $\tilde{\Omega}$ is symmetric.

When testing the model, we use $\tilde{\Omega}$ as an estimate of the covariance matrix $\tilde{\Omega}$, and for conditions on the moments, we use a matrix composed of blocks $\tilde{\Omega}_{ij}$.

3. Data and Empirical Results

In this section, we briefly describe the data set, the technique for constructing cohorts, and the instrumental variable used. Here we also present estimation results.

3.1. Data

To estimate the parameters of the model, we use the RLMS-HSE data for the period from 2000 to 2011 to form a panel of household cohorts. Each household of the survey is interviewed once a year in the period of October to March. On account of the fact that the share of households, interviewed from January to March, is less than 5%, we drop these observations and use the data for three months — October, November, and December. We do so to ensure that we have enough observations to form cohorts for each month of the sample. To avoid the problems caused by seasonality, we consider only those households that were interviewed in the same month from year to year.

We combine household questionnaire with individual questionnaires of household members to get more detailed characteristics (such as expectations) and to join the panel in time. Identification number of household to join in time is the identification number of reference member. This means that to merge household data from different years, we use the identification number of a person who answered household questionnaire. In particular, if the questionnaire were answered by the same person, we attach the data collected from different waves of the survey to the same household.

Investigating the Euler equation on panel data, authors traditionally define consumption as expenses on nondurable goods and services per household member. There are several definitions of nondurable goods in the literature (Grishchenko, Rossi, 2012; Jacobs , Wang, 2004). In this paper, we compute consumption as a sum of expenses on items such as food, alcoholic beverages, tobacco products, utilities, clothing, public transport, fuel, personal care items, entertainment, education, communication services, and medical services.

The RLMS-HSE questionnaire contains questions about spending of the last week (food, alcoholic beverages, etc.) along with questions about spending of last month (various services, diesel, etc.) and last quarter (clothes). We transform all the responses to compute monthly consumption for each of the items by multiplying weekly spending by 4 and dividing quarter spending by 3. To compute real values of variables, we use official data on consumer price index inflation[4].

For each household, we calculate growth rates of real consumption and real income. Following Attanasio and Weber (1995) and Balduzzi and Yao (2007), we exclude observations (a) if growth in consumption $g_{i,t}^{c}$ is below $1/5$ or above 5 and (b) if current growth $g_{i,t}^{c}$ of consumption is less than $1/2$ and, at the same time, future growth $g_{i,t+1}^{c}$ is higher than 2 (or vice versa). We use a similar filter for the growth rate of income. We also exclude observations if the person who answered household questionnaire is younger than 18 years or older than 60 years or if the household lives in rural areas.

An interesting feature of the sample is that consumption is higher than income for one-third of the households. This phenomenon can partly be explained by household loans and by the fact that individuals tend to underestimate their income and, at the same time, overestimate consumption (Lukiyanova, Oshchepkov, 2012). For this reason, we drop such observations only if consumption is twice as large as income.

[4] Consumer price indices (tariff) for products and services. *Source: Federal State Statistics Service*, http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/en/figures/prices/

Most authors who investigate the Euler equation on U.S. data use market returns, assuming that households use stock market instruments to spread their consumption over time. However, because in our sample the share of households that gain profits from operations with securities is less than 1%, we use bank interest rates — credit rate and deposit rate[5].

Data on deposit rates for individuals are available only since 2002; this is why we present the results for the two samples: from 2001 to 2011 (for credit rates) and from 2003 to 2011 (for deposit rates). Furthermore, we exclude 2009 from the sample (rate of growth and the rate from 2008 to 2009) to eliminate the impact of the financial crisis of 2008. If we include the crisis period in the sample, the main results of the paper will not change.

The descriptive statistics of the main variables is given in table 1.

Table 1. Mean values of main variables

Variables	Time period	
	2001–2011 (excluding 2009)	2003–2011 (excluding 2009)
Real consumption growth rate	1.22 (0.65)	1.21 (0.64)
Real income growth rate	1.22 (0.63)	1.20 (0.61)
Real credit rate	1.01 (0.02)	1.01 (0.02)
Real deposit rate	-	0.99 (0.02)
Real consumption per person (in prices of 2000)	1318.03 (1046.98)	1392.31 (1086.83)
Real income per person (in prices of 2000)	1788.84 (1571.77)	1932.99 (1617.01)
Age	38.41 (10.85)	38.51 (10.91)
Education (from 1 = *school or college* to 3 = *bachelor or higher*)	1.07 (0.80)	1.07 (0.80)
Children younger than 7 years (0 = *yes*, 1 = *no*)	0.17 (0.37)	0.17 (0.37)
Level of savings (0 = *low*, 1 = *high*)	0.08 (0.27)	0.10 (0.30)
Number of periods	33	27
The average number of households	244	240
Number of observations	8066	6485

Note: Standard deviations are shown in parentheses.

