JOURNAL of Applied Economic Sciences

JAES

Journal of Applied Economic Sciences

Volume XIII
Issue 7(61) Winter 2018

ISSN-L 1843 - 6110
ISSN 2393 - 5162

Editorial Advisory Board

JOURNAL
of Applied Economic Sciences

Journal of Applied Economic Sciences

Journal of Applied Economic Sciences is a young economics and interdisciplinary research journal, aimed to publish articles and papers that should contribute to the development of both the theory and practice in the field of Economic Sciences.

The journal seeks to promote the best papers and researches in management, finance, accounting, marketing, informatics, decision/making theory, mathematical modelling, expert systems, decision system support, and knowledge representation. This topic may include the fields indicated above but are not limited to these.

Journal of Applied Economic Sciences be appeals for experienced and junior researchers, who are interested in one or more of the diverse areas covered by the journal. It is currently published quarterly in 2 Issues in Spring (30th March), Summer (30th June), Fall (30th September) and Winter (30th December).

Journal of Applied Economic Sciences is indexed in SCOPUS www.scopus.com, CEEOL www.ceeol.org, EBSCO www.ebsco.com, and RePEc www.repec.org databases.

The journal will be available on-line and will be also being distributed to several universities, research institutes and libraries in Romania and abroad. To subscribe to this journal and receive the on-line/printed version, please send a request directly to jaes_secretary@yahoo.com.

Journal of Applied Economic Sciences

ISSN-L 1843 - 6110
ISSN 2393 – 5162

Table of Contents

Gender Differences in Behavior Patterns in Voluntary Pension Systems

Larysa YAKYMOVA
Department of Accounting and Taxation, Faculty of Finance, Entrepreneurship and Accounting
Yuriy Fedkovych Chernivtsi National University[24], Ukraine
l.yakimova@chnu.edu.ua larisa.p.yakimova@gmail.com

Suggested Citation:

Yakymova, L. 2018. Gender differences in behavior patterns in voluntary pension systems. *Journal of Applied Economic Sciences*, Volume XIII, Winter, 7(61): 2031 – 2041.

Abstract:

This article tests four hypotheses about gender differences related to membership in voluntary pension systems in Eastern European countries that belong to different groups "aging, early reformers" (Romania) and "aging, late reformers" (Ukraine). In order to test the hypotheses, we consistently applied three methods to time series of participants' growth rates in the Pillar III of Romanian and Ukraine pension systems: cyclical analysis of time series using the Hodrick-Prescott filter, fractal analysis by conducting Rescaled Range Analysis (R/S-analysis) of time series, and phase analysis of time series. All three methods have confirmed the hypothesis that the parameters of nonlinear behavior depend on gender. R/S-analysis showed that the behavior of men and women in both countries is antipersistent behavior with short-term memory, but the gender gap in Hurst exponent estimates is greater in Romania than in Ukraine. Using fractal and phase analysis, we confirmed the hypothesis that gender differences in behavior patterns increase as financial and stock markets develop, as the gender gap in financial knowledge increases. However, at given the level of significance, the hypothesis that economic fluctuations affect behavior patterns, and the level of influence depends on gender has not been confirmed.

Keywords: gender pension gap; Hodrick-Prescott filter; fractal analysis; phase analysis; quasi-cycle; Romania; Ukraine

JEL Classification: C52; D14; J32

Introduction

The pension crisis of provision in the context of global demographic aging and gender differences in both the labor market and financial literacy lead to an uneven gender structure of beneficiaries of pensions in modern society. The average EU28 gender pension gap in 2014 stood at 40.2% (40.7% in 2013). In many Eastern European countries, the gender pension gap tends to be much lower than in Western Europe (e.g. the gap in Romania in 2013 stood at 28.1%, but in 2014 it increased to 35.3%) (Lodovici *et al*. 2016). This is due to the fact that in Eastern European countries gender differences in the use of part-time work are less pronounced, as well as low pension incomes for men and women. The pension gap is much higher than the average EU gender pay gap (16.1% in 2014) (Lodovici *et al.* 2016). This raises the question of whether there are differences in the behavior of men and women in voluntary pension systems, which will lead to a gender gap in private retirement income? The purpose of this study is to test four hypotheses about behavior patterns regarding membership in voluntary pension systems, using data from the 3rd pillar of pension systems in Romania and Ukraine: H1: Parameters of nonlinear (cyclical) behavior depend on gender; H2: Economic fluctuations affect behavior patterns, and the level of influence depends on gender; H3: Behavior patterns are fractal in nature, and fractal properties depend on gender; H4: Gender differences in behavior patterns increase as financial and stock markets develop, as the gender gap in financial knowledge increases.

1. Literature Review

Issues related to gender differences in pension provision have been the topic of scholarly research since the 1980s. Basically, these are studies of gender gaps in such aspects as (i) pension coverage and retirement income, (ii) retirement patterns, and (iii) decisions on pension investments or retirement savings. The studies were based on data from different countries and used different methods.

Even and Macpherson (1994) used multivariate analysis to examine the gender gap in employee pension coverage and benefits in the US. They showed that the gap in coverage will be higher among the retired than the employed, since (i) the proportion of women in the labor force is lower than that of men, and (ii) pension coverage for women is less likely to convert into retirement benefit because they have shorter job tenure on average, but (iii) the gender gap in coverage narrowed significantly during the 1980s due to the convergence of labor market

[24] Kotsyubynsky St. 2, Chernivtsi, 58012, Ukraine

characteristics for men and women. It is likely that the convergence of the characteristics of the male and female labor markets has led to a reduction in the gender gap in the coverage of private pension systems in many countries. For example, a later study (Antolin *et al.* 2012) showed that in Germany, the UK and the US, the gender gap in coverage of private pension plans is negligible; the largest gender gap is observed in the Netherlands (16.4 percentage points), followed by Ireland (10.3 p.p.), Italy (5.4 p.p.), and Spain (3.0 p.p.). At the same time, Barrientos (1998) concludes that in Chile, the absence of a gender gap in private pension coverage is largely due to the "women's strong pension propensities and pension plan design".

