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PADS FOR RUSSIA: TENTATIVE RESULTS

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Introduction

Russian household consumption expenditures have been growing for the last two decades, beginning at the peak of the transformation crisis in the middle of the 1990s, and have become one of the main engines of economic growth. Several times during the period, consumption expenditures slumped abruptly, but every decline was followed by further increase.

At the same time, Russian household consumption patterns have a few intricate and unexpected features. There is a need for a tool that can explore these patterns and features, explain past changes of consumption, and forecast its structure. The tool must cover consumer choice theory and simultaneously allow the user to build a model that takes into account (1) changes of income and the relative prices of goods and services, and (2) substitutability and complementarity of goods and services, and a wide range of other variables.

The Perhaps Adequate Demand System (PADS) proposed (Almon, 1979) and then developed by both the founder of the system (Almon, 1996) and his colleagues (Bardazzi & Barnabani, 2001) is a perfect tool for the task. This paper describes the use of some PADS applications for Russian data and presents its tentative results.

1. Data availability

One of the constraints imposed on applying PADS for Russia is the absence of required long-term time-series for household consumption expenditures. The Russian State Statistics Service has been collecting

data in a national accounts framework since the beginning of the 1990s, therefore we have decent historical data for total household consumption expenditures. However, data that corresponds to the widely used Classification of Individual Consumption on Purpose (COICOP) has only been collected since 2004.

Moreover, a couple of years ago Russian State Statistics made the transition from SNA1993 to SNA2008 methodology. The main difference of the methodologies that affects household consumption is the calculation of imputed rentals for housing in SNA2008. Together with other changes, old and new time series are not quite commensurable. It is aggravated by the fact that there are no long parallel time series for these methodologies. As a result, nowadays researchers cannot correctly compare household consumption in 2004–2013 with period 2014–2016.

In this paper, we analyze household consumption expenditures in period 2004–2013 for 24 COICOP items and net purchases abroad. These 25 items demonstrate the most detailed picture of household consumption that Russian national accounts can give.

2. Russian household consumption expenditures: retrospective

Russian household consumption expenditures in constant prices have increased by 3 times in 1996–2014 (Fig. 1). In spite of the economic crisis and slump of household consumption in 2015–2016, its volume is still 2.5 times higher than two decades ago. Notably, such rapid growth of household consumption is not an indicator of incredibly prosperous conditions, but largely the implication of its dramatic drop in the 1990s, during the transformation crisis.

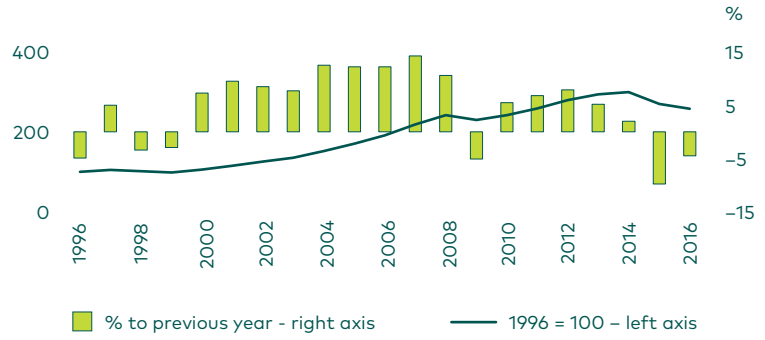

Fig. 1. Dynamics of total household consumption expenditures.

