ON FUTURE PENSIONS FROM THE SECOND PILLAR PENSION FUNDS

Algirdas Bartkus*

Vilnius University, Lithuania

Abstract. *The main focus of this paper lies in the possibility for particular second pillar pension funds participants to get a higher pension, compared with non-participants. These particular participants are the employees with average wages and average employment history. This analysis is of main importance when it comes to the decision to participate in the second pillar or not. Unit roots tests and cointegration analysis are used as the possible tools to investigate the dynamics of retirement income for participants and non-participants. This research has the intention to determine the conditions when replacement from the second pillar will offset the loss from pay-as-you-go system.*

Key words: *second pillar pension funds, PAYG pensions, unit root tests, error correction model, cointegration*

Introduction

After gaining independence, eastern European economies began their transition to a capitalist market system. Pension systems that were inherited from the socialist period underwent several changes. Most emerging economies in central and Eastern Europe began their transition into market economy, first establishing pay-as-you-go (PAYG) systems and after that introducing the second pillar of pension system. This topic is relevant for the most of emerging economies in Eastern Europe as the majority of them will have to deal with pensioners that rejected a portion of PAYG pension in favour of undefined pension from pension funds. In Lithuania, the initial steps were taken for the creation of the PAYG system. PAYG system was finally build up in 1995 and has been operating up to present day. Less than a decade later, the pension system was modified with the introduction of the second pillar pension funds. These funds that operate mainly in emerging markets should not be confused with the general notion of pension funds that prevails in most of the world. They do not act as a provider of main incomes for the elderly, neither are they a source of supplementary income. They provide the replacement for the part of the PAYG pension. If a person decides to participate in these funds, the Social Insurance Fund Board of Lithuania transfers the part of PAYG

* Corresponding author. Vilnius University, Faculty of Economics, Department of Quantitative Methods and Modelling, Saulėtekio ave. 9 II, LT-10222, Vilnius, Lithuania. E-mail: algirdasdzen@yahoo.com

contributions into individual account of the participant. The person who participates in these funds, bears not only the risks that are associated with them, but also resigns from the corresponding part of PAYG pension, which is directly proportional to the part of contributions that were transferred into pension funds and to the length of his participation. In different emerging economies these schemes are different.

One of the aims of introducing the second pillar of pension system in Lithuania was to base a ground for more or less substantial increase in pensions for forthcoming pensioners. For some time the discussion whether membership in pension funds can guarantee a higher pension was of ideological and political nature. Opponents and proponents presented the arguments that were similar to dogmas or some sort of simple calculations of how it will be. In this paper I will try to bring some time series predictions based on theoretical considerations of what it is likely to be if the things go on in the same fashion as they were already going. The aim of this study is to find out if there is a slight chance for a participant in pension funds to get the pension that would be comparable with PAYG pension. Despite being not obligatory, these funds became very popular and accounted for a significant growth, therefore the findings of this study will shed some light on consumption possibilities of the future elderly. In this paper a participant is defined and understood as the person who earns average wages over a lifetime and has the typical (average) employment history.

Literature review and methodology

One section that is usually included in scientific articles covers summaries of similar analyses made in the past. Time series methods up to date have not been used for the questions of this type due to several reasons. The second pillar in Lithuania does not provide pensioners with supplementary income. The second pillar replaces a portion of PAYG pension. The questions of the type I am dealing with are out of interest in most developed countries as their second pillar provides supplementary income and not the replacement for income. Nevertheless, some papers that deal with similar technical issues have already been published. Most notable are by de Jong (2012) and Benzoni et al. (2007). These authors analysed cointegration between labour income and dividends. Benzoni et al. detected the long-run relationship between returns on financial assets and human capital. De Jong extended the model and brought additional insights to the research. Cointegration between assets prizes was analysed by Alexander et al. (2002). They are similar in approach but differ in application from the analysis that is presented here. The whole analysis in the above mentioned papers was focused on optimal portfolio choice. The lack of similar analysis can also be explained by the fact that these funds have been recently established in post-communist countries and the samples are not as large as it is necessary for time series analysis.

Methodology of this analysis will not be discussed due to a large amount and wide availability of time series literature. The details on unit root tests, cointegration and VAR methodology can be found in numerous sources. As for certain recommendations on

intermediate to advanced and advanced level sources I can point the books by Enders (2010), Juselius (2006), Maddala and Kim (1998), Banerjee, Dolado, Galbraith and Hendry (1993). The definitive book on programming R for unit roots tests and applied cointegration analysis is by Pfaff (2010).

Data and research strategy

In this paper I will analyse the interrelationship between two variables: net value of pension fund assets per participant and the transfers from the social insurance agency to a particular pension fund per participant. This is the main data. The alternative approach would be to use total mass of transfers and net value of assets. Additional variables will be introduced on subsequent pages. The demographic factors are ignored as it is known that adverse demographics create similar problems for both, PAYG and funded pension schemes (Barr, 2001).

The main obstacle in the discussion on pension funds was not the long forecasting horizon and uncertainty, as no one really knows how the things will turn out, but the lack of the historical data. Even very general data, such as the amount of transfers from the social insurance agency to a particular pension fund was not and is not given to publicity. The second obstacle was and still is a small sample. It was impossible to perform statistical analysis on the subject three or four years ago because of the small sample size. Pension funds began their activities in the 2nd quarter of 2004 and at the time when this paper was written, there were overall 33 observations on the quarterly basis. Not a large sample, but at least something.

The sample by itself is very atypical. Approximately half of the observations are from the financial crisis period. These economic downturn observations can bias the whole analysis towards the tendencies observed during the "bad times" as it is not very likely that downturn approximates for about the half of the economic cycle. Any doubts on the validity of sample representativeness are welcome and they should be kept in mind. On the other hand, this bias should not be very significant as the first half of the sample includes the periods when economy was booming. The reader should be aware of the sample hazards but also not too sceptical as the sample is the mix of "particularly good" and "particularly bad" times.