Figure 1 represents the dynamics of mean values of real consumption growth rate, credit rate

[5] Interest rates on ruble-denominated loans to non-financial organizations and deposits of individuals. *Source: The Central Bank of the Russian Federation*, http://www.cbr.ru/eng/statistics/

and deposit rate during the period from 2003 to 2011. In theoretical model consumption and interest rate should have positive correlation. This graph corroborate with the theory except the crisis period in 2009 when consumption growth rate and interest rate dynamics had opposite direction. We assume that this may be caused by the reasons different from consumption optimization problem. In particular, the decrease in consumption is stipulated by income decline during the crisis period. To count this fact, for obtaining more precise estimates of model parameters we exclude this particular period from the sample. It worth mentioning that adding crisis period into the sampling does not change the paper results in essence.

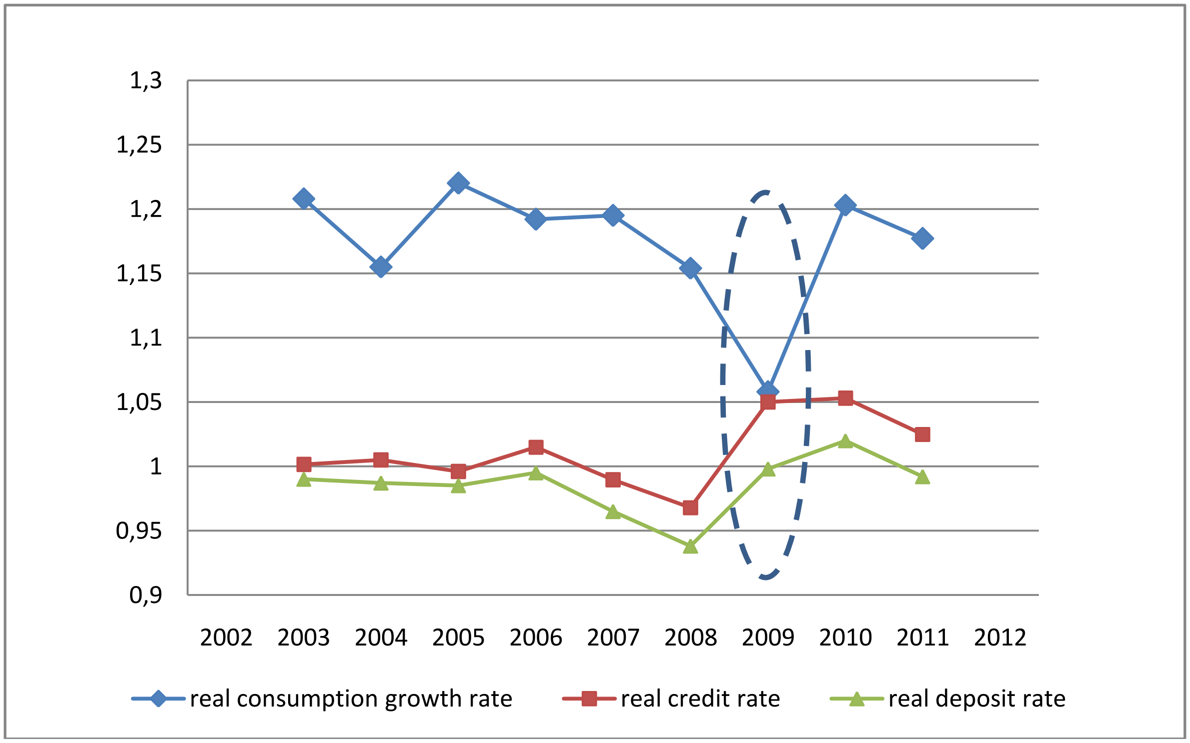

Figure 1. Dynamics of real consumption, credit rate and deposit rate mean values in 2003-2011

3.2. Cohorts

We consider households' consumption dynamics in a cohorts framework. To reduce the effect of measurement error, we categorize all households into synthetic cohorts using characteristics such as income, age, and education (Jakobs, Wang, 2004). In addition, we take into account the presence of children younger than 7 years and the level of savings as additional factors, which influence household consumption dynamics.

