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Consumption and hysteresis: the new, the old, and the challenge

Andreea-Daniela Moraru[a], Alina Barbulescu[b] and Cristina Duhnea[c]

[a]Faculty of Economic Sciences, Ovidius University of Constanta, Constanta, Romania; [b]Faculty of Mathematics and Informatics, Ovidius University of Constanta, Constanta, Romania and Higher Colleges of Technology, Sharjah, UAE; [c]Faculty of Economic Sciences, Ovidius University of Constanta, Constanta, Romania

ABSTRACT

Consumers are reluctant to change immediately their consumption patterns when confronted with budgetary changes, in spite of fluctuating economic conditions. Their reluctance evokes the notion of hysteresis used by economists to describe the persistent influence of past economic events. The importance of hysteresis in economic research represents a natural consequence of the development of economic sciences and of the pursuit of understanding economic systems' evolution by taking into account their 'memory', their conscience of the past. The present paper represents an attempt to review some of the most relevant approaches to hysteresis in economics and to emphasise the impact of the phenomenon on macroeconomic consumption in Romania. The paper aims at reviewing the application of hysteresis to economic models, and subsequently at constructing a two-phase research on households' individual final consumption in Romania during 1990 and 2016, employing both the unit root and the so-called '*true*' approach to hysteresis. The research results indicated the existence of hysteresis at the macroeconomic consumption level, thus revealing several implications for economic policy, inaccessible through the standard economic models.

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households' consumption; hysteresis; remanence; selective memory; persistence

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1. Introduction

The history of hysteresis started in the nineteenth century with the research of the physicist James Alfred Ewing, who introduced the new term to define irreversibility. Being a visionary, he rejected the successive attempts made by his peers to drop the new notion of hysteresis, arguing that they were dealing with a generic phenomenon and that it would enter other domains as well. Indeed, shortly afterwards, hysteresis crossed the borders of ferromagnetism and came into prominence in conductivity, ferroelectricity, biology, chemistry and, last but not least, social sciences.

CONTACT Andreea-Daniela Moraru moraru.ad@gmail.com

Its implantation in the fertile soil of economic science is not at all surprising since the neoclassical economists enthusiastically adopted concepts, metaphors, and equations from physics in their endeavour to establish economics as a science. Hysteresis, as an enlarged concept and subsequently as terminology, therefore entered the field of economics, and starting with the 1980s, even became a favourite topic of research.

Its importance in the economic research represents a natural consequence of the development of economic sciences and of the growing concern to understand economic systems' evolution by taking into account their 'memory', their conscience of the past. Hysteresis represents one of the most important path-dependency forms in economics (Lang, 2009). The inclusion of hysteresis in economic models is a complex activity, and although a plethora of approaches already exists, hysteresis has not yet been formally incorporated into orthodox economic models. Nonetheless, its relevance cannot be denied, since history and expectations play a most important role in determining economic outcomes (Dutt, 1997).

The paper represents an attempt to review some of the most relevant approaches to hysteresis in economics and to emphasise the impact of the phenomenon on macroeconomic consumption in Romania. The results revealed that past economic events affect consumption in Romania, with significant implications for economic policy.

2. Hysteresis and economics: significant landmarks

The term comes from the Greek 'hysterein' translated as 'that which comes later'. The physicist James Alfred Ewing used it for the first time to describe the persistent effects of the temporary exposure of ferric metals to magnetic fields. The subsequent states of the material were better understood by reference to their past states. Ewing (1881, pp. 122–123) mentioned in his work:

> The same tendency towards persistence of previous state is exhibited whenever we change the magnetisation of a piece of iron or steel by the alternate application and removal of any kind of stress […] and accordingly I have called it Hysteresis.

Although the term *per se* was only introduced in 1881, the concept has a history that precedes the nineteenth century. Leibniz enunciated the antithesis hysteresis – equations of state – as early as the seventeenth century, assessing that due to ontological reasons the past in itself cannot have a greater influence on the present than that determined by the traces left by the past in the present (Elster, 1976).

Considering that ontological hysteresis is impossible, one cannot implicitly argue the existence of epistemological hysteresis. Even admitting that the past can only influence the present by the persistent effects of the past in the present, the characterisation of present phenomena exclusively with current variables values may prove incomplete compared to that which can be achieved by evoking hysteresis. Therefore, hysteresis is used for explaining the functioning of systems for which no unhistorical explanation may be thought as viable. According to Franz (1990, p. 110), these systems have a long-run memory and may be considered as 'historical' systems.

Strong epistemological hysteresis is characteristic of systems whose functioning cannot be explained by any possible set of equations of state. Weak epistemological hysteresis is typical of those systems whose working may be described by a set of equations that contain past values of some of the variables, but by no known set of equations containing exclusively present values of all variables (Elster, 1976). The interest for the study of hysteresis may be therefore assimilated to the one for the past up to the extent to which it potentiates the proper ways to understand the present.