The lack of the data implies that no expectations are formed and econometric models under rational, adaptive or even naïve expectations would be of limited use here. On the other hand, as it is often the case with pensions, the agents do not form expectations not only because of the limited availability of data, but also of the short-sighted belief that pensions will be paid sometime in the future and this time has not yet come. Of course, one can always argue that a participant in a pension fund has certain subjective beliefs about his or her future pension. And of course this is true. But subjective opinions should never be mistaken as expectations – they are merely the imagination of the participant.

The limited availability of data neither eliminate uncertainty, nor reduces it, nevertheless, it gives a chance to model it. The most convenient and straightforward

strategy would be to create an econometric model, to obtain predictions for both types of pensions and to compare them. However, the reliability and the results would be dubious and there would not be even a slight chance to measure the accuracy of predictions, comparing the estimates with real data, because we simply do not have it (funded pensions are not paid yet). And overall, the predictions based on the econometric model would be of little use here because the forecasting horizon is very long, compared with a relatively small sample size: forecasting horizon is about three to four times larger than the sample size. At this point of time one needs to find the indirect way to get the answer to the question that one is interested in.

PAYG pensions depend directly on the level of employment and wages, whereas these variables depend on the level of production, income, price inflation, etc. The possible feedback relationships among variables may induce that production, income and price inflation dependent on the level of employment and wages. Speaking very broadly, pensions result directly from the economy and their dynamics reflects and mimics the dynamics of economy. The same applies to funded pensions, with the exception that economy has indirect effects. These pensions depend directly on investments, whereas the investments reflect the dynamics of economy.

It is worth noting that external, global economic shocks may have different effects on the funded and unfunded pensions. If funds invest mainly in Lithuania, the shocks may have identical effects on both the funded and unfunded pensions. But if funds diversify their investments between Lithuania and overseas, the same shock may have different effects on the level of the funded and unfunded pensions. Due to this, the pensions from pension funds have a higher volatility, compared with unfunded pensions. Still, higher volatility does not directly imply either higher, or lower profitability of funded pensions, compared with unfunded pensions.

Overall, due to the diversification of investments, the short-run dynamics of funds may be different than that of state pensions, but if the short-run dynamics in both pension schemes is different, that does not mean that one can expect different pensions from these schemes. The short-run discrepancies are possible, inevitable and they frequently occur. The fact that the growth of net value of assets in pension funds differs from the growth of PAYG pensions does not mean that the participants will get a higher pension than non-participants or vice versa. Short-run disparities never imply the corresponding long-run disparities. As far as we can go, the disparities in pension funds and PAYG system will be implied by the disparities in the long-run dynamics. If the changes in net value of assets and the level of transfers (not their differences) shared a common trend, they would not drift too far from each other and the funded and unfunded pensions would not differ too much. And conversely, if the changes in net value of assets and the level of transfers possessed different trends, they would drift too far from each other and this would lead to substantial differences between the funded and unfunded pensions.

Taking short, first I will determine how the order of integration for net value of assets and possible cointegration with transfers from PAYG can act as possible indicators

for successful replacement of the loss from PAYG. In the second step I will undertake empirical analysis with Lithuanian data.

Modelling transfers

To shed more light into this discussion we will employ a quantitative example of how the change of net value of assets is related to the transfers. PAYG contributions are directly deducted from the salaries. Therefore I will start the analysis with the assumption on wages. Usually it is assumed that wages are rigid and sticky and we have plenty of research that proves that. Contrary, the financial markets data is volatile. Is it possible to model simultaneously the contributions, which are directly deducted from the wages and the net value of assets that is directly affected by the volatile returns? This question stays open. Keeping in mind that in 2009 wages in Lithuania fell by 4.4% and in 2010 they fell again by 3.3% it becomes clear that wages in Lithuania are not completely rigid. But again, did they fall to market clearing levels? The answer is obviously no. Further research is needed in order to determine the reliability of the analysis that will be presented here.

One possible way to model nominal wages is to assume that wages follow a random walk with a drift:

$$W_t = \delta + W_{t-1} + \varepsilon_t + \Delta e_t \tag{1}$$

This specification implies that every quarter wages change by the amount δ, plus composite external innovation $\varepsilon_t + \Delta e_t$. Unexpected changes in wages may arise from two sources: permanent innovation in stochastic trend ε_t and transitory or stationary innovation in stochastic trend Δe_t. Both these trend innovations are unpredictable and induce unexpected changes in the level of the wages paid. The main difference is that innovations ε_t have long lasting effect on wages and e_t have only temporary effect, which in this specification lasts only for one period. The need to include transitory innovations is reasoned by the need to have such process representation that is autocorrelated and can be modelled. Although in further equations for simplicity we will proceed with a simple assumption about transitory random effects and we will denote them as Δe_t, in more general case we should assume the lag polynomial process in the transitory component $\eta(L)e_t$ that allows for more sophisticated autocorrelation structures. The main problem with equation (1) is that this specification is very far from the reality: wages do not change by the fixed amount every quarter. If they did, wages at the beginning of sample would grow at a higher rate, compared with a rate at the end of the sample. Equation (1) implies that growth rates of wages are decreasing and usually that is not the case with nominal wages. The deflation periods are very rare, economies usually experience contrary of this – inflation. Rationally one can assume that wages grow at a constant rate on average. The plausible specification for the process would be:

$$W_t = \delta W_{t-1} e^{\varepsilon_t + \Delta e_t} \tag{2}$$

Equation (2) states that wages grow on average at rate δ. Multiplicative disturbance term allows actual growth to differ from the expected. Taking logs of (2), letting lower-case letters denote logs of variables and denoting $\log \delta$ as δ^* we can rewrite (2) as:

$$w_t = \delta^* + w_{t-1} + \varepsilon_t + \Delta e_t \tag{3}$$

Investigation of wages was necessary because PAYG contributions are deducted from nominal wages. If ρ is contributions rate, we can multiply both sides of (2) by ρ and now we get equation for PAYG contributions:

$$W_t \rho = \delta W_{t-1} e^{\varepsilon_t + \Delta e_t} \rho \tag{4}$$

Taking logs of (4), using lower-case letters for logs of variables and asterisks for logs of parameters, we get:

$$w_t + \rho^* = \delta^* + w_{t-1} + \varepsilon_t + \Delta e_t + \rho^* \tag{5}$$

