Long-run relationship between real consumption and real income in the Russian Federation: An ARDL bounds testing approach

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Abstract

This paper considers an application of the ARDL model and bounds testing approach to the analysis of the long-run relationship between household consumption and aggregate income. We have explored the presence of a long-run relationship between real household consumption and indicators characterizing real income, such as: real gross domestic product (GDP), real gross domestic income (GDI), and GDP at constant household consumption prices. We provide statistical evidence of the lack of a long-run relationship in the first and second cases and its presence in the third case. We have concluded that the nominal GDP deflated by the price index of aggregated consumption is the most applicable indicator for describing the dynamics of real consumption in the Russian Federation.

Keywords: consumption, GDP, real income, ARDL, co-integration, bounds test.

JEL classification: C22, E21

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1. Introduction

A long-run relationship between household consumption and income is one of the classical examples of time series co-integration and is one of the most frequently researched relationships between macroeconomics indicators. The permanent income hypothesis (PIH) proposed by Friedman (Friedman, 1957) is the fundamental hypothesis for modeling and forecasting consumption. According to this hypothesis, when households plan their consumption, they focus on the value of the permanent income on which they can rely throughout life without reference to transitive income shocks.

The most significant extension of the PIH hypothesis to the stochastic case was proposed by Hall (Hall, 1978). In his work he considered a model of the representative economic agent with a quadratic utility function, maximizing the expected discounted stream of utility of consumption. The most important result of this investigation was that the time series of household consumption should be described by a random walk process and that expected changes in income should be included in the consideration of permanent income at the time of obtaining information of such changes, and that real consumption responds only to unexpected changes.

In the works of Campbell (1987), Cochrane (1994) and King et al. (1991) it was analytically shown that real household income under some assumptions is co-integrated with real GDP or real GNP. It was also shown that this theoretical hypothesis is consistent with empirical data.

Real GDP is a good indicator for describing the dynamics of consumption in developed countries, but for developing countries with a high dependence on terms of trade it is real gross domestic income (GDI) that is more relevant (Kohli, 2004; Sefton, Weale, 2006). Estimates of real GDI are published by the World Bank for a large number of countries, including Russia. Real GDI measures the purchasing power of produced GDP according to a basket of gross domestic consumption goods (Bureau of Economic Analysis, 2017). Thus, the dynamics of real GDI takes into account not only changes in the physical volumes of output, but also the purchasing power of income from the sale of export goods. For example, given improving terms of trade it is possible to buy a greater volume of imported goods for the same amount of export, and thereby domestic consumption may increase at constant output. Therefore, the dynamics of real GDI is better than the dynamics of real GDP for describing changes in the welfare of an economy with a high dependence on terms of trade.

In this paper, hypotheses as to the presence of a long-run relationship between real household consumption and real GDP and real GDI are tested for Russia, where the economy is highly dependant upon exports of oil, gas and other commodities. In addition to real GDP and real GDI, a third indicator is also considered: this is GDP at household consumption prices. In contrast

to real GDI, this indicator is based on nominal GDP deflated only by the prices of household consumption goods and services, not by the aggregate price index of all domestic goods, including government spending on final consumption and investment. The third indicator, in our opinion, is more natural for describing household consumption.

2. Methods

Testing the corresponding hypotheses is carried out by constructing an ARDL model and applying the bounds test (Pesaran, Shin, 2001). The use of the ARDL model and the bounds test is justified by the presence of several advantages when compared with other co-integration testing methods. Firstly, unlike other methods, the ARDL approach can be applied regardless of whether the underlying regressors are integrated I(1) or I(0). Therefore, there is no need for prior testing. Secondly, while other co-integration methods are sensitive to sample size, the ARDL approach can be applied even to a small sample size. The bounds testing approach for investigating co-integration is based on UECM, which is suitable for a small amount of data (Mah, 2000; Pattichis, 1999). Finally, the ARDL approach provides consistent, asymptotically normal estimates of the coefficients of the long-run model and Wald-statistics, even when regressors are endogenous (Pesaran, Shin, 2001; Harris, Sollis, 2003; Alam, Quazi, 2003, p. 93). The ARDL model was applied in areas of statistical research, such as the demand for money (Bahmani-Oskooee, 2001), energy consumption (Odhiambo, 2009), CO2 emission (Jalil, Mahmud, 2009) and demand for tourism (Song, Li, 2008).