Bardasi and Jenkins (2010) study the gender gap in private pensions in Britain, applying the Gomulka-Stern and Blinder-Oaxaca decomposition methods to a joint model of the probability of private pension income receipt and of private pension income amounts conditional on receipt; and show that "gaps are associated mainly with gender differences in returns to personal characteristics rather than with gender differences in personal characteristics per se". Ezeyi and Vujic (2017) investigate the gender gap in state and private pensions in England, also using the Blinder-Oaxaca decompositions and quantile regressions. They found the gender pension gap is more marked for private pensions than state pensions and the gender differentials in characteristics matter more for private pension coverage rates than private pension income levels. Using scenario modeling and actuarial calculations, Belloni and Fornero (2008) examine how a working career affects gender differences in retirement income and offer options for correcting the Defined Benefit (DB) scheme to improve the relative position of women with discontinuous or poor careers.

Other studies have found that there are gender differences in retirement patterns. For example, Dahl *et al.* (2002) investigated gender differences in early retirement behavior in Norway and, using a competing risk model, found that women are less likely to take early retirement compared to men and that these differences are due to both different characteristics and different behaviors. Using a multinomial logistic regression model and a model of phased retirement, Cahill *et al.* (2013) came to the conclusion that gender differences with respect to the retirement patterns of the Early Boomers in the US "are more the result of macroeconomic influences that have had a disproportionate impact on men and women, most notably through involuntary transitions from career employment and the likelihood of finding subsequent bridge employment".

The third area of research concerns gender differences in making decisions on pension investments or pension savings. Hinz *et al.* (1997), using the Tobit models, find that women invest in lower-risk pension portfolios than men, and as a consequence, they hold less in the stock funds than men. Bajtelsmita *et al.* (1999) also confirm that women are not prone to risk in making pension decisions, and it is likely that they will retire with much lower pensions than men. In the study, the authors used probit regression and estimated the coefficient of relative risk aversion based on the allocation of wealth into Defined Contribution (DC) pensions. Gerrans and Clark-Murphy (2004) revealed gender differences in the decisions of Scheme for Australian Universities members who were presented with a choice between staying with a DB Fund or moving to one of four Investment Accumulation Accounts strategies; a logistic regression framework was used to examine the choices. However, as well as in previous studies, the gender gap is not uniform and "can be demonstrated as depending on marital status, whether the member considered themselves informed and age". Foster and Smetherham (2013) examined the impact of various characteristics on the on the likelihood of women contributing to a private pension, such as educational attainments, income, occupational group, full-time/part-time status, and whether an individual has any dependent children.

In this regard, should be noted that financial literacy is closely tied to retirement planning and retirement wealth accumulation (Lusardi and Mitchell 2011). For example, Behrman *et al.* (2010) showed this using an instrumental variable approach. In addition, Lusardi and Mitchell (2008, 2011) indicate a common pattern: women are less financially literate than men, and are less likely to plan retirement and be successful planners. Lusardi *et al.* (2014) using multiplicative regression models of financial sophistication showed that older women are consistently less financially savvy than men.

Our study differs from the studies mentioned above in the following aspects. First, in our study, special attention is paid to the nonlinear behavior of participants in voluntary pension provision and the impact of economic cyclicality on this behavior. Secondly, our data allow us to identify gender differences in behavior patterns regarding membership in voluntary pension systems in Eastern European countries that belong to different groups according to Chawla *et al.* (2007): "aging, early reformers" (Romania) and "aging, late reformers" (Ukraine). Finally, we are trying to use a combination of methods (cyclical, fractal, and phase analysis of time series) that were not previously used in studies of gender pension differences.

2. Methodology

To test these hypotheses about behavior patterns regarding membership in voluntary pension systems, we use the time series of the growth rates of participants in Pillar III of the Romanian and Ukrainian pension systems (referred to here as the pension time series). We are interested in using and comparing three types of assessments (analysis) of non-linear behavior of men and women: (i) cyclical analysis of pension time series using Hodrick-Prescott filter (HP filter); (ii) fractal analysis by conducting Rescaled Range Analysis (R/S-analysis) of pension time series, and (iii) phase analysis of pension time series.

In order to identify long-term trends and possible cyclical fluctuations using the HP filter (Hodrick and Prescott 1997), the time series of participants' growth rates $Y = (y_1, y_2, \ldots, y_T)'$ are decomposed into a trend component $\tau = (\tau_1, \tau_2, \ldots, \tau_T)'$ and a cycle component $C = (c_1, c_2, \ldots, c_T)'$. Mathematical details are described in more detail in our previous paper (Yakimova 2018). To identify the turning points of cycles, the so-called peaks and troughs, we use a modified empirical rule of "two consecutive negative (positive) growth rates" (Krznar 2011): the point c_t is the turning point if (i) $\Delta c_t > 0$ and $\Delta c_{t+1} < 0$ and $\Delta c_{t+2} < 0$ for peak; (ii) $\Delta c_t < 0$ and $\Delta c_{t+1} > 0$ and $\Delta c_{t+2} > 0$ for trough. As for the length of the cycle, the "cycle can be defined from trough to trough or from peak to peak; the choice is largely a matter of convention" (Fuchs 1968, p. 162). We will define the cycle "from trough to trough".

For the analysis of cycling, volatility and persistence of time series of cyclical components are calculated. The formal measure of the persistence of cycles (cyclical persistence) is the autocorrelation coefficient $r_1 = \text{corr}(c_t, c_{t-1})$. The volatility of participants' growth rates is used not only to compare male and female behavior, but is also important for determining the impact of economic fluctuations and to assess the sustainability of pension systems since volatility is synonymous with risk. The formal measure of absolute volatility of cyclical fluctuations (cyclical volatility) is the standard deviation of the series σ_c.

To identify the relationship between economic fluctuations and the behavior of men and women in the private pension market, relative cyclical volatility is used, calculated as the ratio of standard deviations of pension time series σ_c and time series of GDP growth σ_{c_GDP}; GDP growth is used as a measure of the business cycle.

In addition, the types of behavior patterns in relation to the business cycle and timing are determined. Algorithm for identifying behavior patterns in relation to economic fluctuations is the standard testing of significance of the correlation coefficient $\rho(0) = \text{corr}(c, c_{GDP})$ using the Student t-test. Checks the null hypothesis H_0: $\rho(0) = 0$, *i.e.*, the correlation coefficient is insignificant, and the behavior is acyclic. An alternative hypothesis (H_A: $\rho(0) \neq 0$) is divided into two hypotheses: H_{A1}: $\rho(0) > 0$, *i.e.*, the correlation coefficient is significant, and the behavior is pro-cyclical; H_{A2}: $\rho(0) < 0$, *i.e.*, the correlation coefficient is significant, and the indicator is countercyclical. The probability of a type I error or significance level in this study is set at $\alpha \leq 0.05$.

