

Filip ChybalskiŁódź University of Technology
e-mail: filip.chybalski@p.lodz.pl

**UNCERTAINTY OF FORECASTING (IN)SOLVENCY
OF PENSION SYSTEM BASED ON THE NDC MODEL¹**

**NIEPEWNOŚĆ W PROGNOZOWANIU
(NIE)WYPŁACALNOŚCI W SYSTEMIE
EMERYTALNYM OPARTYM NA MODELU NDC**

DOI: 10.15611/ekt.2015.1.04

Summary: The main purpose of this paper is to identify and characterise the factors of uncertainty in forecasting the (in)solvency of a pension system based on the non-financial defined contribution model (NDC) and to evaluate the forecasting function of automatic balance mechanisms (ABM). The study is theoretical and empirical. It dismisses the hypothesis of automatic balancing of the NDC model, which justifies the forecasting of its (in)solvency. The paper discusses the problem of uncertainty in the long-term forecasting of the (in)solvency of a pension system and shows the rationale of applying ABM. It has an important forecasting function and support a long-term financial balance in the NDC model. The empirical part of the paper discusses, using a case study, the ABM-based principles of indexation in Sweden, considered to be exemplary in literature. They are juxtaposed to the principles of indexation under the Polish 1st pillar functioning without ABM and are detached from the changes in the economic and demographic conditions of the pension system.

Keywords: pension, NDC, defined contribution, solvency, automatic balance mechanism.

Streszczenie: Zasadniczym celem artykułu jest wskazanie i charakterystyka źródeł niepewności w prognozowaniu (nie)wypłacalności systemu emerytalnego opartego na niefinansowym modelu zdefiniowanej składki NDC oraz ocena funkcji prognostycznej automatycznych mechanizmów bilansujących (ABM – *automatic balance mechanism*). Opracowanie ma charakter teoretyczno-empiryczny. Odrzucono w nim hipotezę o samoczynnym bilansowaniu się modelu NDC, co uzasadnia prognozowanie jego (nie)wypłacalności. Omówiono problematykę niepewności w długookresowym prognozowaniu (nie)wypłacalności systemu emerytalnego i wskazano na zasadność stosowania ABM. Pełni on istotną funkcję prognostyczną i sprzyja długoterminowej równowadze finansowej w modelu NDC. W części empirycznej, w oparciu o metodę *case study*, omówiono zasady waloryzacji oparte na ABM w Szwecji, uznawane w literaturze za jedno z wzorcowych. Przeciwstawiono im zasady waloryzacji

¹ This paper forms part of the project funded by the National Science Centre under grant number DEC-2013/09/B/HS4/01516.

w I filarze w Polsce – niezawierające ABM i oderwane od zmian, jakich może doświadczać otoczenie ekonomiczno-demograficzne systemu emerytalnego.

Słowa kluczowe: emerytura, NDC, zdefiniowana składka, wypłacalność, automatyczny mechanizm bilansujący.

1. Introduction

The process of the ageing of society has caused a complete change in the perception of pension security, now compared to several decades ago. Pension adequacy is no longer the only and basic evaluation criterion of the efficiency of a pension system. Pension systems are now evaluated also in terms of their solvency and financial stability. Why is this? It results directly from the macroeconomic definition of a pension system, according to which it is a tool for distributing the current GDP between generations [Góra 2003; Barr, Diamond 2006]. With the ageing of society, the ratio of pensioners in the total population is rising, and thus their share in the distribution of income is also growing. Earlier on, when people had shorter life span and received pension for a shorter period and at the same time more children were born, the share of pensioners in the distribution of GDP was so low that the stability of pension systems was not jeopardised, despite a relatively high income adequacy. Back then, the evaluation of a pension system in the macro scale was not as significant as it is now. What mattered instead was the system's efficiency in the micro scale. From the perspective of an individual, a pension system is a tool for consumption smoothing or a tool for income allocation in a life cycle [Barr 1993; Barr, Diamond 2006; Blake 2006; Góra 2003]. In the current analyses of public pension systems, the macro perspective is gaining in importance, whereas what matters in the micro scale is no longer high pension adequacy, but rather sufficient adequacy that protects against poverty. An individual may get more outside the public system, for example under the 3rd pillar, which is fully voluntary and privately managed.

Ensuring the solvency of pension systems, both in the short and long-term perspective, requires difficult political decisions as economic criteria are not the only ones that determine the path of pension system reforms. This encourages the postponement of unpopular decisions, such as raising the retirement age, lowering pension benefits or increasing pension contributions. A method to make the solvency of a pension system partially independent from political factors is automatic balance mechanisms (ABM). Accordingly, the main purpose of the paper is to identify and characterise the factors of uncertainty in solvency forecasting and to evaluate the forecasting function of ABM in a pension system based on the NDC (non-financial defined contribution or notional defined contribution)² model.

² The text is a continuation of the author's deliberations on the uncertainty of forecasting variables that describe pension systems. Previously, the focus was on uncertainty in forecasting pension income, which was reflected in a paper published in *Econometrics* 4(38)/2012.