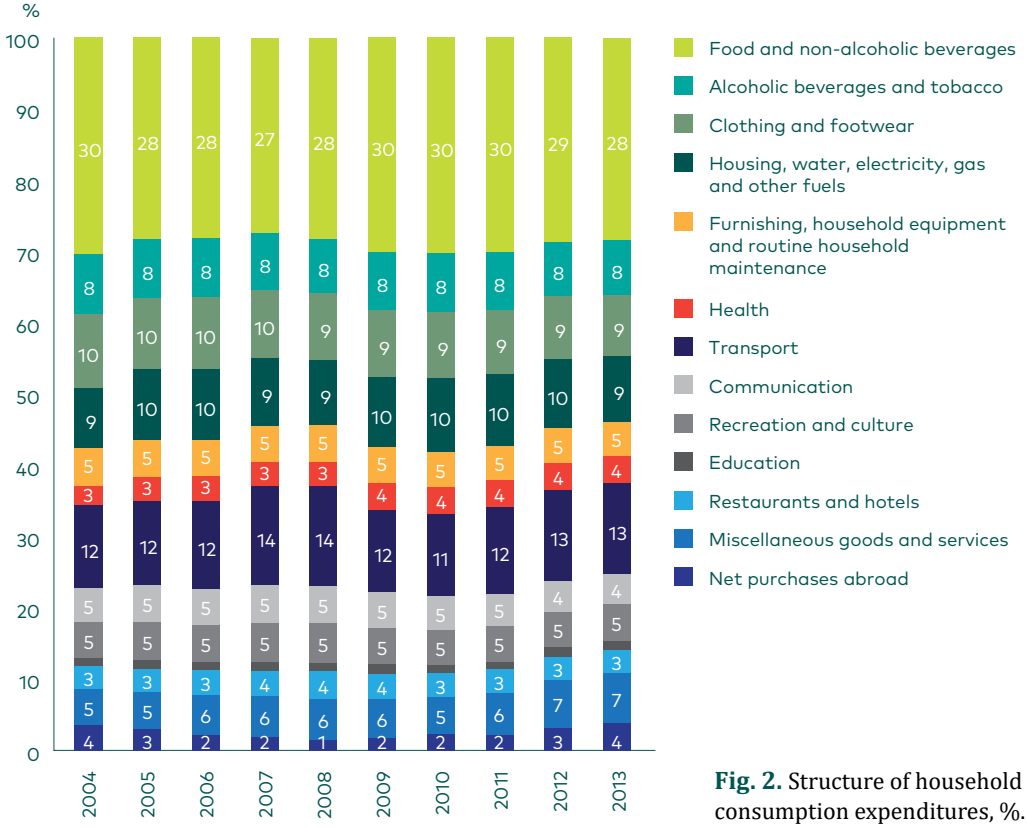

Fig. 2. Structure of household consumption expenditures, %.

The main feature of the structure of household consumption expenditures in Russia is its outstanding stability. Figure 2 splits household consumption into 12 top-level items of COICOP classification and net purchases abroad. The strongest shift of shares that these 13 positions took in 2004–2013 is attributed to net purchases abroad: 3 percentage points (in 2008–2013). The shifts of other items are only 2 percentage points or less. The situation is quite odd taking into account the growth of household consumption's volume by several times.

Another very odd feature of Russian household consumption structure is a very high and stable share of expenditures for food and non-alcoholic beverages: 27–30 % in 2004–2013. The share is enormous in comparison with countries that have approximately the same income and economic development level. In addition, the share of food expenditures seems to be invariant to income changes. There are two initial conjectures that might explain this food expenditures pattern. First, the relatively high price level for food in the country. Second, great

wealth and income inequality, when demand for food is determined by the majority of people with relatively low income.

Another feature of the structure is low shares of expenditures on entertainment (recreation, culture, restaurants, and hotels). In part, it is explicable through high shares of food and non-alcoholic beverages and clothing and footwear.

The combination of rapid growth of household consumption expenditures' volume and its stable structure may lead to suggestion about allegedly equal growth of most of the consumption items. However, this is incorrect (Fig. 3). For instance, during 2004–2013 the volume of net purchases abroad increased by 5.4 times (this item is not displayed in Fig. 3 in order to improve readability of other items). The volume of household consumption expenditures in communication increased by 3.1 times, in miscellaneous goods and services – by 2.7 times, and in recreation and culture, health and transport – by 2.3–2.5 times. Consumption of food and non-alcoholic beverages grew at a slower rate: its volume increased by 1.7 times. The growth of expenditures on alcohol and tobacco was humbler: increasing only 1.5 times during 2004–2013.