The identification of timing types of behavior patterns is based on the following rules: (i) if the cross-correlation coefficient reaches its maximum $\rho_{max}(k) = \max\{\rho(k) = \text{corr}(c_{t+k}, c_{GDPt})\}$ at $k < 0$, the behavior is a leading indicator of business cycle turning points (the behavior outstrips the business cycle for k periods) with a given level of significance α; (ii) if $\rho_{max}(k)$ at $k > 0$, the behavior is a lagging indicator (the behavior lags behind the business cycle for k periods); (iii) if $\rho_{max}(k)$ at $k = 0$, the behavior is a coincident indicator. It is important to note that when identifying the types of behavior patterns, time series of normalized cyclic components are used.

To test the fractal properties of pension time series, we will use Rescaled Range Analysis (R/S-analysis) (Peters 1994, 1996). Peters extended Hurst's method of studying time series of natural phenomena (Hurst 1951) to time series in the economy and capital markets. The measure of the smoothness of fractal time series is the Hurst exponent. In order to calculate the Hurst exponent, we use OLS for estimating the unknown parameters in the logarithmic version of Hurst's equation, *i.e.:*

$$\log(R/S)_n = \log(c) + H \cdot \log(n) \quad (1)$$

where: $(R/S)_n$ is the average value of the rescaled range of cumulative deviations for each sub-periods of length n, H is the Hurst exponent, and c is a constant.

For details, see Peters (1996, 62-63), Kale and Butar (2011, 11-12).

The Hurst exponent H is directly related to the fractal dimension Df, which measures the smoothness of a surface (in this study, the smoothness of pension time series). A direct relation between Df and H is: $Df = 2 – H$. In order to analyze the behavior of participants in voluntary pension systems (including pension time series graphs), the properties of the Hurst exponent H and the fractal dimension Df can be summarized as follows:

- $0 < H < 1$ and $1 < Df < 2$;
- $H = 0.5$ reflects the Brownian motion (random walk); the fractal dimension $Df = 1.5$ half away from 1 (the Euclidean dimension of a line) and 2 (the Euclidean dimension of a plane).

- $H < 0.5$ reflects anti-persistent behavior with short-term memory (the correlation between the past and the future is negative); the fractal dimension $Df > 1.5$, and the pension time series graph is a more jagged curve than for a random walk; each positive "tooth" is almost always compensated by a negative "tooth" of a similar size, and vice versa (reversion to the mean).
- $H > 0.5$ reflects persistent, inertial behavior with long-term memory (the correlation between the past and the future is positive); the fractal dimension $Df < 1.5$, and the time series graph is a less "noisy" (smoother) curve than for a random walk.

It should be noted that "the term "fractional noise" is justified by considerations from spectral theory" (Mandelbrot and Wallis 1969). The noise color for the time series will be determined as follows (Mandelbrot and Wallis 1969, Chardantsev 2005): (i) the value of H in the neighborhood of 0.5 ± 0.1, *i.e.* in the interval (0.4, 0.6) characterizes white (Gaussian) noise; (ii) 0.3 ± 0.1 (0.2, 0.4) is pink noise; (iii) (0, 0.1) is red noise (also known as Brown noise); (iv) (0.6, 1) is black noise or is practically absent.

Thus, in the black noise range, the time series show the maximum persistence, and the memory (cycles) has the greatest length; in the red noise range, the time series show the maximum anti-persistence and the highest volatility, and the memory (cycles) has the smallest length, in other words, behavioral memory is practically nonexistent. To find the length of the memory (the length of cycles), uses the V-statistic of periodicity, determined by the formula:

$$V_n = (R/S)_n / \sqrt{n}. \quad (2)$$

Peters (1996) proposes to draw a curve in the coordinates $log(n) - V_n$; this ratio shows an obvious maximum when R/S ceases to grow as a square root of time. This is often a sign of the existence of a periodic or non-periodic cycle (this maximum should be insensitive to the time step in the initial time series).

Finally, in order to clarify the cyclic properties of time series of participants' growth rates, we use phase analysis. The analysis procedure involves three basic steps.

Step 1. Choice of the dimension ρ of the phase space $\Phi(Y) = \{(y_i, y_{i+1})\}$, $i = 1, 2, \dots n\text{-}1$. For economic time series, and consequently pension series, it is sufficient to construct a phase portrait in a phase space of dimension $\rho = 2$.

Step 2. Restoration of the phase portrait. In order to construct a true phase space, it is necessary to know all the variables relevant to the system. Packard *et al.* (1980) described a simple method developed by David Ruelle to reconstruct the phase space from one dynamic variable. This method fills other dimensions by delaying the values of one observable variable (Peters 1996).

Step 3. Decomposition of the phase portrait into quasi-cycles. The decomposition of the phase portrait into quasi cycles is essentially based on visualization of the graphical representation of the fragments of the phase portrait. The difference between a "quasi-cycle" and a "cycle" is as follows: (i) the initial and final points of the quasi-cycle do not necessarily have to coincide; (ii) the final point of a quasi-cycle is determined by its occurrence in a neighborhood of the initial point; (iii) self-intersection of the initial and final links of a quasi-cycle is allowed, if this leads to the best approximation of its initial and final points.