The paper, which is of a theoretical and empirical nature, discusses the uncertainty in the long-term forecasting of solvency in the NDC model, which is an important argument for the use of automatic balance mechanisms, and the idea and principles of constructing ABMs (based on the example of Sweden), and evaluates the solution that functions in this area in Poland. The paper ends with a summary containing synthetic conclusions.

2. Uncertainty in the long-term forecasting of solvency in the NDC model

In the pillars of pension systems based on the funded defined contribution model (FDC) during the accumulation phase, changes in the value of accumulated capital are a derivative of the rate of return on financial markets, hence such a model balances itself automatically. This is not the case with the NDC model, where the hypothetical capital recorded on an individual account in the accumulation phase is subject to indexation.

The pension system is solvent in a given period (t), if its assets (A) balance its liabilities (L) or are greater than liabilities, i.e.:

$$A_t \geq L_t.$$

The assets of a system consist of contributions (C) and buffer fund (BF)³, whereas liabilities consist of pensions in payment. In the NDC model, which is a variation of the pay-as-you-go (PAYG) model, current contributions finance current benefits, which means that, according to the two-period overlapping generations model developed by Diamond and Samuelson (see [Blake 2006]), the income stream from the younger generations is transferred directly to the payment stream in order to cover the current pension liabilities towards the older generations. At the same time, future liabilities are formed towards the younger generations for when they will retire. In order to understand the uncertainty accompanying the long-term forecasting of assets and liabilities in the NDC model, and at the same time to predict its (in) solvency, it is necessary to observe the numerous factors that determine both sides of the above equation. Given a fixed pension contribution and predetermined retirement age, on the side of assets, there are: (1) quantitative contribution base (the amount of contributors), (2) incomes of contributors and, (3) returns on buffer fund. On the side of liabilities, there is the quantitative base of beneficiaries. It should be noted that in the case of the quantitative contribution base it is sensitive to the age structure of the population (the number of persons of working age) and the situation on the labour market. Moreover, the value of contribution assets is determined by the level of wages. With a given initial level of the buffer fund, its future value is determined

³ A buffer fund would be unnecessary only in a steady state by given income and mortality pattern and set of pension-system rules [Settergren, Mikula 2005].

by the rate of return referring to the assets. On the other hand, the quantitative base of beneficiaries is determined by the estimated life expectancy of pensioners. This proves that a permanent balance in a defined contribution system⁴ with any rate of contribution indexation is a myth. This is due to a number of reasons:

- in the accumulation phase, the adjustment rate, if it is the effect of a political decision and is not well rooted in the dynamics of the above factors shaping the assets and liabilities of the system, may cause their imbalance both over a short and long period of time. Thus, the final capital of a given person (at the moment when he or she retires), which is a derivative of the contributions paid and indexation and at the same time constitutes the basis to calculate lifetime annuity (pension benefit) is only apparently balanced with the actual contributions paid, if the adjustment mechanism is defective;
- in the decumulation phase, when the annuity is determined and is subject to indexation, life expectancy may be a dynamic factor, which again invalidates the previously calculated value of annuity. This is the reason for the insurance-like nature of a pension system with payments in the form of lifetime annuities, which manifests itself during the decumulation phase rather than during the accumulation phase.

The above problem of imbalance during the accumulation phase does not exist in the FDC system without any guarantees concerning the funds. In this model, liabilities are automatically balanced with assets, as the former are a derivative of the latter, adjusted by the rate of return on a portfolio. If the rate is negative, the value of assets goes down and so does the value of liabilities, i.e. the accumulated capital. Thus, it only makes sense to forecast the amount of that capital in the future, and not the solvency of the system, as the system, providing that it does not have any capital guarantees, balances itself automatically. This is not the case with the NDC model, as the rate of return is not the rate of return on a portfolio, but a certain conventional rate of return. Thus the term: notional defined contribution. The falseness of the hypothesis that the NDC model balances itself automatically in the accumulation phase is the basic reason to forecast the solvency of a pension system. This is due to the fact that solvency is not certain. At most, it can be promised.

(In)solvency forecasts can be quantitative or qualitative and perform both preparatory and activating functions. Also, they can be short or long term – the former enable the current balancing of a system's assets and liabilities, whereas the latter may serve the purpose of the long-term planning of a system's finance. However,

⁴ According to Góra [2011], the new pension system in Poland (introduced in 1999) balances itself automatically, and this concerns each part of the system, namely the 1st pillar (NDC) and the 2nd pillar (FDC). A different opinion is held by Otto and Wiśniewski [2013], who believe that the indexation method of contributions and benefits is essential to maintain the solvency of the system. By claiming this, they reject the main thesis of the government report "Review of the functioning of the pension system – safety through sustainability" [Ministry of Labour and Social Policy, Ministry of Finance 2013], according to which the "The 2nd pillar will have a sustainable balance."