Suppose there are N cohorts that are observed for T periods. We present the results for the five variants of breaking into cohorts

• by income,

• by income and age,

• by income and level of education,

• by income and presence of children of preschool age, and

• by income and the level of savings.

We did not use all the characteristics at once to save enough number of households in each cohort. Otherwise, there is a lot of cohorts with missing observations in some periods (for those periods, there is no observations on households that combine into the cohort).

To form cohorts by income, we categorize households by average real income and divide the whole sample into five equal parts (the first cohort includes the poorest 20% of households, and the fifth cohort includes 20% of the richest households). To break into cohorts by two characteristics, we create additional cohorts within each income group — three cohorts by age, three cohorts by education, two cohorts by children, and two cohorts by the level of savings.

To break the sample into cohorts by age, we perform the same steps as for cohorts by income. The first age cohort includes the youngest one-third of households, and the third cohort includes the oldest one-third of the households. We determine age as the average age of the adult members of the household.

We define education of the household as the level of education of the best-educated household member. The first cohort of education consists of households with secondary education or less, the second cohort consists of specialized secondary education, and the third cohort consists of higher education.

We specify the level of savings on the basis of the answer to the question about how long the household will be able to keep consumption at the current level if it loses all sources of income—half a year and more, for several months, not more than a month, and so on. In the first cohort, we combine households that are able to maintain the current consumption no longer than one month; in the second cohort, several months and longer.

For each cohort, we calculate consumption growth rate as the average growth rate of the real consumption of the household. Analogously, we calculate income growth rate. Along this line, for each cohort, we obtain the yearly growth rates of the monthly consumption and monthly income. As the steady-state growth rates, we use the average values of cohorts’ growth rates. The rate of interest and steady-state values is common for all cohorts and changes only in time. All these data are available with a monthly frequency, but only for three months each year.

Apart from solving the problem of measurement errors, the cohorts allowed us to artificially lengthen the time series data. Because the observations on households are available with a yearly frequency, the maximum number of periods without breaking into cohorts is 11 years (for the 2001–2011 sample). In addition, not all years of the survey had available data for a large number of households. The cohorts patched these missing observations, increasing the length of the series to 33 periods (3 months × 11 years).

3.3. Instruments

To estimate the Euler equation with GMM, one needs a set of instrumental variables. Traditionally, authors use lagged values of interest rates and growth of consumption and the growth rate of income as instruments (Attanasio, Low, 2004; Weber, 2000).

However, it is obvious that at the time of making a decision on consumption, households have information on nominal interest rates on loans and deposits (as opposed to the return on the market index). To take this information into account, we adjust the current nominal interest rate for inflation of the previous period and include it into a set of instruments. The adjustment is needed to get a real interest rate. We cannot use the current inflation because this information is not available for a household when it chooses consumption. Thus, this artificial instrument may be considered as an approximation for the household forecast of the real interest rate.

The full set of instruments used consists of a constant, the lagged growth rates of consumption and income, and the current nominal interest rate adjusted for past inflation. This set of instruments, as opposed to a set with lagged interest rates, yields results that are more robust to the crisis period. In addition, the inclusion of lagged interest rate in this set of instruments did not change the main findings of the paper.

3.4. Estimation results

Tables 2 and 3 report the GMM estimates of the linearized Euler equation for credit rate and deposit rate, respectively. For convenience and easier interpretation, we report the estimates of $1/\sigma$ (the elasticity of intertemporal substitution) and the estimates of $1-p$ (the share of rule-of-thumb households). Estimates are for the sample period without crisis and for the five variants of breaking into cohorts.