As it can be seen, contribution rate acts as additional part of intercept. Assuming that initial value is $w_0 = 0$, process in (5) evolves as follows:

$$
\begin{aligned}
w_1 + \rho^* &= \delta^* + \rho^* + \varepsilon_1 + e_1 \\
w_2 + \rho^* &= 2\delta^* + \rho^* + \sum_{i=1}^{2} \varepsilon_i + e_2 \\
w_3 + \rho^* &= 3\delta^* + \rho^* + \sum_{i=1}^{3} \varepsilon_i + e_3 \\
&\vdots \\
w_t + \rho^* &= t\delta^* + \rho^* + \sum_{i=1}^{t} \varepsilon_i + e_t
\end{aligned}
\tag{6}
$$

These equations, with slight changes, can be used for representation of contributions or current transfers. One needs to replace PAYG contribution rate ρ with the rate of transfers into pension funds τ and denote log of τ as τ^*. We will proceed further in this fashion till we get the useful representations for the transfers of PAYG contributions and for the net value of assets of pension funds. PAYG contributions into pension funds are transferred at the appointed frequency. The cumulative process of the funds transferred altogether evolves as follows:

$$
\begin{aligned}
w_1 + \tau^* &= \delta^* + \tau^* + \varepsilon_1 + e_1 \\
\sum_{i=1}^{2} w_i + 2\tau^* &= 3\delta^* + 2\tau^* + \sum_{i=1}^{2} \varepsilon_i + \varepsilon_1 + \sum_{i=1}^{2} e_i \\
\sum_{i=1}^{3} w_i + 3\tau^* &= 6\delta^* + 3\tau^* + \sum_{i=1}^{3} \varepsilon_i + \sum_{i=1}^{2} \varepsilon_i + \varepsilon_1 + \sum_{i=1}^{3} e_i \\
&\vdots \\
\sum_{i=1}^{t} w_i + t\tau^* &= \sum_{i=1}^{t} i\delta^* + t\tau^* + \sum_{i=1}^{t} \varepsilon_i + \sum_{i=1}^{t-1} \varepsilon_i + \ldots + \varepsilon_1 + \sum_{i=1}^{t} e_i
\end{aligned}
\tag{7}
$$

The examination of these equations is necessary in order to choose the appropriate tools to model the changes in contribution rate and in order to get some information about the order of integration. Allowing for a change in τ (constant rate for the first

three periods, a change in the fourth) we can obtain algebraic representation of current funds transferred ft_t:

$$ft_1 = \delta^* + \tau_1^* + \varepsilon_1 + e_1$$
$$ft_2 = 2\delta^* + \tau_1^* + \sum_{i=1}^{2} \varepsilon_i + e_2$$
$$ft_3 = 3\delta^* + \tau_1^* + \sum_{i=1}^{3} \varepsilon_i + e_3$$
$$ft_4 = 4\delta^* + \tau_2^* + \sum_{i=1}^{4} \varepsilon_i + e_4 \tag{8}$$
$$\vdots$$
$$ft_t = t\delta^* + \tau_k^* + \sum_{i=1}^{t} \varepsilon_i + e_t$$

Equations (6), (7) and (8) imply that changes in rate are changes in the intercept of deterministic trend. If these changes were unknown, one could model them with dummy variables, allowing for the change in the intercept of trend function. This strategy is inappropriate in our study, because we possess information on the changes in the rate of transfers and agents also possessed this information in advance. The possible solution is to regress the log of rate on the log of funds transferred.

From equations above it follows that if wages are evolving as a random walk with a drift, it must be that wages are I(1) variable and so funds transferred are also I(1):

$$w_t \sim I(1)$$
$$w_t + \tau^* = ft_t \sim I(1) \tag{9}$$

Modelling assets

Net value of pension funds' assets A_t is the only variable that we have not discussed yet. Assuming for simplicity that rate of transfers is constant and denoting the growth rate of pension funds' assets as r_{i+1}, A_t can be represented with these equations:

$$A_2 = \delta \exp(\varepsilon_1 + e_1)\tau(1 + r_2)$$
$$A_3 = \delta \exp(\varepsilon_1 + e_1)\tau(1 + r_3)[\delta \exp(\varepsilon_2 + \Delta e_2) + (1 + r_2)]$$
$$A_4 = \delta \exp(\varepsilon_1 + e_1)\tau(1 + r_4)[\delta^2 \exp(\sum_{i=2}^{3} \varepsilon_i + \sum_{i=2}^{3} \Delta e_i)$$
$$+ \delta \exp(\varepsilon_2 + \Delta e_2)(1 + r_3) + \prod_{i=2}^{3}(1 + r_i)]$$
$$\vdots \tag{10}$$
$$A_t = \delta \exp(\varepsilon_1 + e_1)\tau(1 + r_t)[\delta^{t-2} \exp(\sum_{i=2}^{t-1} \varepsilon_i + \sum_{i=2}^{t-1} \Delta e_i)$$
$$+ \delta^{t-3} \exp(\sum_{i=2}^{t-2} \varepsilon_i + \sum_{i=2}^{t-2} \Delta e_i)(1 + r_{t-1})$$
$$+ \delta^{t-4} \exp(\sum_{i=2}^{t-3} \varepsilon_i + \sum_{i=2}^{t-3} \Delta e_i) \prod_{i=t-2}^{t-1}(1 + r_i) + \ldots + \prod_{i=2}^{t-1}(1 + r_i)]$$