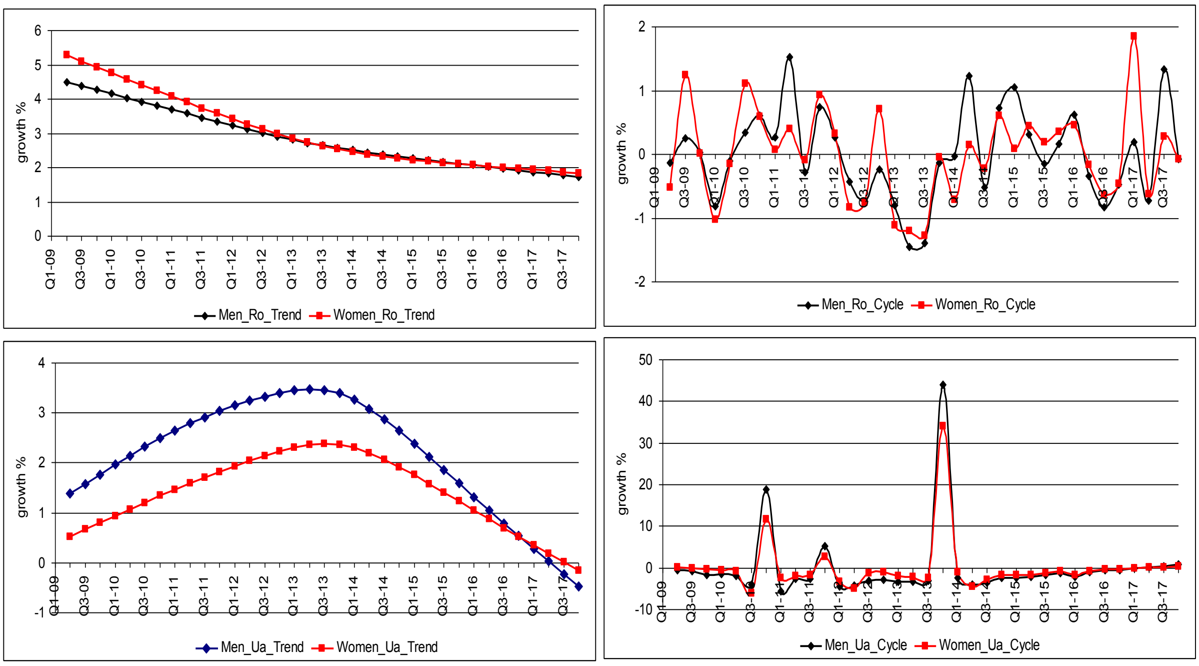
It is important to note that this procedure does not provide statistical analysis, since a short history of voluntary pension provision causes small samples.

3. Case studies

The comparative study of gender differences in behavior patterns was carried out based on data on the number of participants in Pillar III in Romania and Ukraine collected from official websites (Financial Supervisory Authority 2018; National Commission for Regulation of Financial Services Markets 2018). In order to correctly compare gender gaps in these countries, we studied quarterly series for the period 2009 through 2017; in order to identify the gender gap in Romania, we further investigated the monthly series for the period 31.12.08 through 31.12.17; we deliberately did not make a seasonal adjustment, since the purpose of this study is a comparative analysis of actual pension behavior.

In order to conduct a cyclical analysis of time series of participants' growth rates, we have decomposed all the series into trends and cycles using the HP filter with a smoothing parameter is $\lambda = 1600$ for quarterly data. Figure 1 illustrates the following differences in the behavior of men and women. In Romania, there is a steady decreasing trend for both men and women, but the rate of reduction in the growth of new female participants is greater than that of male participants. How can this be explained? Probably, women more trusted the new pension system with its introduction, but the desire to participate in it was lost faster than for men. Curves of cyclic components also show greater instability in the behavior of women than men; as a rule, the amplitude of cyclical fluctuations for time series of women is greater; nevertheless, the timing of peaks and troughs tend to coincide.

Figure 1. Trends and cyclic components of time series of participants' growth rates in Romanian and Ukrainian voluntary pension systems by gender (quarterly aggregation)



Source: Author's elaboration based on Financial Supervisory Authority (2018) and National Commission for Regulation of Financial Services Markets (2018)

Figure 1 also illustrates the dates of the turning points of cycles that were defined by the empirical rule. For the time series of men, these are troughs: Q1-10, Q2-13, Q3-16; and peaks: Q2-11, Q2-14, Q3-17. For the time series of women these are troughs: Q1-10, Q3-13, Q3-16; and peaks: Q3-11, Q4-14, Q1-17. It should be noted that "unstable" turning points have been identified, for example, in the second cycle of men there are two "unstable" troughs Q3-14 and Q3-15 (for them $\Delta c_{t+3} < 0$). Probably, beginning in 2014, the effect of the third quarter (Q3-trough) is observed in the pension behavior of men. This same calendar anomaly is also observed in the behavior of women, but not so steadily as in the behavior of men. Thus, the lengths of quasi-cycles, taking into account the unstable troughs, are equal to 4, 5, 13 quarters for men and 4, 5, 8, 9 quarters for women. But we recall that to refine the length of quasi-cycles, we will additionally use other methods of analysis.

In Ukraine, trends for both men and women are bell-shaped curves with a peak in 2013 (Q2-13 for men and Q3-13 for women). The crisis of 2013-2014, the subsequent annexation of territories, military actions and the resulting economic downturn caused an outflow of participants, and the pre-crisis rising trend has not recovered.

With regard to gender differences, unlike Romania, first, the growth rate at the beginning and the rate of decline at the end is greater in men than in women; secondly, the amplitude of cyclical fluctuations of male time series is greater; but in time, the significant peaks and troughs usually coincide (as well as in Romania). Thus, in the time series of women four troughs Q1-11, Q2-12, Q2-14, Q1-16 was identified (quasi-cycles are equal to 5, 7 or 8 quarters); and in the time series of the men five troughs Q1-11, Q1-12, Q2-13, Q2-14, Q1-16 (quasi-cycles are equal to 4, 5, 7 quarters). It is noteworthy that in Ukraine, unlike Romania, the calendar anomaly is manifested by the effect (Q1/Q2-trough) of the beginning of the year.

Table 1 shows the results of estimating the cyclical persistence and volatility of time series of participants' growth rates; a comparison of estimates with the visually identified gender differences shows good agreement. All correlation coefficients r_1 are insignificant at $\alpha \leq 0.05$, thus cyclical fluctuations of all time series are antipersistent; but "slightly more persistent" were the cycles of growth rates of male participants, both in Romania and in Ukraine. In Romania, absolute and relative cyclical volatility of the growth rates of female participants are greater than that of male participants, and in Ukraine, on the contrary; but in Romania, the gender gap is 1.6%, and in Ukraine is 32.3%. This result contradicts the hypothesis H4, we will further refine it using a more reliable mathematical toolkit. The relative cyclical volatility of all time series is less than 1, which means that the amplitude of fluctuations in pension behavior of men and women both in Romania and Ukraine is less than the amplitude of fluctuations in national business cycles.