By definition, maintenance of stable expenditures structure and varying growth rates of consumption volumes can coexist if price changes follow a determined pattern. The pattern suggests higher deflators for goods and services, volumes of which had been showing low growth rates, and vice versa.

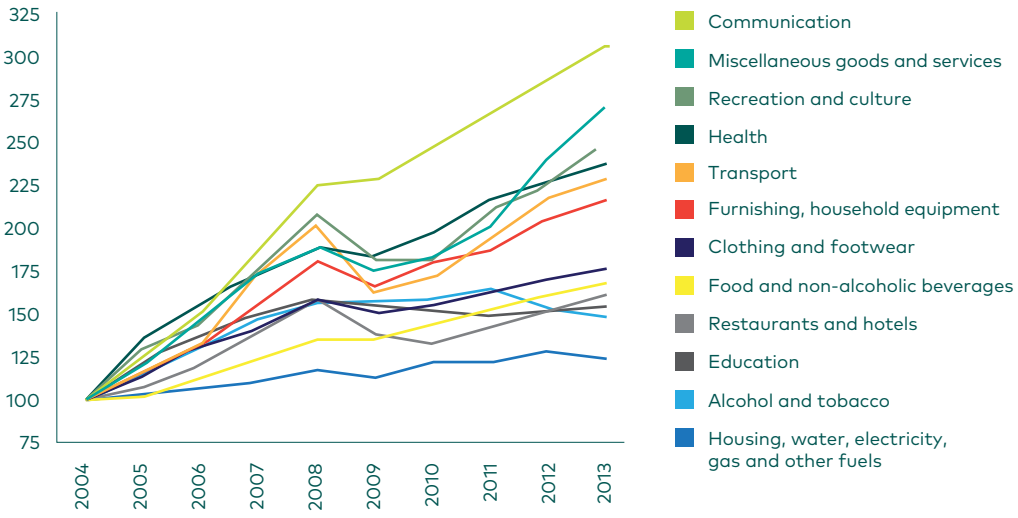

Fig. 3. Volumes of household consumption expenditures, 2004 = 100.

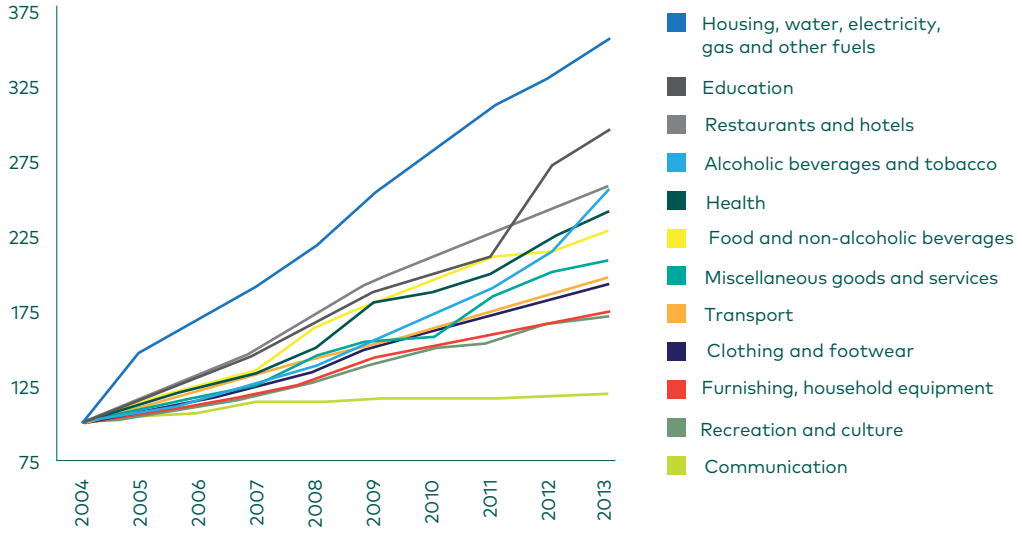

Fig. 4. Deflators of household consumption expenditures, 2004 = 100.