Subsequently to its introduction to magnetism, the ease of perceiving intuitively the hysteresis effect facilitated its entrance to various domains: conductivity; ferroelectricity; biology; chemistry; and social sciences.

As in other such domains, the phenomenon was also observed in economics and used to describe the persistent influence of past economic events. Moreover, it was considered as a significant progress in economic theory and credited with the potential to reduce the distance between economic modelling and reality (Cross et al., 2009).

The term may be considered as a new addition to the economic vocabulary, with only rare occurrence before 1970. The notion was, however, present especially in the study of consumption, starting in the late 1940s. Duesenberry (1948) in his relative consumption theory and Modigliani (1949) proved that households have the tendency to maintain consumption when faced with an income reduction, consumption behaviour being influenced by customs. Brown (1952) also observed, both in cases of income growth and reduction, the lack of promptness in consumer reactions attributed to a kind of inertia he called *hysteresis*. The idea of the influence of previous events on the present was explored by Georgescu-Roegen (1950) by raising the question regarding the dependence of indifference varieties on the economic experience of an individual, and emphasising that they were not invariant because the temporary experiences of a person were visible even after the initial conditions had been restored. The notion, although not the term itself, was also used in the works of Haavelmo (1970) and von Weizsäcker (1971), focused on consumer behaviour. The establishment of the term hysteresis in consumer behaviour was completed in Georgescu-Roegen's 1971 work , *The Entropy Law and the Economic Process*, in which although he did not offer a consistent definition of hysteresis, he described a general framework for its application to social sciences and especially to consumer behaviour theory. He signalled the difficulties in assessing hysteresis in human behaviour, due to the impossibility of evaluating the effect of the latest experience on consumer behaviour until it actually took place, that is, until one observed exactly what was intended to be predicted (Georgescu-Roegen, 1996).

After 1970, hysteresis had become the usual practice, especially in the fields of unemployment and international trade. Edmund Phelps (1972) found new opportunities to use the term for describing dependence from the past in unemployment, while Murray Kemp and Henry Wan (1974) consecrated hysteresis in international trade. In international trade, hysteresis denotes the persistent influence of temporary factors such as exchange-rate variations and their impact on prices and quantities, with the most illustrative example being that of sunk costs. In the 1980s, pieces of empirical evidence were brought demonstrating that unemployment did not return to natural or equilibrium levels following the implementation of disinflation strategies, but remained

at a high level or even increased. These proofs marked the moment when economists started developing alternative explanations for the persistence of unemployment based on the accumulation of consequences of the most significant previous shocks experimented by the economy, thus introducing hysteresis (Lang, 2009).

Later on, hysteresis has also been used to explain several phenomena in foreign investments, capital formation or marketing. But although its relevance to economic systems has been acknowledged, it has not yet been incorporated in formal economic models (Cross et al., 2010). The current economic conditions do, however, create an excellent framework for empirical testing as well as for a deeper theoretical development of hysteresis in economic science.

3. Consumption and hysteresis: the research methodology

3.1. Methodological considerations: the models

In economics, hysteresis was incorporated in formal models in two approaches: the first is based on the existence of zero/unit roots of differential equations, while the second describes *'true'* hysteresis.

In the first case, hysteresis is illustrated as a natural consequence of the Cauchy-Lipschitz theorem on the existence of solutions of systems of linear differential equations.

Let us consider the equation:

$$x_t = \alpha x_{t-1} + \beta + \varepsilon_t \tag{1}$$

where β is a constant and ε is a stochastic variable.

Equation (1) may be written as:

$$x_t = \alpha^t x_0 + \sum_{i=1}^{t} \alpha^{i-1}(\beta + \varepsilon_i) \tag{2}$$

If the equation has a unit root $(\alpha = 1)$ then the solution of (2) is:

$$x_t = \ x_0 \ + t\beta + \sum_{i=1}^{t} \varepsilon_i. \tag{3}$$

This solution points out that the current value of x depends on past values, thus signalling hysteresis. If $\alpha < 1$ and $\varepsilon = 0$ the solution of (2) becomes:

$$x = \frac{\beta}{1 - \alpha} \tag{4}$$

so x depends exclusively on α and β.

For small values of t, the past influences present values of x; to the limit, however, x tends to the values which do not indicate a dependence on the past (4), confirming the presence of hysteresis only as a particular case.

Criticism was brought to this approach, the most important referring to the over-simplification of the concept and the impossibility of characterising the structural changes of hysteresis effects, since it only takes into account the application to linear systems (Setterfield, 2009; Cross, 1993). This alienation from its usages in physics and mathematics determined the approach to hysteresis through unit/zero roots in linear differential equations to be labelled as *'bastard'* usage (Piscitelli et al., 2000).