For all series, the hypothesis H_0: $\rho(0) = 0$ was confirmed, thus all behavior patterns are acyclic, and the participants' growth rates have no relation to the health of the economy in both Romania and Ukraine. The values of the cross-correlation coefficients $\rho(k)$ ($k = 1, 2, 3, 4$) are also statistically insignificant at a given significance level of 0.05, so synchronism with business cycles could not be established. Thus, we reject the hypothesis H2 that economic fluctuations affect behavior patterns, and the level of influence depends on gender.

Table 1. Cyclical analysis of time series of participants' growth rates

Country	Gender	Aggregation level	Cyclical persistence	Absolute cyclical volatility	Relative cyclical volatility	Relation to the economy
Romania	Men	quarterly	0.2023	0.6997	0.5885	acyclic
	Women	quarterly	0.0289	0.7114	0.5984	acyclic
	Total	quarterly	0.1409	0.6459	0.5433	acyclic
Ukraine	Men	quarterly	–0.1150	8.5248	0.4923	acyclic
	Women	quarterly	–0.1014	6.4479	0.3723	acyclic
	Total	quarterly	–0.1110	7.5823	0.4378	acyclic

Source: Author's calculations based on Financial Supervisory Authority (2018), National Commission for Regulation of Financial Services Markets (2018), National Institute of Statistics (2018), and State Statistics Service of Ukraine (2018)

In order to test the H3 hypothesis about the fractal nature of behavior patterns, and also to strictly identify the cycles and memory depth, we apply Rescaled Range Analysis (R/S-analysis). It should be noted some features of the application of R/S-analysis to identify and compare the gender gap in pension behavior. First, we used the same time interval and aggregation level (for comparison by country). But since the history of private pension provision is short, we have short time series; this can lead to a bias of the estimates of fractal analysis. Secondly, the pension time series were normalized to have a mean of 100% and a unit variance. Thirdly, to calculate the values of R/S(n), we used the Peters approach (Peters 1994), that is, we used the values of n, which are dividers of the total number of observations. Thus, all R/S-values use all the data, but the number of quarterly data was reduced to 30, and the monthly data to 100. Therefore, we first processed the first 30 (100) data, then the last; this is because the R/S-analysis should not be sensitive to the starting point if there is enough data.

Table 2 shows that all values of the Hurst exponent $H < 0.5$ (values of the adjusted multiple coefficient of determination (Adj. R^2) and p-values indicate a good fit of all Hurst regressions and the statistical significance of all estimates of the Hurst exponents). This means that the behavior of both men and women, both in Romania and in Ukraine, is an anti-persistent behavior with short-term memory. The graphs of the cyclical components in Figure 1 confirm that with fractional noise at $H < 0.5$ large positive deviations are accompanied by large negative deviations and vice versa. At the same time, there are some differences.

Table 2. Rescaled range analysis of time series of participants' growth rates

Country	Gender	Aggregation level	Hurst exponent	*P*-value	Avg. R^2	Fractal dimension	Fractional noise
Romania	Men	monthly	0.4020	0.0004	0.9582	1.5980	white
	Women	monthly	0.4106	0.00001	0.9939	1.5894	white
	Total	monthly	0.3363	0.0005	0.9532	1.6637	pink
	Men	quarterly	0.4635	0.0004	0.9862	1.5365	white
	Women	quarterly	0.3629	0.0359	0.7532	1.6371	pink
	Total	quarterly	0.3320	0.0102	0.8905	1.6680	pink
Ukraine	Men	quarterly	0.4259	0.0003	0.9904	1.5741	white
	Women	quarterly	0.4853	0.0002	0.9924	1.5147	white
	Total	quarterly	0.4598	0.00003	0.9978	1.5402	white

Source: Author's calculations based on Financial Supervisory Authority (2018) and National Commission for Regulation of Financial Services Markets (2018)

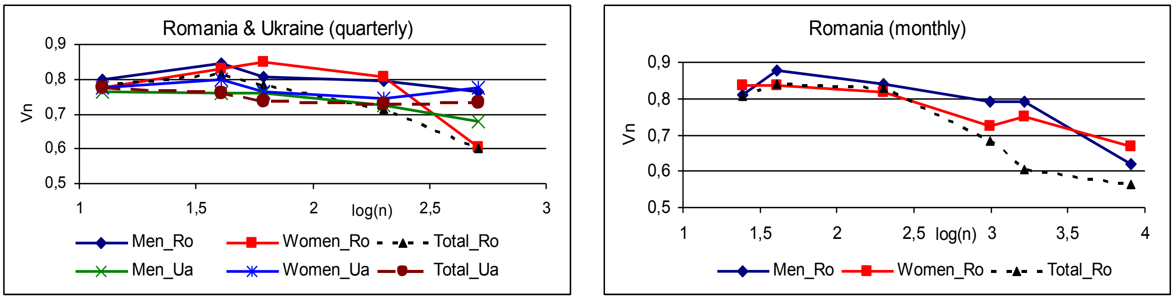
Monthly aggregation produced Hurst exponent estimates at the lower boundary of the white noise range ($H_m = 0.40$ for males and $H_w = 0.41$ for females), but the overall behavior is already in the pink noise range ($H_t = 0.34$); the gender gap is not statistically significant. To compare pension behavior by gender and countries, we use quarterly aggregation. In this case, there is a significant difference in the behavior of men and women in Romania ($H_m = 0.46$ and $H_w = 0.36$). The more unstable (pink noise) is the behavior of women, the length of their memory and cycles is shorter. In Ukraine, the gender gap in pension behavior is less pronounced and reverse

(H_m = 0.43 and H_w = 0.49). Thus, using Hurst exponent estimates, we can conclude that the gender gap in pension behavior is 27.7% in Romania and –12.2% in Ukraine. Why is there a larger gender gap in Romania? The answer to this question is as follows. Pension behavior depends on the ability to plan voluntary retirement savings and assess long-term risks, *i.e.* depends on financial literacy. In this sense, our result correlates with the conclusion of Lusardi and Mitchell (2011) that “in Russia and for residents of East Germany, there are no sex differences in financial knowledge–and both women and men are equally financial illiterate”. At the same time, a comparison of East and West Germans showed: (i) West Germans are the most financially literate; (ii) financial literacy in the West is much lower for women than for men. Hence, we can conclude that in the Western countries the gender gap is greater than in Eastern Europe. Hence, we can conclude that in the Western countries the gender gap is greater than in Eastern Europe.