Net purchases abroad had the most significant volume increase, but simultaneously had a price decrease – their 2013 deflator is just 82 % of the 2004 level. The price level of household expenditures in communication increased only 1.2 times (Fig. 4), in recreation and culture –1.7 times, and in transport –2.0 times. The most substantial growth of price deflators – by 3.6 times – regards housing, water, electricity and other fuels, the same item that demonstrated the slowest increase of consumed volume.

3. Estimation of PADS for Russia

The most appropriate and correct mode of estimation of PADS equations is to launch a program specially written for solving the task in some programming environment. However, to apply the demand system for Russian data, we used a simplified procedure in Excel. Despite the simplicity of the procedure, the expected results have been obtained. Nevertheless, Excel is not conducive to many actions that can improve the quality of estimates.

The core of the estimation procedure is applying the Excel tool Solver. The tool enables optimizing the value of one cell depending on any range of cells within the limit of 200 modified variables and 100 constraints. The Solver can solve nonlinear tasks with the generalized gradient

descent method. To give a task to the tool, one should set an optimized cell, a group of cells to be modified, and constraints. As a whole, the solving process is a black box: the user cannot see what happens, but only gives input and gets results.

The estimation of PADS with Solver implies the minimization of the sum of squared residuals of PADS equations by all years and goods and services. The cells, which have to be modified by the Solver optimization process, are constant terms (ai), time trends (bi), coefficients on real income (ci), coefficients on change of real income (di), lambdas (λ_i and λ_k), μ_G and ν_g.

Estimated PADS equations are written in (1):

$$x_i = (ai + bi \cdot t + ci \cdot \left(\frac{y}{P}\right) + di \cdot \Delta\left(\frac{y}{P}\right)) \cdot \left(\frac{p_i}{P}\right)^{-\lambda_i} \prod_{k=1}^{n} \left(\frac{p_i}{p_k}\right)^{-\lambda_k} s_k \left(\frac{p_i}{P_G}\right)^{-\mu_G} \left(\frac{p_i}{P_g}\right)^{-\nu_g} \quad (1)$$

where

x_i – consumption per capita of item i in constant prices;
t – time;
y – nominal total expenditures (or income) per capita;
P, PG, Pg – overall, group and subgroup price indexes, respectively;
Δ – difference between t and $t–1$ values;
p_k – price index for item i (in the base year = 1);
s_k – share of item i in the expenditures of the base year;
ai, bi, ci, di, λk, μG, νg – parameters to be estimated.

Specification of the PADS equations for Russia also included formation of 4 groups and 2 subgroups of homogenous goods and services (Table 1, columns G and S):

- Group 1 “Food”;
- Group 2 “Clothing and footwear”;
- Group 3 “Health”;
- Group 4 “Transport”;
- Subgroup 1 “Proteins” (within “Food” group);
- Subgroup 2 “Personal transport” (within “Transport” group).

While trying to estimate PADS for Russia, the decision to expel time trends from equations for each good and service was made. The decision is justified by a few combined causes: relatively short time series, rapid growth of real income, growth of consumption volumes for all product items, and low levels of consumption in the beginning of the estimation period. Due to these causes, simultaneous application of both real income and time trends in the estimated equation created issues with multicollinearity of the variables and gave hardly interpretable results. Presumably, variation of consumption volumes was not sufficient for revealing shifts in consumers’ tastes and habits, which had to be exposed by using time trends.