The contributions of Vito Volterra, especially the predator–prey model (Volterra, 1927), demonstrate that hysteresis was a major preoccupation for mathematicians as early as the beginning of the 1900s. An important temporal lag between physical hysteresis and mathematical hysteresis is noticed, however. Moreover, although applicative studies used mathematical approaches of hysteresis, these were mere calculations and not functional analyses. Only in 1966 did hysteresis become the object of the functional analysis when R. Bouc modelled a series of hysteretic phenomena, regarding hysteresis as a map between function spaces (Visintin, 2006).

Between 1970 and 1980, M.A. Krasnosel'skii, A.V. Pokrovskii and their colleagues elaborated a formal model with hysteresis operators starting from the magnetic hysteresis model of Franz Preisach (Preisach, 1935), and conducted a systematic analysis of the mathematical properties of these operators. Their efforts were concretised in a monograph published in 1983 and translated into English in 1989. This model elaborated by Krasnosel'skii and his collaborators represented the conceptual basis for the introduction of '*true*' hysteresis in economics by Cross (1993) and Amable et al. (1993, 1994, 1995).

In the following paragraphs, there will be presented the analysis elaborated by Krasnosel'skii, using the explanations offered by Mayergoyz (1986, pp. 604–605) and Cross (1993, pp. 59–66).

The system is considered to be affected by pairs of expansionary and contractionary shocks such as that a value a of the shock will raise the output, while a value b of the shock will determine the output's decrease. The combinations of critical values of a and b are denoted by Hab, which defines a set of hysteresis operators (hysterons).

The economic agent is affected by a shock σ_t. When the shock reaches the critical value a, then the agent's output will rise by 1. When σ_t drops to the critical value b then the agent's output will decrease by 1.

The hysteron Hab describes how the aggregate shock σ_t determines the increase or the decrease of the output for a certain agent, and this output is denoted as $Hab\ \sigma_t$.

The shocks' intensity required to determine the output increase or decrease, respectively, differs between agents and also, in the case of the same agent, over time, which imposes the necessity to define a function $g\ (a,b)$ specifying the relative weight of the output of each agent in the aggregate output y_t. Then, the total output may be written as:

$$y_t = \iint_{a \geq b} g(a,b) Hab\ \sigma_t\ dadb.$$

The hysteresis effect may be illustrated by the following situation: a first expansionary shock determines the augmentation of the output for those agents

whose values of a are less than the aggregate shock. A subsequent contractionary shock will not surpass the b values of all agents which previously increased output, so the initial shock continues to influence their current output. The initial condition is that the first shock σ_0 is less than b_0 so that the entire system is affected, determining the decrease of the output of all agents, all *Hab* carrying the value -1. A second shock, σ_1, then affects the system. The outputs of the agents with values of a less than or equal to σ_1 will increase while the other agents will continue to reduce output, which will lead to the subdivision of agents in two categories: the category of agents increasing output (S+) and the category of agents decreasing output (S-). A subsequent contractionary shock σ_2 will determine the agents with values of b greater than or equal to σ_2 to decrease output, while the rest will continue to increase output, thus modifying the subdivision of agents in the two categories. For some of the agents, the effects of the initial expansionary shock have been annulled by the effects of the subsequent contractionary shock. One may, therefore, assert that the memory of the system is selective, and only the non-dominated maximum and minimum values of previous shocks are remembered, thus affecting current output.

A second expansionary shock σ_3 will determine the output to increase for agents with values of a less than or equal to σ_3. A second contractionary shock σ_4 will determine the output to decrease for those agents with values of b greater or equal to σ_4. The new conditions create the opportunity for a new subdivision of agents in the two categories. Continuing the process and allocating decreasing values for input maxima and increasing values for input minima will lead to a new division between categories.

Aggregate output is determined by the subdivision of agents, which is in turn determined by the extreme values of the experimented shocks. In other words, the system's memory records only the non-dominated maxima and minima experienced. The aggregate output can be written as:

$$y_t = \iint_{S_{t+}} g(a,b) Hab\ \sigma_t da db\ + \iint_{S_{t-}} g(a,b) Hab\ \sigma_t da db.$$

Given that $Hab\ \sigma_t = +1$ for agents in the category of increasing output (S+) and $Hab\ \sigma_t = -1$ for agents in the category of decreasing output (S-), then the aggregate output can be written as:

$$y_t = \iint_{S_{t+}} g(a,b) da db - \iint_{S_{t-}} g(a,b) da db.$$

According to the compelling mathematical definition of hysteresis given by Krasnosel'skii and Pokrovskii (1989) and supported by Mayergoyz (1991), a system with memory is considered to be a hysteresis system if it has two properties: remanence and selective memory. Remanence is best illustrated by the first example of magnetic hysteresis given by Ewing: after successively applying to a probe two opposite magnetic fields of the same intensity, the probe would not return to the initial state. Similarly, one may interpret remanence in economic systems: if the system

experiences successively two equal but opposite shocks it will not return to the initial state. The selective memory refers to the system's property to retain only the non-dominated maxima and minima, that is, the most significant previous shocks experienced.