3. Data

All data was obtained from the official website of the Russian Federal State Statistical Service (Rosstat). All series are available from the 1st quarter of 1995 to the 4th quarter of 2018 in quarterly terms. The series for real GDP, real household consumption, and real gross investment are used constant prices for the year 2011, obtained by chaining the corresponding Rosstat series at prices for 2003, 2008, 2011 and 2016. The series for nominal GDP, nominal household consumption, and nominal gross investment are obtained by linking data from the corresponding Rosstat series for 1995-2011 and 2011-2018. All data are cleared from seasonality by the X-12 ARIMA procedure. Regression analysis was performed in the Eviews statistical package.

4. Results

For testing the presence of co-integration we applied the bounds test for the ARDL model. The estimated model is:

$$lnC_t^r = \alpha_0 + \sum_{i=1}^{p} \psi_i C_{t-i}^r + \beta lnZ_t + \sum_{i=0}^{q-1} \beta_i \Delta \ln Z_{t-i} + u_t \qquad (1)$$

$$\Delta \ln Z_t = \sum_{i=1}^{s} P_i \Delta \ln Z_{t-i} + \varepsilon_t.$$

where C_t^r is real household consumption, Z_t is an explanatory variable, u_t is a stochastic disturbance.

Three alternative variables are considered as: real GDP, real GDI and GDP at constant prices of household consumption.

This model corresponds to case 3 in Eviews (case 3 - constant). This choice is based on the presence of a linear trend in data, constant inclusion and lack of trend in the co-integration equation. The actual sample size is 96, the critical values of the bounds F-test are automatically given for a sample size equal to 80.

We will choose the maximum number of lags for real household consumption and for explaining variable equal to 4.

We begin analysis of Russian macroeconomic indicators with the long-run relationship between real consumption and real GDP. Figure 1 shows a graph of the logarithm of the ratio of consumption to GDP at constant prices. This does not show a return to the average, and therefore does not look like a stationary time series.