4. Results without constraints

Initial results were obtained without imposing any constraints on the estimated parameters (the results are presented in Table 1). The quality of the equation's fitting seemed to be appropriate for most of the items. The standard error of the estimate (as a % of 2010 value) exceeded 10 % only for 4 of 25 items. The residuals' autocorrelation coefficient was above 50 %, 40 %, and 20 % for 5, 10, and 16 items, respectively.

Table 1

Estimation Results (No Constraints)
Weighted Lambda L = 0.141, μ_1 = 0.22, μ_2 = 4.89, μ_3 = 0.30, μ_4 = 2.13, v_1 = –1.16, v_2 = –0.29

№	Title	G	S	Lamb	Share	IncEl	Dinc	PrEl	Err%	Rho
1	Bread and cereals	1		0.00	4.1	1.12	0.16	-0.34	3.2	-0.07
2	Meat	1	1	0.22	8.5	1.21	0.23	-0.01	3.7	0.06
3	Fish and seafood	1	1	0.67	1.6	0.96	-0.03	**0.03**	1.6	0.75
4	Milk, cheese and eggs	1	1	0.99	4.3	1.07	0.12	-0.43	4.3	0.48
5	Oils and fats	1		0.08	1.2	1.15	0.22	-0.44	1.5	0.45
6	Fruit and vegetables	1		0.04	5.6	1.15	0.11	-0.35	7.2	0.36
7	Food products n.e.c.	1		–0.07	2.7	0.97	–0.01	–0.28	2.0	0.06
8	Non-alcoholic beverages	1		–1.74	2.2	**–0.75**	**–1.74**	1.31	6.2	0.51
9	Alcoholic beverages			1.34	6.2	1.08	0.17	–1.32	8.6	0.46
10	Tobacco			0.10	1.9	0.96	0.00	–0.23	1.6	–0.14
11	Clothing	2		0.66	7.1	0.96	–0.02	–1.85	3.7	–0.01
12	Footwear	2		–2.74	2.2	1.44	0.47	–1.27	2.6	0.19
13	Housing, water, electricity, gas and other fuels			0.32	10.4	1.77	0.91	–0.40	14.4	0.26
14	Furnishing, household equipment and routine household maintenance			0.46	5.1	0.70	–0.29	–0.55	2.7	–0.23

№	Title	G	S	Lamb	Share	IncEl	Dinc	PrEl	Err%	Rho
15	Medical products, appliances and equipment	3		1.94	2.0	0.11	–0.89	**–2.14**	3.1	0.19
16	Outpatient and hospital services	3		–0.13	1.6	1.70	0.70	–0.18	2.5	0.44
17	Purchase of vehicles	4	2	–0.52	4.9	1.48	0.32	–0.77	15.0	0.24
18	Operation of personal transport equipment	4	2	–1.78	3.3	0.31	–0.69	**0.18**	7.2	0.89
19	Transport services	4		–2.06	3.3	2.40	1.48	**0.27**	9.7	0.19
20	Communication			0.32	4.8	**–0.32**	**–1.31**	–0.43	6.6	–0.05
21	Recreation and culture			0.75	4.8	0.83	–0.23	–0.82	5.2	0.19
22	Education			0.39	1.2	1.40	0.46	–0.52	1.6	0.35
23	Restaurants and hotels			0.25	3.3	1.62	0.57	–0.38	4.9	0.50
24	Miscellaneous goods and services			–0.44	5.3	0.69	–0.37	**0.25**	12.6	0.79
25	Net purchases abroad			2.17	2.3	**–0.65**	**–1.53**	–2.21	15.7	0.53

Notes: G – groups; S – subgroups; λ – lambda estimated; share – share of an item in 2010; IncEl – income elasticity in 2010; Dinc – ratio of coefficient on the change of income and income coefficient; PrEl – own price elasticity; Err – the standard error of estimate as % of 2010 value; Rho – residuals' autocorrelation coefficient; μ and ν – coefficients for groups and subgroups, respectively.

However, some of the estimated parameters seemed obviously logically incorrect or at least hardly explicable (these values are indicated as bold in Table 1). These inappropriate estimates can be split into several categories.