Piscitelli et al. (2000, pp. 63–71) took a step further in the arguments exposed by Krasnosel'skii (1983, 1989), Mayergoyz (1986, 1991), and Cross (1993) and developed an algorithm for computing hysteresis variables for time series.

3.2. Methodological considerations: the economic background

The importance of consumption within national economies sustains its continuous study. Romania is no exception with final consumption accounting for approximately 70% of the GDP. The recent evolution of consumption is consistent with the general evolution of both the Romanian economy and the international economic context. The most important turning points in the evolution of Romanian consumption offer an accurate reflection of the social, political, and economic state of the country.

Following the dismissal of the Communist Party at the end of 1989, new political factors opted for orientation toward a market economy, but as in the case of other former socialist countries, this alternative generated serious negative consequences for the population. During the 1990s, Romania faced significant gaps compared to the Western European countries as far as economic development was concerned. The accumulation of disequilibria caused by the slow rhythm of the reforms rather frequently doubled by inconsistent public policies reflected upon the evolution of economic phenomena and processes. A significant problem faced by the Romanian economy after 1990 was inflation. The phenomenon was definitely present before the year 1990, but the specific mechanisms of the socialist economy kept it under control. Once released from this artificial restraint the inflation rate reached high levels during the 1990s, with a peak of 256.1% in 1993.

Although in the late 1990s GDP continued to drop, and the inflation rate was on a rather upwards path, the year 1999 laid the foundations for economic growth at the beginning of the twenty-first century. The year 2000 marked a growth of 1.6% of the GDP, after three years of involution. In addition, the inflation rate, the budget deficit, and the unemployment rate dropped. The priorities of the new government formed following the elections organised in 2000 targeted economic growth and the reduction of the inflation rate as preliminary objectives for EU accession.

Positive economic results generated by the EU accession objective characterised the period 2000–2006. The major economic indicators grew and consolidated the positive trend initiated at the beginning of the new century.

Following EU accession on 1 January 2007, the positive trend continued up to and including 2008. Although starting with the second half of 2007 the effects of the global crisis became apparent, the Romanian economy experienced the first signs of the crisis only in 2009 when the GDP dropped, the budget deficit increased, and the national currency faced depreciation. According to Duhnea (2012), the net direct investments, which recorded unprecedented growth between 2006 and 2008,

amounted to only 3.5 billion euros in 2009, lower by 61.9% compared to the previous year, signalling a compression trend that persisted throughout 2010 and 2011.

As for the evolution of consumption in Romania, one may notice a close interdependence with the overall development of the national economy. In the early 2000s the proliferation of credit opportunities and the growth of real salary determined an increase in consumption, the annual growth rate attenuated during 2005–2006 and dropped in 2009 (by 5.4%), when the effects of the economic crisis became obvious. The growth rate of households' consumption, which surpassed the growth rate of GDP, illustrated the accentuated dynamism of consumption during 2000–2008. In 2010, households' consumption in constant prices increased slightly, only to return in 2011 to the level from 2009. The period 2009–2016 shows an oscillatory evolution of households' consumption, with levels below those registered in 2008, although GDP has been on an obvious ascendant path following 2012 (Figure 1). Figure 2 shows the households' consumption share in GDP, for the period 1990–2016.

3.3. Methodological considerations: the data

For the research presented in this paper, official annual data for the period 1990–2016 on households' actual individual final consumption (C), on the disposable income of households (Y), and on the monetary aggregate M_1, were used.

According to the methodology of the National Institute for Statistics, actual final consumption 'comprises the households' actual individual final consumption and the government's actual collective final consumption. The households' actual individual final consumption includes households' expenditure for purchasing goods and services to meet their members' needs, expenditure for individual consumption of general