Discrepancies in time between the growth of wages and the value of assets result from peculiarity of collecting the contributions for period t, but transferring them into pension funds in period $t + 1$. A very important detail is that short-run transitory wage

effects e_t have a long lasting effect on the level of assets. These equations represent assets well, but they are of little use if we want to study interrelationships between funds transferred and assets, and they do not tell us much about the order of integration of the assets. Not distinguishing between temporary and long-run shocks we can easily rearrange (10) and obtain a more useful set of equations:

$$A_2 = \delta \exp(\varepsilon_1)\tau(1+r_2)$$

$$A_3 = \delta^2 \exp(\sum_{i=1}^{2} \varepsilon_i)\tau(1+r_3)\left[1 + \frac{1+r_2}{\delta \exp(\varepsilon_2)}\right]$$

$$A_4 = \delta^3 \exp(\sum_{i=1}^{3} \varepsilon_i)\tau(1+r_4)\left[1 + \frac{1+r_3}{\delta \exp(\varepsilon_3)} + \frac{\prod_{i=2}^{3}(1+r_i)}{\delta^2 \exp(\sum_{i=2}^{3} \varepsilon_i)}\right] \tag{11}$$

$$\vdots$$

$$A_t = \delta^{t-1} \exp(\sum_{i=1}^{t-1} \varepsilon_i)\tau(1+r_t)\left[1 + \frac{1+r_{t-1}}{\delta \exp(\varepsilon_{t-1})} + \ldots + \frac{\prod_{i=2}^{t-1}(1+r_i)}{\delta^{t-2} \exp(\sum_{i=2}^{t-1} \varepsilon_i)}\right]$$

The product of the first two factors is in fact the level of wages (defined in (2)). Taking logs of (11), denoting the log of assets as a_t, the log of returns as r_t^* and the log of cumulative growth factor (the expression in square brackets in (11)) as κ_t, we get:

$$a_2 = w_1 + \tau^* + r_2^*$$

$$a_3 = w_2 + \tau^* + r_3^* + \kappa_3 \tag{12}$$

$$\vdots$$

$$a_t = w_{t-1} + \tau^* + r_t^* + \kappa_t$$

If we assume that a) growth rate of assets does not differ from the predictable growth rate of wages $\delta = 1 + r$ and b) all changes in wages are completely predictable, so that all random shocks are set to zero $\varepsilon_t = 0$, we could rewrite (11) as:

$$A_2 = \delta^2 \tau$$

$$A_3 = 2\delta^3 \tau$$

$$A_4 = 3\delta^4 \tau \tag{13}$$

$$\vdots$$

$$A_t = (t-1)\delta^t \tau$$

In order to obtain a more estimable form of a process we may switch to the log form, so that system of equations (13) becomes:

$$a_2 = 2\delta^* + \tau^*$$

$$a_3 = 3\delta^* + \tau^* + \log 2$$

$$a_4 = 4\delta^* + \tau^* + \log 3 \tag{14}$$

$$\vdots$$

$$a_t = t\delta^* + \tau^* + \log(t-1)$$

Obviously, there is a logarithmic trend in data generating equations. That means that taking first differences of (14) we will not get I(0) process due to the presence of logarithmic trend in (14):

$$\Delta a_3 = \delta^* + \log 2$$
$$\Delta a_4 = \delta^* + \log 3 - \log 2$$
$$\vdots$$
$$\Delta a_t = \delta^* + \log(t-1) - \log(t-2)$$

(15)

It is worth mentioning that representations (13) to (15) are too deterministic. The stochastic treatment would be more accurate, but also more complicated and not much more informative. Logarithmic trend implies that a) the logs of the net value of assets may display diminishing growth, b) their first differences would exhibit downward alteration that is gradually decreasing and c) the second differences would be more or less constant with one large skip in the first period. Due to the fact that we can control this skip with dummy variables, second differences are I(0). If these three assumptions hold, the growth rate of assets would not differ significantly from the growth of wages. It follows that the level of assets must be I(2) or very near to it. I will not present the final answer concerning the order of integration here, because net values of assets is a nonlinear process and it would require a large amount of time to fully study and understand the properties of it. In this paper we will assume that although nonlinear, this process can be well approximated with I(2) process. On the other hand, the cumulative process of the funds transferred altogether (equation (7)) is definitely I(2). As the net value of assets differs from the former because of the differences among the growth rates of wages and capital, these differences should not be substantial if the growth rates of wages do not differ very much from the growth rate of capital. If the order of integration of assets is less than two, that would mean that cumulative effect is pushed out by insufficient growth of capital that is significantly less than the predictable growth rate of wages. And that would be a basis to conclude that over the long-run second pillar pension funds will not accumulate the supplementary pension that would offset the losses from the reduction of PAYG pension. The possibility to offset the losses may be formulated as the assumption concerning the order of integration of assets. The hypothesis that pension funds can have a chance to compete with PAYG scheme in maintaining the consumption of old-age pensioners is:

$$a_t \sim I(2) \tag{16}$$

If this assumption holds, it is very likely that in order to achieve stationarity we will need to difference log of wages and log of transfers once, but log of assets – twice. Differencing log of net value of assets once we will obtain I(1) variable and in our analysis it will make more sense from both econometric and economic point of views. Economic argument is that the change in log of net value of assets is the growth rate of funds transferred, which is one of measures of efficiency. Econometric argument is that

if the variable is I(1), we will be able to search for a long-run equilibrium relation among several variables, which are all I(1). If the linear combination of both I(1) variables is stationary, the variables will be cointegrated.

Cointegration is a powerful tool to study interrelationships among nonstationary variables. If these variables are cointegrated, they will be in a long-run equilibrium. Long-run equilibrium means that variables change in such a manner that they preserve more or less fixed distance among each other. External shocks or any variable shocks, induce the changes in variables that eliminate disequilibrium and the variables change in order to preserve the equilibrium. One can be misled by the notion of distance between the variables. The fixed distance in this setting would mean that the dynamics will be observed on the basis that has already occurred or was implied from the very beginning. The distance in this particular case may arise from the difference in time between the periods for which the record of transfers is kept and for which the actual transfers into pension funds are proceeded (this was explicitly shown in (10) and following equations in which interest rate is included).