Negative income elasticities: non-alcoholic beverages, communication, and net purchases abroad.

Positive price elasticities: fish and seafood, non-alcoholic beverages, operation of personal transport equipment, transport services, and miscellaneous goods and services.

Ratio of coefficients on change of real income and on real income below –1: non-alcoholic beverages, communication, and net purchases abroad.

Other situations: a) very high negative value of own price elasticity for medical products, appliances and equipment that contradicts the suggestion about low price sensitivity of these vitally important goods; b) very high value of μ_2 coefficient for clothing and footwear.

5. Results with imposed constraints: tentative results

Results with imposed constraints are given in Table 2.

For improving the logical interpretability of the estimated parameters, a set of constraints was imposed on them, including the following:

- price elasticities must be negative for all items;
- price elasticity for medical products, appliances and equipment must be inside of interval (–1; 0);

Table 2

Results with Imposed Constraints
Weighted Lambda L = 0.256, μ_1 = 0.22, μ_2 = 2.00, μ_3 = 0.30, μ_4 = 2.13, v_1 = –1.16, v_2 = –0.29

№	Product group	λ	Share	IncEl	Dinc	PrEl	Err%	Rho
1	Bread and cereals	0.00	4.1	1.12	0.16	–0.45	3.4	0.04
2	Meat	0.22	8.5	1.21	0.23	–0.12	4.3	0.13
3	Fish and seafood	0.99	1.6	0.96	–0.03	–0.39	1.6	0.73
4	Milk, cheese and eggs	0.99	4.3	1.07	0.12	–0.54	4.6	0.52
5	Oils and fats	0.08	1.2	1.15	0.22	–0.55	1.6	0.40
6	Fruit and vegetables	0.04	5.6	1.15	0.11	–0.47	7.9	0.30
7	Food products n.e.c.	–0.07	2.7	0.97	–0.01	–0.40	2.4	0.13
8	Non-alcoholic beverages	–0.25	2.2	1.02		–0.23	9.7	0.92
9	Alcoholic beverages	1.34	6.2	1.08	0.17	–1.43	8.6	0.41
10	Tobacco	0.10	1.9	0.96	0.00	–0.35	1.7	0.03
11	Clothing	1.00	7.1	0.96	–0.02	–1.58	5.3	0.49
12	Footwear	–1.48	2.2	1.44	0.47	–0.37	2.0	0.21
13	Housing, water, electricity, gas and other fuels	0.32	10.4	1.77	0.91	–0.51	15.7	0.20

№	Product group	λ	Share	IncEl	Dinc	PrEl	Err%	Rho
14	Furnishing, household equipment and routine household maintenance	0.46	5.1	0.70	–0.29	–0.66	2.5	–0.31
15	Medical products, appliances and equipment	0.61	2.0	0.11	–0.89	–0.98	3.7	0.59
16	Outpatient and hospital services	–0.13	1.6	1.70	0.70	–0.30	2.6	0.48
17	Purchase of vehicles	–0.52	4.9	1.48	0.32	–0.88	14.9	0.25
18	Operation of personal transport equipment	–1.28	3.3	0.31	–0.69	–0.41	7.3	0.90
19	Transport services	–1.64	3.3	0.97		–0.24	4.4	0.56
20	Communication	0.32	4.8	1.02		–0.54	8.4	0.72
21	Recreation and culture	0.75	4.8	0.83	–0.23	–0.94	5.1	0.24
22	Education	0.39	1.2	1.40	0.46	–0.64	1.6	0.25
23	Restaurants and hotels	0.25	3.3	1.62	0.57	–0.49	5.2	0.50
24	Miscellaneous goods and services	–0.01	5.3	0.69	–0.37	–0.25	13.0	0.80
25	Net purchases abroad	2.17	2.3	1.23		–2.33	17.3	0.49

Notes: λ – lambda estimated; share – share of an item in 2010; IncEl – income elasticity in 2010; Dinc – ratio of coefficient on the change of income and income coefficient; PrEl – own price elasticity; Err – the standard error of estimate as % of 2010 value; Rho – residuals' autocorrelation coefficient; μ and ν – coefficients for groups and subgroups, respectively.