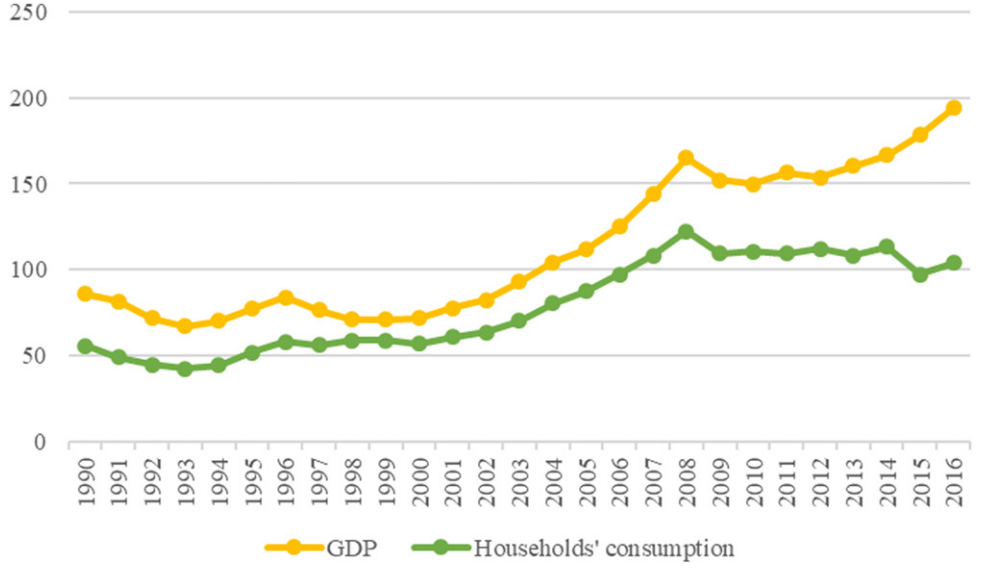

Figure 1. The evolution of households' consumption and GDP (1990–2016) (millions of Lei, comparable prices). Source: Designed by authors based on data available in *Statistical Yearbooks of Romania* (1995–2014) and Monthly Bulletins (2015, 2016).

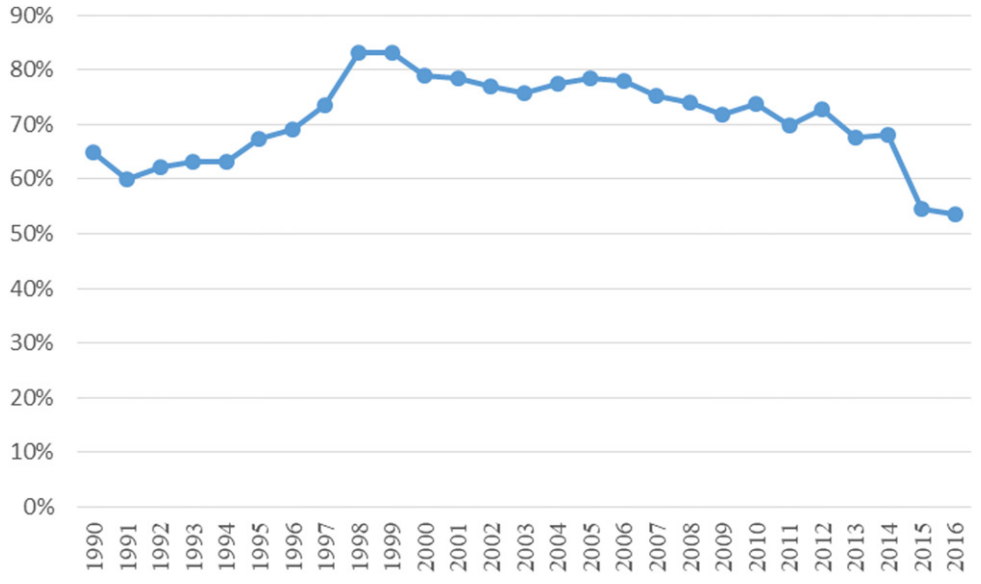

Figure 2. Households' consumption share in the GDP (1990–2016) (millions of Lei, comparable prices). Source: Designed by authors based on data available in (1995-2014) and Monthly Bulletins (2015, 2016).

government (education, health, social-security and social activities, culture, sport, recreation, waste collection) and expenditure for individual consumption of non-profit institutions serving households (religious organisations, trade unions, political parties, unions, foundations, cultural and sport associations)' (National Institute of Statistics, Monthly Statistical Bulletin, No 2/2012, p. 140). The households' actual individual final consumption accounts for more than 90% of the actual final consumption, which justifies our choice to use this variable in the study.

According to the definition provided by the Central European Bank (www.ecb.int), M_1 (narrow money) 'includes currency such as banknotes and coins, as well as balances which can immediately be converted into currency or used for cashless payments, i.e. overnight deposits'. The choice for the latter indicator is justified by the fact that 'money (M_1) is no doubt a dominant asset: the store of value' (Dwivedi, 2005, p. 248). Moreover, the 'monetary theory has emphasized two different, but not mutually exclusive, functions of money: a medium of exchange and a store of wealth' (Batten & Thornton, 1985, p. 30) and is simultaneously related to the current households' consumption. Therefore, it represents the most suitable option given the particularities of the Romanian economy in which case the aggregate M_1 is best represented compared to the additional elements of the M_3 aggregate, considered by other authors as a representation of wealth. According to the most recent Annual Report of the National Bank of Romania (2016, p. 67), the weight of M_1 in M_3 has continued its ascendant path of the past five years, reaching, at the end of the period, the record of the last 22 years (57.3%).

The sources for the data were the Statistical Yearbooks of Romania (1995–2014), the Monthly Statistical Bulletins (2012–2016), and the Monthly Bulletins of the

National Bank of Romania (1998–2016). All the data were deflated and the series were stationarised by taking the first order differences.

The research was conducted on the time series for households' consumption, disposable income of households, and the monetary aggregate M_1, used to approximate wealth, containing 27 observations. The number of observations is suitable for a reliable analysis (Tiron, 1976).