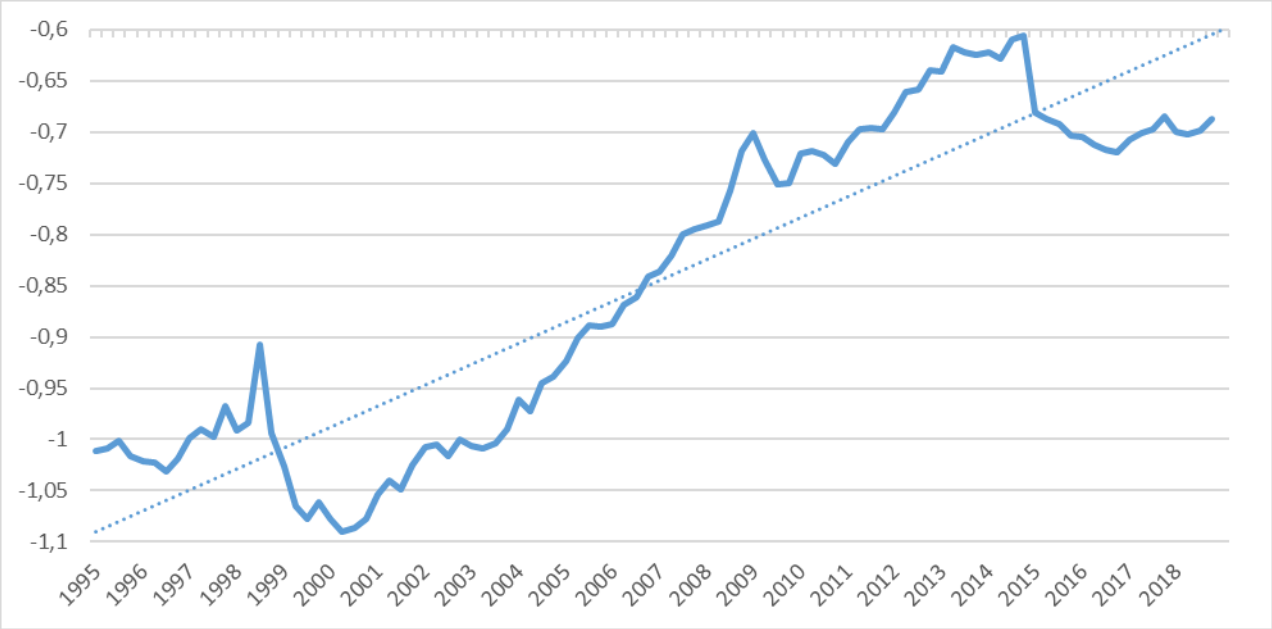

Figure 1 – Logarithm of the ratio of consumption to GDP at constant prices.

Due to test results, based on the AIC criterion, the ARDL model (1, 4) was selected. The test results are presented in Table 1.

Table 1 – Testing the presence of co-integration between consumption and GDP at constant prices.

F-statistics	3.54	
	I(0)	I(1)
1% critical value	7.095	8.26
5% critical value	5.06	5.93
10% critical value	4.135	4.895

According to the results of the F - bounds test, the null hypothesis of a lack of co-integration is not rejected. It can therefore be concluded that real GDP and real household consumption in the

Russian Federation do not possess a long-run relationship. This can be explained by the presence of a stochastic trend in the relative prices of output and household consumption. The dynamics are shown in the Figure 2.

A similar issue concerning the lack of co-integration between household consumption and GDP at constant prices was discussed by Whelan (Whelan, 2003). Whelan analyzed the problem of rapid growth of labor productivity in the sector of production of durable goods and provided a two-sector theoretical model in which the indices of real consumption and GDP are not co-integrated. In the case of the Russian economy, the presence of a stochastic trend in the relative prices of output and household consumption may be explained by the presence of a stochastic trend in the terms of trade.

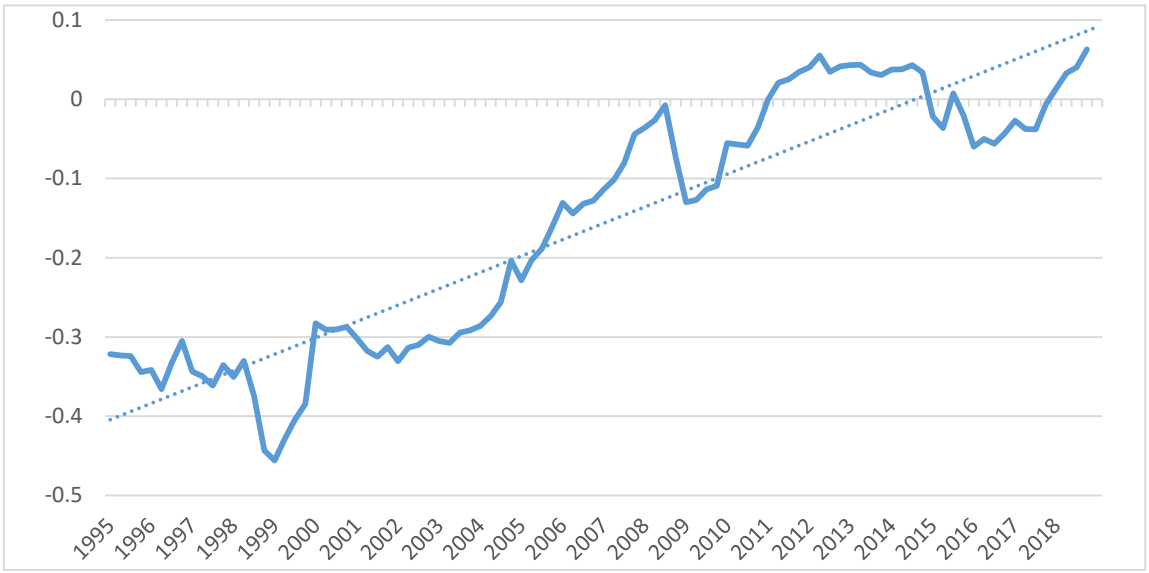

Figure 2 – Logarithm of the ratio of the GDP deflator to the consumption deflator.