If the assumptions in (9) and (16) are true, and if log of transfers ft_t and change of log of net assets Δa_t behave in the fashion described above, there is no chance that differences between pensions will be substantial. If the assumption (16) is wrong, but ft_t and a_t are cointegrated, that would mean that the difference between the pensions would increase with time (more or less fixed distance is kept among the level of assets and the funds transferred) and not in favour of pension funds. The chance that one can accumulate higher pension by participating in pension funds can come only if assumption (16) is true and the variables are not cointegrated.

Removing size distortions, seasonal and other effects

First of all we need to separate deterministic and stochastic trends and to isolate the effects of deterministic changes on variables. The deterministic part is fully predictable, it does not affect the stochastic component and so we will not lose much by removing all these components from the series. The technical problem with variables is that in the case of transfers, the changes in rate affect only the deterministic component of trend. But in the case of the capital accumulated it is not so simple. Well in fact, changes in rate also affect only the deterministic trend, but the modelling of trends in this case would be more complicated, because the movements that are induced by the deterministic component are more messed up with the ones that are induced by stochastic factors. At this moment one can only guess whether the chance for participants in pension funds to get a higher pension does depend on the rate of transfers.

Lithuanian pension funds are classified into four groups according to their risk-level: funds that invest mainly in stocks (70-100% of assets are directed into stocks); funds with average share of stocks (30-70% of assets are directed into stocks); funds with the small share of stocks (up to 30% of assets are directed into stocks); the conservative funds (they do not invest in stocks). The analysis is conducted separating the funds into

four categories: conservative, moderate (funds with the small share of stocks), balanced (funds with average share of stocks) and risky (funds that invest mainly in stocks) and analysing them separately. The names for these categories are given arbitrarily and are not of frequent use in Lithuania.

In the first step, funds transferred for one participant ($ft_t - m_t$), where m_t is the log of number of participants) are filtered for the effects of the changes in the rate of transfers, seasonal effects and financial crisis effects:

$$ft_t - m_t = x_t'\theta + z_t \qquad (17)$$

The variable of interest is defined subtracting the log of participants from the log of funds transferred in order to control the results for the growing number of participants and to avoid the possibilities to observe large amounts of transfers that occurred not due to the growth of the wages but due to the increasing number of participants. In (17) vector x_t' includes the constant, log of rate of transfers τ_t^*, seasonal dummies SD_i and financial crisis dummy CD, which assumes the value of 0 for all periods prior to the third quarter of 2008 and 1 for the remaining periods. (17) yields estimate of $\hat{z}_t$, that is a near-detrended and almost concentrated value of the funds transferred. All seasonal effects, all size distortion effects that arise from the change in the rate of transfers, the structural shifts induced by financial crisis and the interception of the deterministic trend are completely removed from the series.

Net value of assets for one participant is also filtered, but in a bit different fashion, compared with the funds transferred:

$$a_t - m_t = x_t'\theta + v_t \qquad (18)$$

Here vector x_t' includes the constant, log of rate of transfers τ_t^*, two transfer time dummies TTD_i and cumulative sum of start pulse dummy $SCPD$. Start pulse dummy takes value of 1 for the second quarter of 2004 and value of -1 for the third quarter of 2004. This dummy represents the blip or very large changes in the first observations of first and second differences of assets that arise from the presence of logarithmic trend or from stochastic changes that are very similar to it. Accordingly, the cumulative sum of this dummy was used for the removal of deterministic components from the net value of assets. The first transfer time the dummy takes values of 1 for the 2nd, the 3rd and the 4th quarters of 2010, the second transfer time dummy takes values of 1 for all observations since the 1st quarter of 2011. These dummies represent the changing frequency of transfers. Seasonal dummies were insignificant and thus were not included. (18) yields estimate of $\hat{v}_t$, that is a near-detrended net value of assets, without any distortions that can arise from logarithmic trend, from the changes in the rate of transfers or from the changes in the frequency of transfers. The only deterministic component that is left in the data (in both $\hat{z}_t$ and $\hat{v}_t$) is the slope of trend. This is done in order to preserve information that is contained in the log of cumulative growth factor κ_t, that can intermix with predictable growth of wages.

Unit root tests

In this article cointegration among the variables is studied employing the mixture of different time series analysis methods. Four VECM's (each for every type of funds) were estimated using the Johansen methodology. But first of all, the possibility to get a higher pension will exist only if log of assets is $I(2)$. If that is not the case, further analysis will shed more light on what can possibly happen.

Due to the fact that both $\hat{z}_t$ and $\hat{v}_t$ even after the adjustment for financial crisis displayed significant permanent blips from the mid 2008, the Perron test on unit roots was performed. The choice between Perron's and Zivot-Andrews' tests was in favour of the former, because the inspection of data plots revealed clear breaks in the 2nd quarter of 2008. In addition, the financial crisis was an exogenous shock on Lithuanian economy and should be treated as exogenous and not as endogenous as it is with the Zivot-Andrews test.

TABLE 1. **Perron unit root test results for prefiltered transfers and assets**

	Test statistics		Critical values		
	for $\hat{z}_t$	for $\hat{v}_t$	1% level	5% level	10% level
Conservative	-2.94	-3.06	-4.32	-3.76	-3.46
Moderate	-2.67	-3.29	-4.32	-3.76	-3.46
Balanced	-3.04	-3.34	-4.32	-3.76	-3.46
Risky	-2.09	-3.42	-4.32	-3.76	-3.46

Source: test statistics calculated by the author, critical values taken from Perron (1989).