Table 2. Estimates of parameters (credit rate)

	Cohorts				
	Income	Income Age	Income Education	Income Children	Income Savings
$1/\sigma$	7.901** (3.984)	1.452 (1.909)	0.177 (1.050)	0.294 (1.228)	2.184* (1.312)
$1-p$	0.648*** (0.079)	0.585*** (0.090)	0.342*** (0.059)	0.471*** (0.083)	0.556*** (0.092)
J stat	20.004 [0.458]	72.688 [0.126]	45.212 [0.922]	65.946 [0.006]	45.948 [0.239]
LM stat $H_0: p_1 = p_2 = \ldots = p_N$	2.190 [0.701]	16.488 [0.284]	14.334 [0.425]	31.091 [0.000]	9.393 [0.402]
LM stat $H_0: \sigma_1 = \sigma_2 = \ldots = \sigma_N$	3.246 [0.518]	20.209 [0.124]	14.628 [0.404]	15.325 [0.082]	12.544 [0.184]
Number of periods	30	30	30	30	30
Average number of households in cohort	49	16	16	24	24
Number of observations	5	15	15	10	10

Note: Standard errors are shown in parentheses; *p* values are shown in square brackets. Significance at *10%, **5%, and ***1% levels.

Table 3. Estimates of parameters (deposit rate)

	Cohorts				
	Income	Income Age	Income Education	Income Children	Income Savings
$1/\sigma$	3.745*** (1.204)	8.392** (3.890)	0.517 (0.960)	5.875*** (2.132)	2.650** (1.271)
$1-p$	0.587*** (0.067)	0.578*** (0.085)	0.339*** (0.060)	0.408*** (0.079)	0.542*** (0.090)
J stat	18.502 [0.554]	67.573 [0.234]	37.163 [0.991]	51.773 [0.101]	49.092 [0.153]
LM stat $H_0: p_1 = p_2 = \ldots = p_N$	2.749 [0.601]	10.405 [0.732]	11.992 [0.607]	16.697 [0.054]	9.810 [0.366]
LM stat $H_0: \sigma_1 = \sigma_2 = \ldots = \sigma_N$	1.834 [0.766]	13.357 [0.499]	10.396 [0.733]	11.589 [0.237]	12.004 [0.213]
Number of periods	24	24	24	24	24
Average number of households in cohort	48	16	16	24	24
Number of observations	5	15	15	10	10

Note: Standard errors are shown in parentheses; *p* values are shown in square brackets. Significance at *10%, **5%, and ***1% levels.

We also present the results of the *J* test on overidentification restrictions (*J* stat) and the results of the Lagrange multiplier tests (LM stat). We use the Lagrange multiplier test to check whether parameter values are the same for different cohorts. The null hypothesis of the first test states that the degree of rationality in households is the same for all cohorts: $p_1 = p_2 = \ldots = p_N$. The null hypothesis of the second test states that the coefficient of risk aversion is the same for all cohorts: $\sigma_1 = \sigma_2 = \ldots = \sigma_N$.

Both models — with credit rate and with deposit rate — provided similar results. Depending on the way of cohort construction, the proportion of households who do not solve optimization problem and use only the rule-of-thumb to choose consumption varies from 30% to 65%. The estimates of the elasticity of intertemporal substitution are positive, but they are significant only for two variants of breaking into cohorts — by income and by income and the level of savings. In both cases, breaking into cohort is based on the financial characteristics of households.

There are at least two reasons why the elasticity of substitution may turn to be insignificant for other variants of breaking into cohorts. First, a small number of time periods may lead to high values of standard errors — the estimates are not precise enough. Second, this result may be caused by the heterogeneity of households within cohorts. If a cohort consists of households with different preferences (with different values of the parameters of the model), aggregating data on household consumption may distort information about true parameters of the model.

Results of *J* and LM tests for income-children cohorts prove the presence of the problems mentioned previously. The *J* test says that moment conditions do not hold for these cohorts. Lagrange multiplier tests show different values of the model parameters for different cohorts. Thus, we may conclude that the dynamics of consumption is largely determined by the presence of children.

Table 4 reports estimates on two subsamples — the first subsample consists of households in which there are no children of preschool age, and the second subsample consists of households with children. Within each subsample, we break households into cohorts by income and present results for models with credit and deposit rates.

For households with children of preschool age, the estimates of the elasticity of intertemporal substitution are insignificant. In other words, for families with small children, we do not find any dependencies between expected interest rates and consumption dynamics. In this case, $1-p$ reflects not the share of nonrational households but the sensitivity of consumption to changes in income. One of the explanations for this result suggests that households with children may redistribute their income between periods and smooth consumption, but they do not take interest rates into account.