- coefficients on change of income must be removed for non-alcoholic beverages, transport services, communication, and net purchases abroad;
- value of μ_2 coefficient for clothing and footwear must be below 2.

After imposing the constraints, the quality of the estimation fitting necessarily worsened, but remained rather satisfactory. Figure 5 shows actual and forecast household consumptions expenditures per capita in constant prices for some of the considered COICOP items. The same picture is also typical for the rest of goods and services not displayed on the plots. Although volumes of consumption expenditures per capita differ in initial level, growth rates, presence of slumps and boosts, and the forecast curves are pretty close to the actual values.

Fig. 5. Actual and forecast volumes of household consumption expenditures by selected COICOP items, thousands of 2010 Russian rubles.

Due to consumer price theory, own price elasticities of all goods and services must be negative and relatively high in absolute magnitude in comparison with absolute values of cross price elasticities. With this, values of cross price elasticities must be positive for most of the items. If several items form a group or a subgroup of goods and services, then their cross price elasticities must be comparable in magnitude with own price elasticities, while their signs can be both positive and negative according to substitutability or complementarity of the items.

In general, the values of calculated cross price elasticities correspond to expectations determined by consumer price theory. In some cases, several cross price elasticities appear to be positive, which is incorrect, but their magnitudes are too low to seriously influence the results.

The highest values of income elasticities belong to housing, water, electricity, gas and other fuels (1.77), outpatient and hospital services (1.70), restaurants and hotels (1.62), and purchase of vehicles (1.48). Housing, water, electricity, gas and other fuels include expenditures on maintenance and repair of the dwelling that is believed to have determined such a high value of income elasticity. We can suggest that dwelling conditions are very important for Russians, and growth of income allows for housing repair. The importance of repair expenditures is underscored by a high share of old dwellings and the existence of additional countryside houses that belong to millions of urban inhabitants in the country. High income elasticity of outpatient and hospital services can be explained by overcrowding of public health offices and sometimes by doubts about the quality of public health services.

The lowest values of income elasticities belong to medical products and appliances and equipment (0.11), which is quite natural because of the vital necessity of some drugs, and operation of personal transport equipment (0.31).

The highest estimated own price elasticity belongs to net purchases abroad (2.33). It is an evident consequence of internet trade development throughout the world, which makes conditions for cheaper goods and faster deliveries. This item is followed by clothing, which has own price elasticity that equals –1.58.

Alcoholic beverages also have large negative price elasticities (–1.43). Stagnation in 2008–2011 and reduction in 2011–2013 of household consumption expenditures' volume of alcoholic beverages was accompanied by acceleration of their price growth since 2009 (Fig. 4). The changes of the variables have led to an initial conjecture about unusually high price sensitivity of alcohol consumption in Russia. Further, the conjecture can be modified or supplemented with other ones. For instance, stagnation and reduction of alcohol consumption may have been caused by increased government enforcement in the alcohol market and by generational shifts of behavioral patterns.

Further developments

The results presented in this paper are tentative and necessarily require further development. The development can touch new iterations for adjusting, cleaning and improving the estimates and getting better equation fitting and logically interpretable parameter values.

In addition, it would help to use a more appropriate programming environment for PADS estimation. Nevertheless, the simplified estimation procedure depicted in the paper has a very easy learning curve and can be used for rapid PADS calculations. Another important direction of further development is the construction of some bridge between Russian COICOP data in SNA2008 and SNA1993. Accomplishing this task will probably allow for inserting time trends into equations specification.

The application of PADS for Russian data should finally become a base for analysis of patterns and features of household consumption expenditures and one of the main parts of the Russian INFRORUM-type model RIM.

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