3.4. Methodological considerations: the research goal and hypotheses

The goal of our research was to reveal the presence of the hysteresis phenomenon in Romanian households' final consumption. To this end, we employed an integrated unit root – '*true*' hysteresis approach, where the unit root theory was partially applied to evaluate the time series used for research. Both the unit root and the '*true*' hysteresis approaches were presented earlier in the paper.

Initially, a statistical analysis was performed for testing the following hypotheses about the study series: the autocorrelation (using the autocorrelation function and the Durbin-Watson test for the first order autocorrelation), the existence of a unit root against the stationarity (by the Augmented Dickey – Fuller and KPSS tests), and the series' homogeneity (by the Pettitt, Buishand and Standard Normal Homogeneity Test -SHNT tests). The latter tests were performed since hysteresis is associated with structural changes determined by the historical experience (Setterfield, 2009).

All tests were performed at a significance level of 0.05. Emphasis will not be placed on these tests since they are well known in statistics. The reader may refer to Pfaff (2008).

The research was conducted in two phases.

In the first phase, we aimed at testing the relationship between the dependent variable households' actual individual final consumption (C) and both the current and previous values of two independent variables: disposable income of households (Y) and wealth (W).

The following hypotheses were formulated:

Hypothesis 1. *Consumption is influenced by the current income.*

Hypothesis 2. *Consumption is influenced by both current and previous income.*

Hypothesis 3. *Consumption is influenced by current income and previous consumption.*

Hypothesis 4. *Consumption is influenced by current income and current wealth.*

Hypothesis 5. *Consumption is influenced by current income and current wealth and previous income and previous wealth.*

XLStat and E-views Enterprise software (Edition 7.0) were used for performing the statistical analysis and the modelling.

In the second research phase, we took the '*true*' hysteresis approach to test for the presence of hysteresis in Romanian households' final consumption. To this end, we applied the algorithm elaborated by Piscitelli et al. (2000, pp. 63–71) (Reprinted by permission from Springer Nature: Springer Nature COMPUTATIONAL ECONOMICS, A test for Strong Hysteresis, Piscitelli, L., Cross, R., Grinfeld, M., Lamba, H., COPYRIGHT © Kluwer Academic Publishers (2000)).

Finally, the cointegration test of Johansen was performed.

4. The research results

The results of the statistical analysis for the initial series of income, consumption, and wealth were the following.

All the series were autocorrelated. In Figure 3 we present the autocorrelograms of the consumption and wealth series. The dashed lines represent the limits of the confidence interval at the confidence level of 0.95.

The Durbin-Watson test confirmed the existence of the first order autocorrelation.

The ADF and KPSS tests rejected the stationarity hypothesis for all the series. The non-stationarity was also confirmed by the slow damping of the autocorrelogram. Therefore, the series were stationarised by taking the first order difference.

After testing the hypothesis H_0: *the series is homogenous* (there is no change point in the time series) against the alternative H_1: *the series is not homogenous* (there is at least a change point in the series), the null hypothesis was rejected for all the series. The results of the Pettitt, Buishand, and SNHT tests are presented in Table 1, together with the change points.

In the following we denote the series of independent variables, respectively by: income – current and previous levels (Y_t, Y_{t-1}), previous consumption (C_{t-1}), and wealth (W) – current and previous levels (W_t, W_{t-1}).

In the first research phase a series of econometric models having households' consumption as a dependent variable were tested. Considering the series of dependent variables to be consumption (C_t), the following models were created:

Model 1	$C_t = a_0 + a_1 Y_t + u_t$
Model 2	$C_t = a_0 + a_1 Y_t + a_2 Y_{t-1} + u_t$
Model 3	$C_t = a_0 + a_1 Y_t + a_2 C_{t-1} + u_t$
Model 4	$C_t = a_0 + a_1 Y_t + a_2 W_t + u_t$
Model 5	$C_t = a_0 + a_1 Y_t + a_2 W_t + a_3 Y_{t-1} + a_4 W_{t-1} + u_t,$

where u_t is the residual random variable.

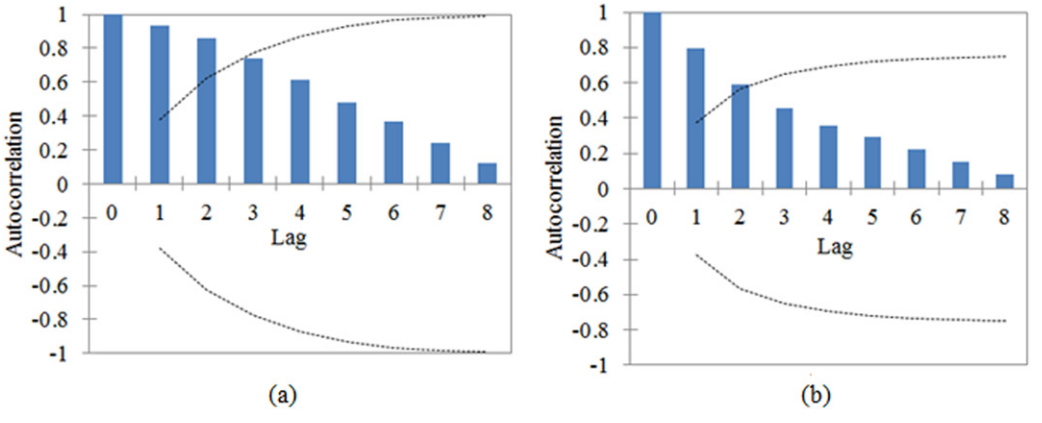

Figure 3. Autocorrelograms of the (a) consumption and (b) wealth series. Source: Authors' compilation, software generated.