We then tested for the presence of a long-run relationship between real household consumption and real GDI. Figure 3 shows the graph of the logarithm of the ratio of real household consumption to real GDI. This also demonstrates a trend behavior.

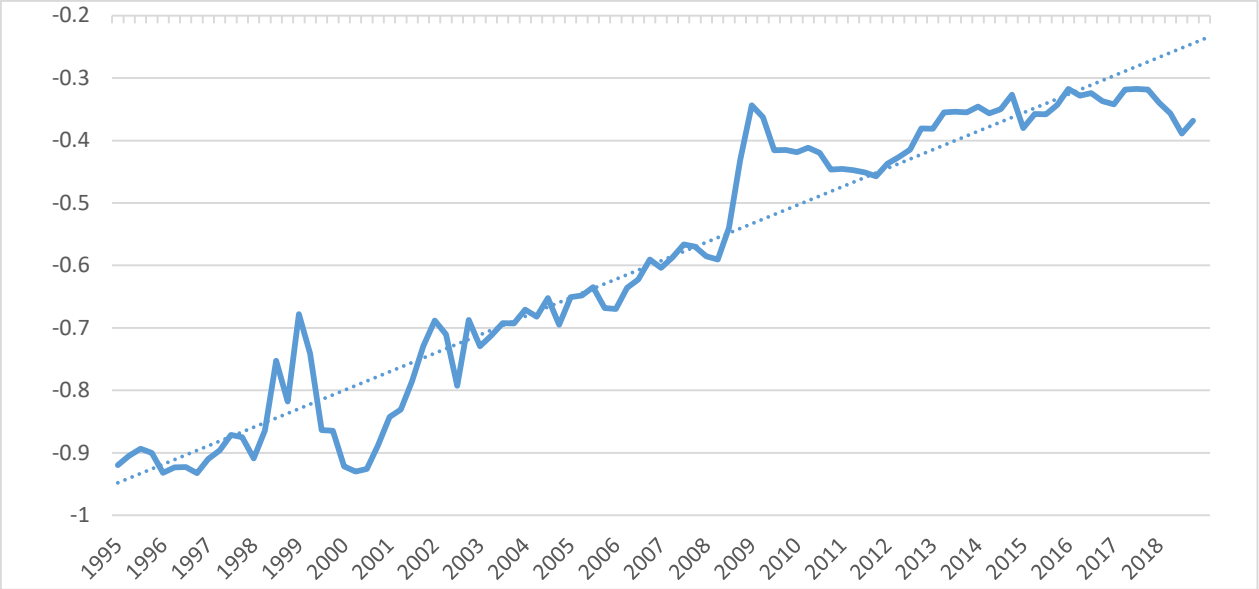

Figure 3 – Logarithm of the ratio of real household consumption to real GDI.

The results of the F-bounds test are provided in Table 2. According to the AIC criterion, the ARDL model (4, 2) was chosen.

Table 2 – Testing for the presence of co-integration between household consumption at constant prices and real gross income.

F-statistics	0.89	
	I(0)	I(1)
1% critical value	7.095	8.26
5% critical value	5.06	5.93
10% critical value	4.135	4.895

According to the results of the bounds test, the null hypothesis of a lack of the co-integration is not rejected. We have therefore not found a long-run relationship between real consumption and real GDI. The reason for this may be that the aggregated domestic consumption price index is irrelevant for measuring household consumption prices. In particular, government spending on final consumption at constant prices is, as a rule, calculated according to employment in the government sector, so a steady increase in salaries in the government sector leads to a more intensive increase of the index of prices of government spending on final consumption compared to the index of household consumption prices. Due to this specificity, in particular, we notice an uptrend in Figure 3.

At the final stage of the empirical analysis we test the presence of a long-run relationship between real household consumption and GDP at constant prices of household consumption. The graph of the ratio between the two is provided in Figure 4. In contrast with the previous cases, the time series shows a return to the average, so this looks like a stationary time series.