Table 4. Estimates of the model parameters (based on cohorts of income)

Households	Credit rate		Deposit rate	
	Without children	With children	Without children	With children
$1/\sigma$	2.400*	0.147	2.461*	1.541
	(1.394)	(0.692)	(1.400)	(1.113)
$1-p$	0.624***	0.326**	0.621***	0.191
	(0.082)	(0.165)	(0.083)	(0.202)
J test	23.029	16.716	22.677	13.748
	[0.287]	[0.671]	[0.305]	[0.843]
LM test	7.478	3.295	6.577	3.099
$H_0: p_1 = p_2 = \ldots = p_N$	[0.113]	[0.510]	[0.160]	[0.541]
LM test	5.861	2.299	5.435	1.117
$H_0: \sigma_1 = \sigma_2 = \ldots = \sigma_N$	[0.210]	[0.681]	[0.245]	[0.892]
Number of periods	30	30	24	24
The average number of households in cohort	41	8	41	8
Number of observations	5	5	5	5

Note: Standard errors are shown in parentheses; *p* values are shown in square brackets. Significance at *10%, **5%, and ***1% levels.

For households without children, the estimates of the elasticity of intertemporal substitution vary from 2.4 to 2.5 and significantly differ from zero at the 10% significance level. The share of households who do not solve optimization problem is 62%. *J* test shows that moment conditions hold. LM tests do not reject the hypothesis of equal values of parameters for different cohorts. These results are robust to the choice of interest rate.

These estimates of the elasticity of intertemporal substitution are high as compared with the estimates for the U.S. economy — they do not exceed unity (Attanasio, Weber, 1995). For the reason that the elasticity links the expected growth rate of consumption and the expected interest rate together, we may suggest that this result is largely caused by the difference in the ratio of variations of these variables. The variation of the U.S. stock market returns is a few times as high as the variation of credit/deposit rates in Russia. At the same time, the variation of the consumption growth rate in Russia is higher than the variation of consumption growth rate in the United States. In other words, because of large difference in variations, it is quite natural to assume that the expected 1% change in credit rate will have a greater impact on household consumption than the expected 1% change in stock market return.

4. Concluding Remarks

The paper presents the estimates of the elasticity of intertemporal substitution and the degree of agents' rationality for Russian households. The theoretical model we use assumes that the dynamics of consumption can be determined, first, by the expected real interest rate and, second, by the rule-of-thumb.

To estimate the parameters of the model and to take the heterogeneity of agents into account, we used disaggregated data on households from the RLMS-HSE panel survey. Assuming that the main financial instruments available for households are credits and deposits, we based our inference on credit rate and deposit rate accordingly. Following recent papers that investigate the Euler equation, we applied filters to the growth rates of consumption and income to exclude obvious measurement errors. We also dropped "young" and "old" households and households from rural areas.

To solve the problem of measurement errors, we estimated the linear version of the model and categorized the sample into cohorts by characteristics such as income, age, level of education, presence of children, and level of household savings.

Estimates were obtained with GMM and accounts for the impact of macroeconomic shocks and autocorrelation caused by the overlapping observations. We also accounted for the fact that expectation in the Euler equation is taken over time, not over households, and presented moment conditions out for each cohort separately. As instrumental variables, we used the lagged growth rates of consumption and income and proxy variable for the real interest rate forecast.

We found that when choosing consumption dynamics, Russian households used the simple rule of thumb along with solving optimization problem. This result is consistent with a case when households adjust optimal consumption to changes in their current income. The estimated reaction of logarithm of household consumption to the change in current income is 0.62. In other words, if current income rises by 100%, then consumption rises by 62%, even if optimal consumption remains unchanged. If turning to the interpretation in terms of household types, this result indicates a high share of households that use the rule-of-thumb.

The estimates of the elasticity of intertemporal substitution vary from 2.4 to 2.5, depending on what interest rate we use—credit rate or deposit rate. These estimates are significant and indicate that households solve optimization problem to redistribute consumption between periods.

Thus, estimation results support the hypothesis of both consumption smoothing and rule-of-thumb behavior of Russian households.

Acknowledgements

This study was carried out within "The National Research University Higher School of Economics' Academic Fund Program in 2013-2014, research grant No. 12-01-0147".

We thank the Russia Longitudinal Monitoring survey, RLMS-HSE, conducted by the National Research University Higher School of Economics and ZAO "Demoscope" together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology RAS for making these data available

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