Table 1. Results of the homogeneity tests for income (Y), wealth (W) and consumption (C).

	Pettitt		Buishand		SNHT	
Series	Reject H_0	Change point	Reject H_0	Change point	Reject H_0	Change point
Y	Yes	2003	Yes	2005	Yes	2006
W	Yes	2004	Yes	2005	Yes	2006
C	Yes	2002	Yes	2003	Yes	2004

Source: Authors' computations; software-generated data.

Table 2. Consumption function models: results.

	Estimated coefficients				
Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Y_t	1.082***	0.967***	0.111	1.190***	0.992***
Y_{t-1}		0.005			−0.145
C_{t-1}			0.876***		
W_t				−0.436**	0.126
W_{t-1}					−0.211
Constant (a_0)	0	9.148	3.380	0	4.444
R^2	0.977	0.788	0.935	0.979	0.835
F-statistic	1148.006***	42.820***	166.007***	591.815***	20.139***

***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.
Source: Authors' computations; software-generated data.

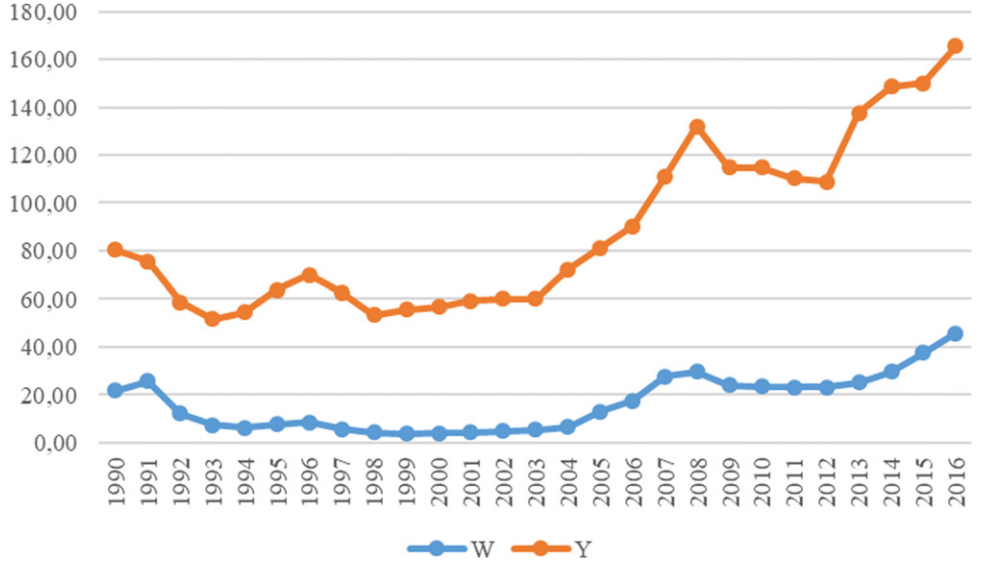

Figure 4. The evolution of households' income and wealth (1990–2016) (millions of Lei, comparable prices). Source: Designed by authors based on data available in (1995-2014) and Monthly Bulletins (2015, 2016).

For each model, the significance of the coefficients was tested, using the Student t-test and the significance of the model as a whole, using the F-test. The results of these tests are shown in Table 2.

From Table 2, it results that only in Models 1 and 4 are the variables significant. Therefore, consumption is influenced by current income and wealth, while previous