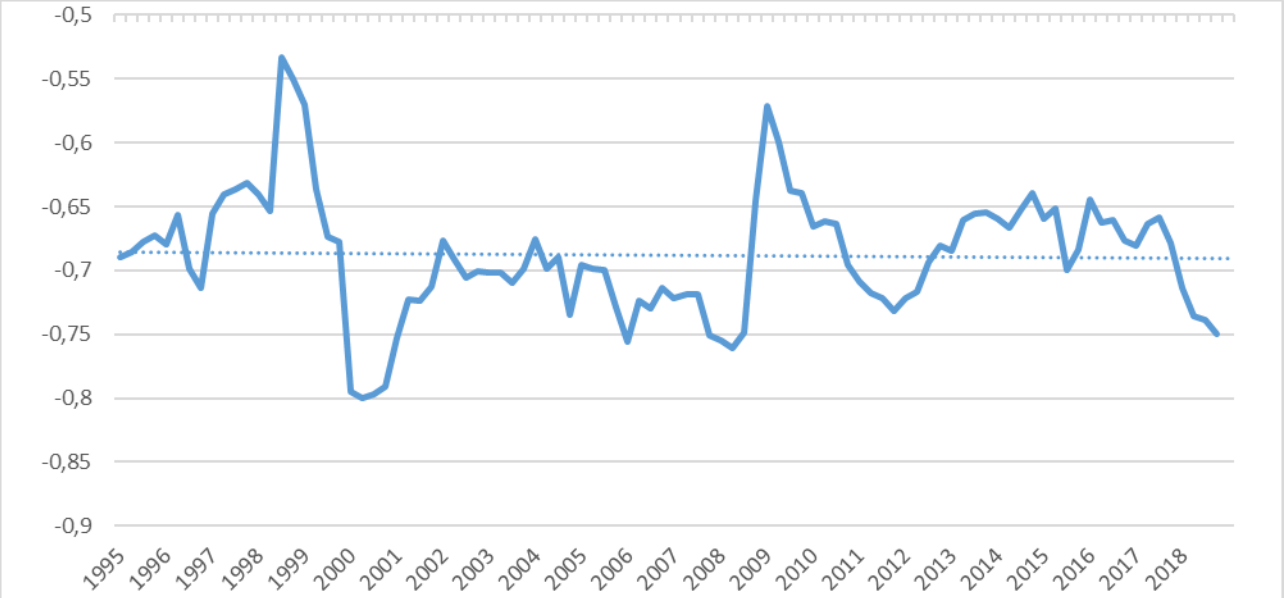

Figure 4 – Logarithm of the ratio of nominal household consumption to nominal GDP.

The results of the F-test are provided in Table 3. According to these results, the null hypothesis of a lack of co-integration is rejected at a 1% significance level.

Table 3 – Testing the presence of co-integration between household consumption at constant prices and real income.

F-statistics	22.05	
	I(0)	I(1)
1% critical value	7.095	8.26
5% critical value	5.06	5.93
10% critical value	4.135	4.895

The resulting dynamic equation for the real household consumption is as follows:

$$\Delta \ln C_t^r = -0.129_{(0.042)} - 0.232_{(0.035)} \ln C_{t-1}^r + 0.229_{(0.035)} (\ln C_t^r - (0.989_{(0.017)} \ln Yreal_{t-1}) + 0.330_{(0.047)} \Delta \ln Yreal_t) \quad (2)$$

Thus, real household consumption and GDP at constant prices of household consumption in the Russian economy may be considered as a co-integrated time series. Moreover, long-run income elasticity does not differ from unity.

5. Concluding Remarks

This paper has presented statistical evidence for a long-run relationship between real household consumption and GDP at household consumption prices in Russia – where the economy is highly dependent on commodity prices - based on a bounds test for the ARDL model. Real GDP and real GDI do not show a long-run relationship with real household consumption, and so cannot serve as relevant indicators for describing the dynamics of consumption. The results of the work can

be applied to the modeling of household consumption in countries where economies are highly dependent on the terms of trade.

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