In our case, the difference is not very large, since both countries have a common socialist past, but in Romania it was "shorter", and Romania more quickly integrated into the European Union, and this is reflected in behavioral patterns. The Hurst exponent estimates for total pension behavior in Romania and Ukraine (H_{ro} = 0.33 and H_{ua} = 0.46) lead to mixed conclusions. In Romania, Hurst exponent is closer to zero, so the volatility of pension behavior is more pronounced and, accordingly, the risk of a private pension system is higher. In Ukraine, a large H value shows less "noise", and points to a more pronounced fractal nature. This means that the risk of a large deviation (black swan) is much higher than implies a normal distribution (as was the case in the past, see Figure 1). At the same time, these jumps and a following drop in the growth of participants are explained by the fact that employers periodically use the policy of "nudge" (and, perhaps, even stronger techniques), *i.e.* the process of joining professional and corporate pension funds is a partially controlled process. Accordingly, the gender gap in employment in industry explains the larger jumps in the growth of men. In addition, the gender gap in the labor market is the reason for the gender gap in the coverage of voluntary pension provision. In Ukraine, the total coverage is 2.31% of the population over the age of 15, the coverage of men is 2.97%, and the coverage of women is 1.76%; while in Romania, the total coverage is 2.74%, the coverage of men is 2.80%, and the coverage of women is 2.69%. Thus, our data support the findings of Even and Macpherson (1994) that, due to the development of the labor market, its characteristics for men and women converge, and as a result, the gender gap in coverage is reducing.

The values of the Hurst exponent in the Table 2 show that there is no long-term memory in all series, but to clarify, we calculated and analyzed the V-statistics for all pension time series. The $log(n) - V_n$ plots for quarterly aggregation (see Figure 2) show that the "breakdown" of the trend occurs at the second or third points, that is, the estimated memory length is approximately the same for all and is equal to 5-7 quarters. As for the monthly aggregation for Romania, the first local maximum of the V-statistics of the time series of men is the second point, and the second local maximum is the fifth point; for the time series of women, the local maximum at the fifth point (although the second point is not the maximum, but after it the trend begins to decline). This means that the estimated length of the memory of men is 5 months and 25 months (or 6.25 quarters), and women–25 months. The question arises: why is the motion of V-statistics fundamentally different for approximately equal values of the Hurst exponent? We will try to find the answer by using the phase analysis.

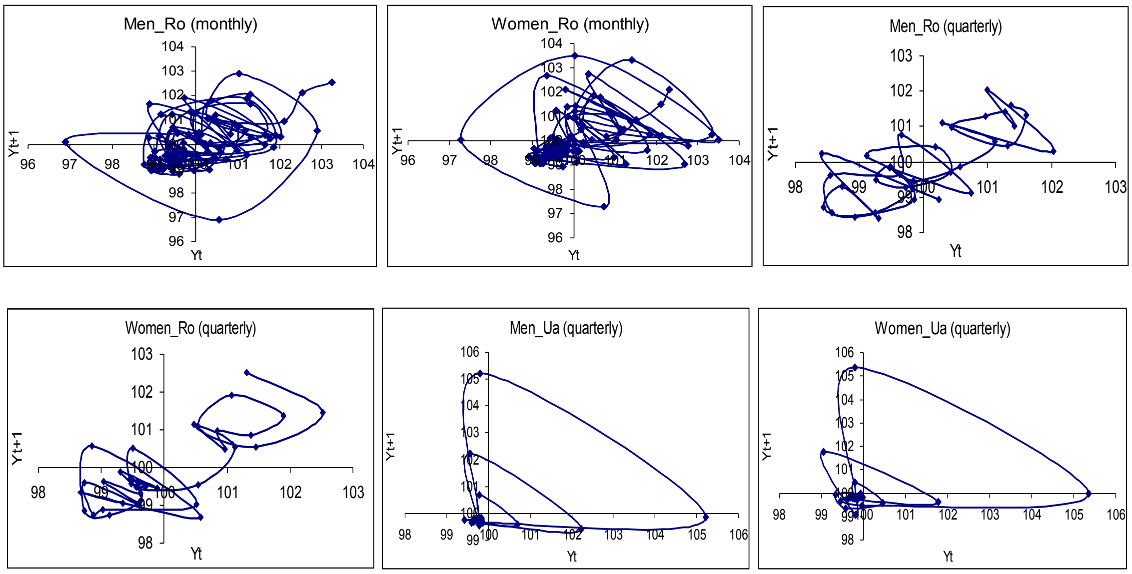
Figure 2. V-statistics related to time series of participants' growth rates (quarterly and monthly aggregation)



Source: Author's elaboration

Figure 3 illustrates the phase portraits of time series of participants' growth rates in Romanian and Ukrainian voluntary pension systems separately for men and women and for quarterly and monthly aggregation. The phase portraits reflect significant differences between countries and insignificant gender differences within each country. Nevertheless, the cycling of the time series of men is more persistent than that of women (especially in Romania). These conclusions are consistent with estimates of the persistence of time series of cyclical components (see Table 1) and fractal characteristics (see Table 2).