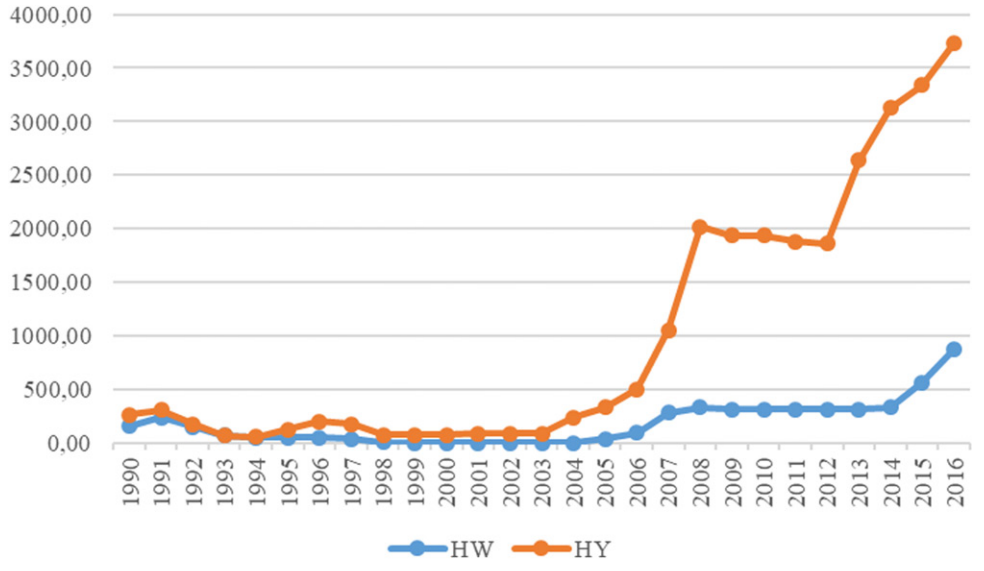

Figure 5. The evolution of income and wealth transformed in hysteresis time series (HY and HW) during 1990–2016. Source: Designed by authors based on data available in Statistical Yearbooks of Romania (1995–2014) and Monthly Bulletins (2015, 2016).

Table 3. Johansen Cointegration Test Summary for consumption, income, wealth and the transformed hysteresis time series (HY and HW).

Sample (adjusted): 1992 2015
Included observations: 24 after adjustments
Trend assumption: Linear deterministic trend
Series: DY DC DM HW HY
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None**	0.753063	77.23199	69.81889	0.0113
At most 1	0.612701	43.66509	47.85613	0.1172
At most 2	0.404726	20.89969	29.79707	0.3639
At most 3	0.264885	8.450076	15.49471	0.4186
At most 4	0.043389	1.064597	3.841466	0.3022

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesised No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.753063	33.56690	33.87687	0.0544
At most 1	0.612701	22.76540	27.58434	0.1837
At most 2	0.404726	12.44961	21.13162	0.5039
At most 3	0.264885	7.385479	14.26460	0.4446
At most 4	0.043389	1.064597	3.841466	0.3022

Max-Eigenvalue test indicates no cointegration at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Authors' computations; software generated data.

consumption, previous income, and previous wealth do not have a significant influence. The relationship between consumption and income is obvious and unquestioned. The relationship between consumption and wealth (with M_1 used as a proxy

for wealth) is consistent with previous studies conducted in Romania (Moraru & Moise-Titei, 2012).

In the second research phase, for the '*true*' hysteresis approach, only the variables found significant at the previous stage were taken into account as independent variables. These are income and wealth. During this phase, the stationarised series of income and wealth were transformed in hysteresis time series (HY and HW) using the algorithm suggested by Piscitelli et al. (2000), as presented in the previous sections of this paper.

Figures 4 and 5 show the evolutions of income and wealth between 1990 and 2016, before and after the hysteresis transformation, respectively.

The Augmented Dickey-Fuller (ADF) was applied to the hysteresis transformations of income (HY) and wealth (HW) and the stationarity hypothesis was not rejected.

Subsequently, the existence of cointegration relationships between the studied series was tested using the Johansen cointegration test, and the results are presented in Table 3.

The existence of cointegration relationships was not rejected at the significance level of 0.05.

5. Conclusions

We may therefore conclude that hysteresis in the case of consumption in Romania cannot be overruled, or, in other words, temporary influences on consumption determinants seem to have remanent effects on consumption. Our study revealed that income and wealth strongly influence consumption in Romania and that the presence of hysteresis cannot be denied. Therefore, the non-dominated shocks affect the equilibrium of the system. In other words, severe changes occurring in one or both of the independent variables determine a lasting impact on consumption.

It is our strong belief that decision makers should be aware of this reality and act accordingly; up to the present moment, however, this seems not to be the case. The effects of the economic crisis determined the government to adopt to adopt a series of austerity measures. Among those, some of the most controversial measures adopted in 2009 and especially in 2010 had a strong, unfortunate, and, one may add, lasting impact on consumption. These include, but are not limited to, the increase of VAT from 19% to 24%, the extensively debated and contested measure of cutting budgetary salaries by 25%, a 16% tax on deposit interests, capital market and monetary market operations income, and notable increases of local taxes as well. To sum up, the economic recovery policy focused on cutting salaries, pensions, subventions, social allowances, and unemployment benefits and at the same time on increasing numerous taxes. Even though some of the measures have been reversed since then, their effects are most likely to last for a significant length of time. Up to 2016, the level of households' consumption has maintained below the peak level registered in 2008, before the economic crisis.

Considering that the current economic context represents a favourable framework for empirical testing of hysteresis and may not only herald new opportunities for study but also set new directions for economic policy orientation, the present

paper aimed at following up the inclusion of the phenomenon at the level of macroeconomic consumption in Romania. The research results admitted the presence of hysteresis, thus revealing implications inaccessible by a different approach and pointing out several concerns regarding the effects of recently adopted economic measures on consumption in Romania.

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