Due to the fact that the series were prefiltered for a certain amount of deterministic impacts and the intercept of the deterministic trend was also removed, Perrons model A, which accounts for the lowest amount of deterministic components was selected. None of the values calculated was less than the critical value at any appropriate significance level, from which follows that both variables are nonstationary and at least $I(1)$. Inspection of plots of first differences indicated the presence of transitory blips in $\Delta\hat{z}_t$ and $\Delta\hat{v}_t$ (which means that permanent blips may be characteristic for $\hat{z}_t$ and $\hat{v}_t$). Consequently, the stationarity of first differences will be tested with tests that involve as few as possible deterministic components: simple Dickey-Fuller's test without a constant and a trend, KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test for level stationarity and the Zivot-Andrews test for a shift in the intercept. The test results are presented in the following tables.

TABLE 2. **Dickey-Fuller unit root test results for first differences of transfers and assets**

	Test statistics		Critical values		
	for $\Delta\hat{z}_t$	for $\Delta\hat{v}_t$	1% level	5% level	10% level
Conservative	-8.4372	-6.5731	-2.62	-1.95	-1.61
Moderate	-7.5424	-6.6836	-2.62	-1.95	-1.61
Balanced	-7.6795	-6.5485	-2.62	-1.95	-1.61
Risky	-6.2945	-6.8996	-2.62	-1.95	-1.61

Source: test statistics calculated by the author, critical values taken from Hamilton (1994).

TABLE 3. **KPSS unit root test results for first differences of transfers and assets**

	Test statistics		Critical values		
	for $\Delta\hat{z}_t$	for $\Delta\hat{v}_t$	1% level	5% level	10% level
Conservative	0.1058	0.0565	0.739	0.463	0.347
Moderate	0.1118	0.0548	0.739	0.463	0.347
Balanced	0.1955	0.0541	0.739	0.463	0.347
Risky	0.1513	0.0568	0.739	0.463	0.347

Source: test statistics calculated by the author, critical values taken from Kwiatkowski et al. (1992).

TABLE 4. **Zivot-Andrews unit root test results for first differences of transfers and assets**

	Test statistics		Critical values		
	for $\Delta\hat{z}_t$	for $\Delta\hat{v}_t$	1% level	5% level	10% level
Conservative	-9.9756	-6.9151	-5.34	-4.8	-4.58
Moderate	-9.6347	-7.1615	-5.34	-4.8	-4.58
Balanced	-8.3471	-7.0937	-5.34	-4.8	-4.58
Risky	-6.9824	-7.6530	-5.34	-4.8	-4.58

Source: test statistics calculated by the author, critical values taken from Zivot and Andrews (1992).

The Phillips-Perron test was not conducted, because the residuals in neither of Dickey-Fuller equations were autocorrelated. The tests with the distinction between deterministic and stochastic trends (Schmidt-Phillips and Elliott-Rothenberg-Stock) were omitted, because almost all deterministic trend components were removed by prefiltering or differencing. The least appropriate from these tests is the Zivot-Andrews: $\Delta\hat{z}_t$ and $\Delta\hat{v}_t$ display temporary and not permanent blips in the 2nd quarter of 2008, so we have to deal with an outlier and not with the structural shift, plus financial crisis should be treated as exogenous and not endogenous shock. The choice to perform this test is mainly motivated by the curiosity to find out the date for structural break. Any lagged changes were included in any test equation, except that two lagged changes in the Zivot-Andrews equation for the transfers of balanced funds helped to get rid of the autocorrelation in the residuals. Zivot-Andrews tests indicate that structural break for growth rate of transfers most likely occurred in the 2nd quarter of 2008 and for the growth rate of assets – in the 4th quarter of 2008. The most plausible explanation is that different dates for structural shift are obtained because of the mistreatment of structural break, when in fact it was an exogenous and not endogenous break. Less plausible, but more interesting explanation is that labour market data could have indicated the events that led to the downturn in financial markets. All Dickey-Fuller, KPSS and Zivot-Andrews statistics are less than the critical values at all appropriate significance levels, so we can reject null hypothesis of nonstationarity in the Dickey-Fuller and Zivot-Andrews case and we do not reject null of stationarity in the KPSS case. It follows that both variables, $\Delta\hat{z}_t$ and $\Delta\hat{v}_t$, are in fact I(0). The result that $\hat{v}_t$ is I(1) means that condition (16) does not hold and that cumulative effect in the value of assets is pushed out by insufficient growth of capital, which is significantly less than the

predictable growth rate of wages. Of course, that means that if things go on in the same fashion as they already were going, over the long-run second pillar pension funds will not accumulate the replacement for PAYG pension, which would offset the losses from the reduction of PAYG pension. The reasons for this behaviour may be very different and will not be analysed separately as that is not the aim of this study. The empirical analysis of Lithuanian financial market conducted by Klimavičienė (2011) suggests that price impact of negative reviews is very strong in Lithuanian stock market. This could be one of the reasons. Insufficient growth is a very serious issue as pensions from pension funds will not be indexed and the purchasing power of these pensions will decrease with time.

Cointegration analysis

In advance one could suspect that $\hat{z}_t$ and $\Delta\hat{v}_t$ could be cointegrated. As it turned out they cannot be cointegrated because the order of integration for $\hat{z}_t$ is I(1), and for $\Delta\hat{v}_t$ is I(0). The variables that may form equilibrium are $\hat{z}_t$ and $\hat{v}_t$ and this equilibrium has different meaning. The equilibrium between $\hat{z}_t$ and $\Delta\hat{v}_t$ asserts that the growth rates of net value of assets are compatible with the growth rates of nominal wages. This in turn means that pension funds will accumulate replacements for PAYG pension that will be compatible with the loss of a portion of PAYG pension. The equilibrium between $\hat{z}_t$ and $\hat{v}_t$ implies that the accumulated growth rates of net value of assets are compatible with the growth rates of nominal wages. This means that growth rates of net value of assets are not sufficient and do not keep up with the growth rate of nominal wages. Preservation of this equilibrium would mean that in the long-run supplementary pensions paid for the participants with an average employment history will be less and less compared with the reduction of PAYG pension. If this ever happens, pension funds will face a crowd of pensioners with unfulfilled "expectations" that were fuelled up and boosted with numerous advertisements and promotional actions, especially in the starting period. A very detailed and comprehensive historical analysis is presented in Lazutka (2008, 2007 and 2006). The results up to now are not in favour of the pension funds or their participants. The chances for the first funded pension to offset a reduction of PAYG pension would exist only if the variables are not cointegrated.