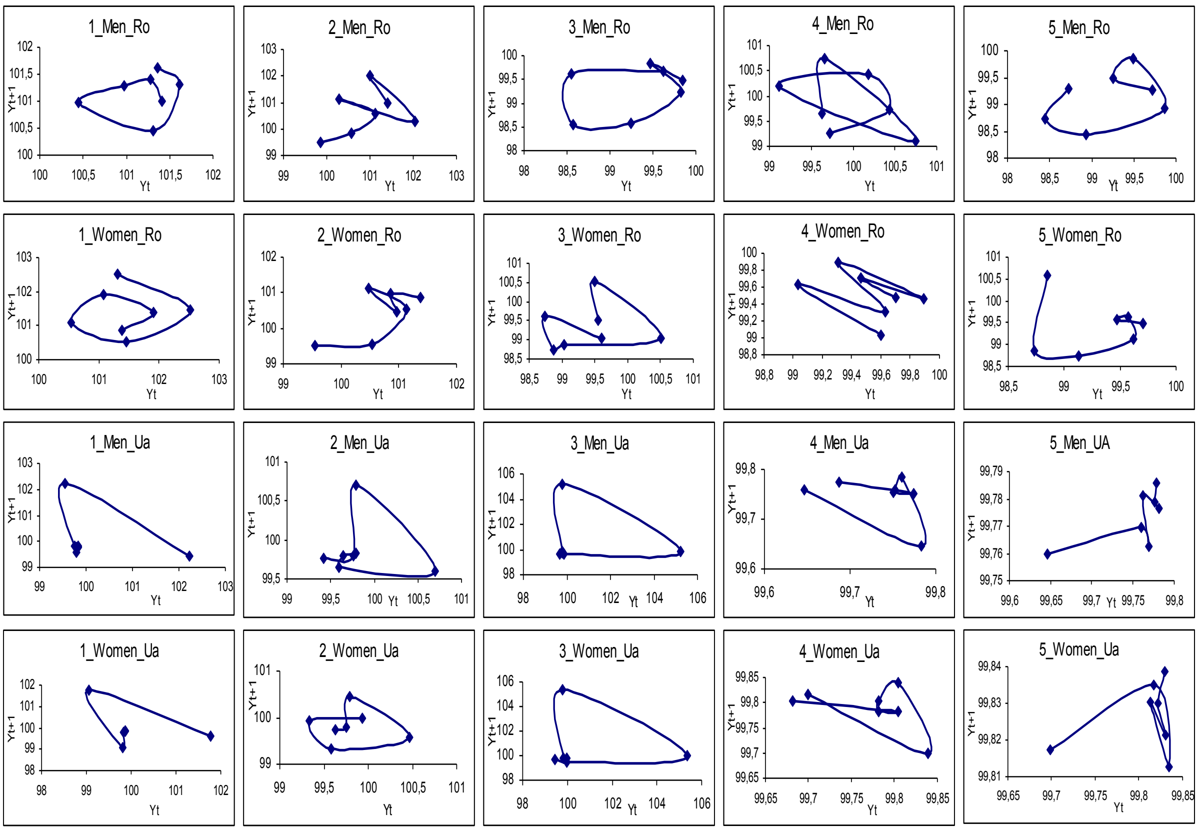
Figure 3. Phase portraits of time series of participants' growth rates (quarterly and monthly aggregation)



Source: Author's elaboration based on Financial Supervisory Authority (2018) and National Commission for Regulation of Financial Services Markets (2018)

The decomposition of phase portraits (quarterly aggregation) into quasi-cycles showed that for all pension time series, the greatest number of completed quasi-cycles with a length of seven quarters is observed. Figure 4 shows that for Romania, the time series of the growth rate of men actually consists of four seven-quarter completed quasi-cycles, and women–of two quasi-cycles; for Ukraine, both time series consist of three seven-quarter quasi-cycles, and the forms of quasi-cycles are almost identical.

Figure 4. Decomposition of the phase portraits into quasi-cycles (quarterly aggregation)



Source: Author's elaboration based on Financial Supervisory Authority (2018) and National Commission for Regulation of Financial Services Markets (2018)

This again confirms the hypothesis that gender differences in behavior patterns increase as financial and stock markets develop, as the gender gap in financial knowledge increases. It should be further noted the following, the Hurst exponent value for women in Ukraine is higher than for the men of Romania (see Table 2); but since the difference is insignificant, it was expressed in a more qualitative form, but in fewer quasi-cycles of time series of Ukrainian women.

As for the monthly aggregation for Romania, the decomposition of phase portraits into quasi-cycles gave the following results: (i) the time series of men has 13 completed five-month quasi-cycles (out of 21 possible); (ii) in the time series of women there are only 7 such quasi-cycles; (iii) for both women and men, completed quasi-cycles 25 months long are two out of four and all of them are self-intersecting. The result obtained illustrates the approximate equality of the Hurst exponents.

Conclusion

The main purpose of this study was to test four hypotheses about behavior patterns regarding membership in voluntary pension systems. Nevertheless, when we investigated these hypotheses using data from Romania and Ukraine, not all of them were confirmed. Cyclical analysis of time series using the Hodrick-Prescott filter: (i) long-term trends differ in the rate of growth, but significant gender differences were not found in the forms of the curves in both Romania and Ukraine; (ii) cyclical fluctuations of all time series are antipersistent, but in both countries "slightly more persistent" were the cycles of growth rates of male participants; at the same time, in Ukraine, unlike Romania, the cyclical volatility of the growth rates of male participants is significantly larger than female participants (we explain this paradox using the policy of "nudge" and the gender gap in employment in industry); (iii) hypothesis H2 was not confirmed for both countries at a given significance level of 0.05. To test hypothesis H3, R/S-analysis was used; Hurst exponent estimates for all series are less than 0.5 (p-values <0.05), *i.e.* the behavior of men and women in both countries is an anti-persistent behavior with short-term memory; the gender gaps in Hurst exponent estimates are 27.7% in Romania and –12.2% in Ukraine. Using fractal and phase analysis, we confirmed the H4 hypothesis that gender differences in behavior patterns increase as financial and stock markets develop, as the gender gap in financial knowledge increases. On the other hand, the gender gap in the coverage of the population by voluntary pension provision is declining as the characteristics of the male and female labor markets converge.

Since in this study not all issues of gender differences are considered, the future research directions are as follows. First, hypothesis testing based on data from two countries is probably not sufficient, so future studies need to use data from other countries. Secondly, it is necessary to identify and compare factors that affect gender differences in behavior patterns in these countries. Thirdly, it is necessary to identify whether there is a gender gap in pension contributions and with what factors it correlates. The results of these studies will be most useful to pension policy makers.

References

[1] Antolin, P., Payet, S., and Yermo, J. 2012. Coverage of Private Pension Systems: Evidence and Policy Options. *OECD Working Papers on Finance, Insurance and Private Pensions*, 20: 1–36. DOI: http://dx.doi.org/10.1787/5k94d6gh2w6c-en

[2] Bajtelsmita, V.L., Bernasekb, A., and Jianakoplosb, N.A. 1999. Gender differences in defined contribution pension decisions. *Financial Services Review*, 8: 1–10.

[3] Bardasi, E., and Jenkins, S.P. 2010. The gender gap in private pensions. *Bulletin of Economic Research*, 62(4): 343–363. DOI: 10.1111/j.1467-8586.2009.00336.x

[4] Barrientos, A. 1998. Pension reform, personal pensions and gender differences in pension coverage. *World Development,* 26(1): 125–137. DOI: https://doi.org/10.1016/S0305-750X(97)10009-2

[5] Behrman, J.R., Mitchell, O.S., Soo, C., and Bravo, D. 2010. Financial literacy, schooling, and wealth accumulation. *PARC Working Paper Series*, 32: 1–42.