Johansen's tests for cointegration are based on two error correction (ECM) models. The first assumes VAR(2) process for levels:

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + e_t \qquad (19)$$

The second ECM assumes VAR(1) process for levels:

$$\Delta y_t = \Pi y_{t-1} + e_t \qquad (20)$$

Vector y_t contains $\hat{z}_t$ and $\hat{v}_t$. VAR(1) specification is sufficient from statistical point of view: the errors are not autocorrelated, more or less normally distributed, but raises certain awareness from economic point of view. VAR(1) specification implies

ECM with nil lags, which in turn implies that at least the growth rate of wages is not autocorrelated, which is not true. Of course, if the equilibrium errors were large and the largest portions of movements in variables were induced by the disequilibrium, this specification could be useful. VAR(2) implies at least very usual autoregressive patterns for variables, but on the other hand, it may lead to overparameterization and to a significant loss of degrees of freedom when one deals with a very small sample.

TABLE 5. **Johansen's tests for VAR(1) specification, testing H_o:$r = 0$**

	Test statistics		Critical values (λ_{trace} test / λ_{max} :: test)		
	λ_{trace} test	λ_{max} :: test	1% level	5% level	10% level
Conservative	19.27	11.51	16.31/15.69	12.53/11.44	10.47/9.52
Moderate	16.75	9.84	16.31/15.69	12.53/11.44	10.47/9.52
Balanced	16.90	11.24	16.31/15.69	12.53/11.44	10.47/9.52
Risky	16.82	10.96	16.31/15.69	12.53/11.44	10.47/9.52

Source: test statistics calculated by the author, critical values taken from Osterwald-Lenum (1992).

All trace statistics are larger than their critical counterparts at all conventional levels, but maximal eigenvalue statistics are larger than critical values only at 10% significance level and only for conservative funds is this statistic larger than critical value at 5% significance level. One can assume with more or less assurance that one cointegrating vector exists.

TABLE 6. **Johansen's tests for VAR(2) specification, testing H_o:$r = 0$**

	Test statistics		Critical values (λ_{trace} test / λ_{max} :: test)		
	λ_{trace} test	λ_{max} :: test	1% level	5% level	10% level
Conservative	20.83	15.18	23.52/19.19	17.95/14.90	15.66/12.91
Moderate	28.22	22.88	23.52/19.19	17.95/14.90	15.66/12.91
Balanced	24.50	20.23	23.52/19.19	17.95/14.90	15.66/12.91
Risky	22.36	13.91	23.52/19.19	17.95/14.90	15.66/12.91

Source: test statistics calculated by the author, critical values taken from Osterwald-Lenum (1992).

All trace statistics are larger than their critical counterparts at all conventional levels. For moderate and balanced funds, maximal eigenvalue statistic is larger than critical values at 1% significance level, for conservative funds at 5%, but for risky funds only at 10% significance level. The conclusion in VAR(2) setting does not differ from the conclusion in VAR(1) setting – one cointegrating vector exists.

The variables will be cointegrated and ECM representations will be meaningful if the variables respond to the disequilibrium or if at least one speed of adjustment coefficient (element in vector α) is statistically significant.

ECM for VAR(2) in levels is:

$$\Delta y_t = \alpha\beta' y_{t-1} + \Gamma_1 \Delta y_{t-1} + \mu + e_t \qquad (21)$$

ECM for VAR(1) in levels is:

$$\Delta y_t = \alpha \beta' y_{t-1} + e_t \tag{22}$$

TABLE 7. **Estimates of the speed of adjustment coefficients (standard errors in parentheses) for VAR(1) and VAR(2) specifications**

	VAR(1)		VAR(2)	
	$\Delta \hat{z}_t$ equation	$\Delta \hat{v}_t$ equation	$\Delta \hat{z}_t$ equation	$\Delta \hat{v}_t$ equation
Conservative	0.0299 (0.0082)	0.0687 (0.0569)	-0.0037 (0.0325)	-0.4864 (0.1723)
Moderate	-0.0253 (0.0109)	-0.2334 (0.0742)	-0.0009 (0.0270)	-0.5024 (0.1530)
Balanced	-0.0260 (0.0133)	-0.3146 (0.0923)	0.0050 (0.0237)	-0.5187 (0.1350)
Risky	-0.0624 (0.0240)	-0.2560 (0.1404)	0.0121 (0.0306)	-0.4403 (0.1132)

Source: calculated by the author.

In VAR(1) model almost all coefficients of α vectors are statistically significant under conventional levels with the exception of a coefficient from $\Delta \hat{v}_t$ equation. In this setting, in moderate, balanced and risky funds, both variables (net value of assets and transfers) respond to the disequilibrium. The absolute magnitude of the coefficient indicates that the impact of assets is more noticeable than the impact of transfers. As it can be seen from (8) and (12), disequilibrium may be induced by the unexpected changes in the rate of return r_t^* or may be rolled over from the past and reflected through the cumulative growth factor κ_t. Of course, it is not unexpected that disequilibrium which originates from the surprises in the rate of return is eliminated by the changes in the net value of assets, as the net value of assets is directly the result of r_t^*. At first sight, what is unusual about the results is that transfers also contribute to the error correction. This may be explained by the fact that higher returns usually denote positive shocks or the expectations of positive shocks and they may also have positive effects on the main sources of contributions: on wages and employment. That is why the responses of the variables have the same directions. A different pattern of error correction is observed in conservative funds. Disequilibrium is eliminated by the changes of transfers and not by the changes of net value of assets. This may arise if the changes in net value of assets do not depend on wage or employment shocks or respond to these shocks with a substantial lag. Most probably this is exactly what we have observed here. Conservative funds invest large portions of assets into bonds and deposits with defined returns, so the expectations are fulfilled and the errors may arise only from the portion of investments with undefined returns. The changes in the interest rates paid on bonds or deposits have the effects on employment and wages or reflect these changes, therefore the error is corrected by the transfers as they are the result of wages and employment. The contrary direction of adjustment process may be explained by the fact that interest rates paid on low risk financial instruments are less volatile and disequilibrium is likely to be transmitted into the next period where because of the autoregressive nature of the system, the change of the same direction in transfers will be observed.

In VAR(2) model we have significant speed of adjustment coefficients only for $\Delta \hat{v}_t$ equations. The absolute magnitudes are larger than in VAR(1) model. The directions of change do not differ among different funds. Insignificant coefficients in equations of transfers mean that transfers do not respond to disequilibrium and probably the changes in the growth rate of capital do not induce any changes in the growth rate of transfers. This means that capital and labour markets are not interrelated, which is hard to believe. Coefficients for conservative funds have the same signs as coefficients for the remaining funds in equations for $\Delta \hat{v}_t$ which again contradicts the fact the low risk investment returns are usually paid in the promised amount so that the returns of conservative funds usually lag way behind the trends of the market or are even contrary in the direction.

Cointegrating vectors are normalized with respect to $\hat{v}_t$, so that error correction term is:

$$\beta' y_{t-1} = \begin{bmatrix} 1 & -\beta_{12} \end{bmatrix} \begin{bmatrix} \hat{v}_{t-1} \\ \hat{z}_{t-1} \end{bmatrix} \tag{23}$$

TABLE 8. **Estimates of the parameters of cointegrating vector (standard errors in parentheses) for VAR(1) and VAR(2) specifications**

	VAR(1)	VAR(2)
Conservative	-24.0165 (5.8057)	-1.2428 (1.7183)
Moderate	11.1842 (4.8054)	-0.1577 (1.4455)
Balanced	10.1255 (3.9386)	1.9729 (1.8960)
Risky	6.7663 (1.9670)	-1.2412 (1.7542)

Source: calculated by the author.

Cointegrating vectors of VAR(1) models shows that if transfers go up, net value of assets decreases in moderate, balanced and risky funds. The lowest decrease can be observed in risky funds. This relationship represents the diminishing returns of the net value of assets and the presence of logarithmic trend in data generating process, which was discussed earlier. Conservative funds tell a completely different story – net value of assets grows as transfers increase. Again, probably the best possibilities to overcome the diminishing returns induced by the logarithmic trend and the best possibilities to accumulate funds necessary for the replacement of reduced PAYG pension arise from the investments in the low risk assets.

Cointegrating vectors of VAR(2) models have coefficients that are statistically insignificant, which in turn means that equilibrium errors may be considered as the values of net assets, which again makes no sense. Even if the coefficients were statistically significant, they would not represent diminishing returns that are implied by the equation (14) and (15), as they are too low in their absolute magnitude. The signs of the parameters make no sense as it is impossible to explain the negative coefficients for all funds except a positive one for balanced funds. Overall VAR(1) specification gave more meaningful results, despite the initial doubts.

Additional warnings and limitations

Analysis results and conclusions should not be perceived as a collection of "undoubtful facts" or as unreserved. Moderation is demanded and necessary for several reasons. As it was already mentioned, all the results may be biased by the relatively small sample. The small sample hinders extraction of long-run properties and tendencies. 33 quarterly observations are not enough for strong judgements, or for equilibrium analysis. There is no consensus whether time disaggregation can yield significant gains in the study of long-run relationships (Maddala & Kim, 1998), but one can be sure that 33 annual observations would deliver us more reliable results compared with 33 quarterly observations.

A reader should be aware that the model that is presented here does not imply structural relationships. First of all, note that only wages can be causal to the net value of assets, as they are the source of PAYG contributions and as they are the only source for pension funds investments. Any other relationships should not be considered as causal yet, as I have not provided any discussion on transmission channels from the net value of assets into the wages. The finding that wages respond to the disequilibrium should not be misinterpreted as the causality of assets to wages. As it was mentioned, this model is a sophisticated tool to investigate the behaviour of the variables of interest and should not be placed in one line with the econometric models for labour or financial markets. The main technical task is to determine the role of the log of cumulative growth factor κ_t in (12).

These results are obtained under the assumption that a person earns average wages over a lifetime and has the typical (average) employment history, they cannot be generalised and applied for the individuals who earn significantly more than average.

All calculations were performed using statistical software **R**.

Conclusions

All unit root tests indicate that net values of assets for all funds are I(1) and not I(2). That means that cumulative effect in the net value of assets is pushed out by insufficient growth of capital, which is significantly less than the predictable growth rate of wages.

Disequilibrium between the net values of assets and the transfers may be induced by the unexpected changes in the rate of return or may be rolled over from the past and reflected through the cumulative growth factor.

In moderate, balanced and risky funds, net values of assets and transfers respond to the disequilibrium and the impact of assets is more noticeable than that of transfers. A different pattern of error correction is observed in conservative funds. Disequilibrium is eliminated by the changes of transfers and not by the changes of net value of assets. This may arise if the changes in net value of assets do not depend on wage or employment shocks or respond to these shocks with a substantial lag. This means that investment in low-risk financial securities, contrary to the risky investments, acts as additional protection of assets from the swings in financial as well as in labour market.

Examination of cointegrating vectors reveals that moderate, balanced and risky funds exhibit diminishing returns, whereas in conservative funds net value of assets grows as transfers increase. This means that the changes in net value of assets are not related to the changes in the labour market or respond with a substantial lag.

If things go on in the same fashion as they already were going, over the long-run the second pillar pension funds will not accumulate the supplementary pension, which would offset the losses from the reduction of PAYG pension.

Up to this point of time, conservative funds showed most promising results in retaining and accumulating the value of funds transferred and they act as the best protection from unexpected swings in the labour and financial markets.

The results of this study should be an alarm signal for pension funds to review their investment strategies or at least to take a closer look at them.

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