[6] Belloni, M., and Fornero, E. 2008. Gender differences in retirement income and pension policy: simulating the effects of various DB and DC schemes. *ENEPRI Research Report*, 59: 1–21.

[7] Cahill, K.E., Giandrea M.D., and Quinn, J.F. 2013. Are gender differences emerging in the retirement patterns of the early boomers? *BLS Working Paper*, 468: 1–46.

[8] Chardantsev, A.V. 2005. *Opredeleniye «prognoziruyemosti» ekonomicheskikh protsessov* [Definition of "predictability" of economic processes]. PhD diss., Stavropolskiy gosudarstvennyy agrarnyy universitet.

[9] Chawla, M., Betcherman, G., Banerji, A. 2007. *From red to gray: The "third transition" of aging populations in Eastern Europe and the former Soviet Union*. The World Bank, Washington, D.C. DOI: 10.1596/978-0-8213-7129-9

[10] Dahl, S., Nilsen, O.A., and Vaage, K. 2002. Gender differences in early retirement behaviour. *IZA Discussion Paper*, 522: 1–38.

[11] Even, W.E., and Macpherson, D.A. 1994. Gender Differences in Pensions. *The Journal of Human Resources,* 29(2): 555–587. DOI: 10.2307/146110

[12] Ezeyi O. and Vujic S. 2017. Twin peaks: an analysis of the gender gap in pension income in England. Paper presented at the *Twenty-Second Annual Conference of the Society of Labor Economists*, May 5–6, in Raleigh, NC, USA.

[13] Foster, L., and Smetherham, J. 2013. Gender and pensions: an analysis of factors affecting women's private pension scheme membership in the United Kingdom. *Journal of Aging & Social Policy*, 25(3): 197–217. DOI: 10.1080/08959420.2013.791783

[14] Fuchs, V.R. 1968. *The Service Economy*. National Bureau of Economic Research. New York, USA.

[15] Gerrans, P., and Clark-Murphy, M. 2004. Gender differences in retirement savings decisions. *Journal of Pension Economics and Finance*, 3(2): 145–164. DOI: 10.1017/S1474747204001477

[16] Hinz, R.P., McCarthly, D.D., and Turner, J.A. 1997. Are women conservative investor? Gender differences in participant-directed pension investments. In Gordorn, M.S., Mitchell, O.S., and Twinney, M. (eds.), *Positioning Pensions for the Twenty-First Century* (pp. 91-106). University of Pennsylvania Press, Philadelphia, USA.

[17] Hodrick, R. J., and Prescott, E. C. 1997. Postwar US business cycles: an empirical investigation. *Journal of Money, Credit and Banking*, 29(1): 1–16.

[18] Hurst, H. E. 1951. Long term storage capacity of reservoirs. *Transactions of the American Society of Civil Engineers*, 116(1): 770–799.

[19] Kale, M. and Butar, F. 2011. Fractal analysis of time series and distribution properties of Hurst exponent. *Journal of Mathematical Sciences & Mathematics Education*, 5(1): 8–19.

[20] Krznar, I. 2011. Identifying recession and expansion periods in Croatia. *CNB Working Papers*, W-29: 1–32.

[21] Lodovici, M.S., Drufuca, S., Patrizio, M., and Pesce, F. 2016. *The gender pension gap: differences between mothers and women without children*. Brussels: European Parliament. DOI: 10.2861/255486

[22] Lusardi, A., and Mitchell, O.S. 2008. Planning and financial literacy: How do women fare? *American Economic Review: Papers & Proceedings*, 98(2): 413–417.

[23] Lusardi, A., and Mitchell, O.S. 2011. Financial literacy around the world: an overview. *Journal of Pension Economics and Finance,* 10(4): 497–508. DOI: 10.1017/S1474747211000448

[24] Lusardi, A., Mitchell, O.S., Curto, V. 2014. Financial literacy and financial sophistication in the older population. *Journal of Pension Economics and Finance/First View Article*/April 2014: 1–20. DOI: 10.1017/S1474747214000031

[25] Mandelbrot, B.B., and Wallis, J.R. 1969. Computer experiments with fractional Gaussian noises. Part 1: Sample graphs, averages and variances. *Water Resources Research*, 5: 228–241. Available at: DOI: https://doi.org/10.1029/WR005i001p00228

[26] Packard, N., Crutchfield, J., Farmer, J., and Shaw, R. 1980. Geometry from a time series. *Physical Review Letters*, 45(9): 712–716. DOI: 10.1103/PhysRevLett.45.712

[27] Peters, E.E. 1994. *Fractal Market Analysis*. New York: John Wiley & Sons, INC.

[28] Peters, E.E. 1996. *Chaos and Order in the Capital Markets: A New View of Cycles, Prices, and Market Volatility*. Second edition. New York: John Wiley & Sons, INC.

[29] Yakimova, L. 2018. Modeling the Impact of Crises on Evolution of Pension Systems. In I. Nekrasova, O. Karnaukhova, and B. Christiansen (eds.), *Fractal Approaches for Modeling Financial Assets and Predicting Crises* (pp. 115–138). IGI Global, USA. DOI: 10.4018/978-1-5225-3767-0.ch007

*** Financial Supervisory Authority. 2018. *Evolution of Indicators*. Available at: https://asfromania.ro/index.php/informatii-publice/statistici/statistici-pensii/evolutie-indicatori

*** National Commission for Regulation of Financial Services Markets. 2018. *Information on the state and development of non-state pension provision of Ukraine*. Available at: https://nfp.gov.ua/ua/Informatsiia-pro-stan-i-rozvytok-nederzhavnoho-pensiinoho-zabezpechennia-Ukrainy.html

*** National Institute of Statistics. 2018. *Quarterly Gross Domestic Product of Romania, in the period 2000-2017*. Available at: http://www.insse.ro/cms/en/content/gdp-evolution-fourth-quarter-2017-estimated-data-flash

*** State Statistics Service of Ukraine. 2018. *National accounts.* Available at: http://www.ukrstat.gov.ua/

JOURNAL of Applied Economic Sciences

ISSN 2393 – 5162 ISSN - L 1843-6110