there is an important argument in favour of a short-term but frequent action aimed at balancing the system, and thus in favour of using mainly short-term rather than long-term forecasts. This argument is the huge uncertainty associated with the long-term forecasting of the value of a system's assets and liabilities. As an example, let us analyse the quantitative contribution base. Although a significant threat is predicted for the PAYG model, and at the same time NDC, because of demographic changes, it is hard to forecast the migration balance 20-30 years ahead. Hill [2010], even believes migration to be the biggest unknown, because it usually concerns young people, which is why a high emigration rate increases the ratio of old people to young people, and a high immigration rate – the other way round. If in the years to come a large number of people move from the east to the Western Europe, the pace of the ageing of societies in Eastern Europe will increase, whereas it will decrease in Western Europe. Moreover, the previously unreported migration of elderly people – retirees from Northern Europe to Spain or Greece may intensify, which again will invalidate forecasts concerning older age cohorts both in the south and north of Europe. The above deliberations lead to the conclusion that the existence of certain economic factors may invalidate demographic forecasts [Hill 2010]. The above and other limitations that negatively affect the reliability of long-term forecasts of pension system solvency are of course known to the institutions that develop these forecasts. For example the Polish Social Insurance Institution [ZUS 2013], observes in its study that “because of the nature of chance events, the long time horizon of a forecast, the assumptions made and the available data, the results should be treated as the realisation of three scenarios.” In fact the three scenarios are characterised by very divergent results (Tab. 1).

Table 1. Forecast of annual balance of the FUS pension fund (Polish Social Insurance Fund) (in million PLN)

Year	Option I	Option II	Option III
2020	-67 025	-77.459	-58.652
2040	-68.450	-101.016	-34.356
2060	-124.295	-165.915	-43.574

Source: [ZUS 2013].

Also the Economic and Scientific Policy Department of the European Parliament (2011) suggests that the above mentioned forecasts should be treated with much reserve. When developing financial forecasts for pension systems in EU Member States by 2060, it was noted that projections of pension expenditure may be underestimated as higher life expectancy and lower labour productivity growth may influence pension systems more than assumed. The same problem refers to labour market participation and effective retirement age. The uncertainty of the forecasts of life expectancy is also difficult to assess, which was experienced in the past to

a surprisingly large extent [European Parliament 2011]. Life-expectancy projections have consistently under-predicted mortality improvements. 15-year forecasts of the population at older ages in Europe and North America are underestimated by around 10 percent [National Research Council 2000]. For example, subsequent forecasts (from 1981, 1996 and 2004) of the population aged 65 and over in 2060 for the United Kingdom, were: 12, 14 and above 18 million, respectively [Whitehouse 2007].

Thus, if the usefulness of long-term forecasts of the (in)solvency of a pension system is very limited in the decision-making process due to the high uncertainty accompanying them, what is the alternative solution? There is no doubt as to the fact that (in)solvency forecasts should play an important activating, and even preparatory function. However, to make forecasts reliable enough to meet the requirement mentioned above, their time horizon must be adequately short, which is the characteristic feature of the automatic balance mechanism discussed in the next item.

3. Automatic balance mechanism as a method to reduce the impact of forecast uncertainty on the NDC system balance

As has already been observed, both during the funds accumulation phase and during the decumulation phase, the capital and benefits, respectively, are indexed based on a given interest rate. It is specifically this indexation, as the effect of an appropriate political decision that guarantees the long-term balance in the NDC model. However, if wrongly designed, it leads to a system's imbalance.

A properly constructed adjustment mechanism should guarantee the automatic balancing of a system, which means equality between its assets (contributions) and liabilities (pensions in payment). This can work in two main ways: (1) by taking the relevant political decisions at the appropriate time, (2) by ensuring the automatic balancing of the rate of adjustment with the economic and demographic situation in the country. According to Diamond, given on the one hand the ease with which politicians increase benefits and reduce taxes and on the other hand the problems they have with reducing benefits and increasing taxes, if there is (today) a law that provides for a future increase in taxes (contributions) and a reduction of benefits, the political cost of maintaining the balance of a pension system is lower because it is easier to pass a law that will "hurt" in the future than one that will "hurt" today [Diamond 2004]. This argument is the main and basic reason for applying a set of indicators that monitor the financial stability of a pension system both over a short and long period of time. Moreover, it recommends the introduction of the system's balance mechanism. Then, the monitoring indicator (or indicators) performs the function of a "trigger" of considered mechanism without the need to make an appropriate political decision. The principles of adjustment change automatically under the automatic balance mechanism. The ABM is a set of predetermined measures established in the appropriate acts of law, which aims at maintaining

the required level of the solvency of a pension system based on the PAYG model. A major advantage of the ABM is its relative resistance to political factors, because the principles of “triggering” the ABM, provided for in legal regulations, do not require additional political decisions [Vidal-Melia et al. 2008]. What is important is not only their monitoring activity, but primarily their anticipating activity that serves the purpose of balancing the expected value of a system’s assets (contributions) and liabilities (pensions in payment) in the future.

While indicators that monitor the solvency of a pension system, due to their predictive properties, may at most perform an activating function⁵, a well-constructed ABM should contain in itself the entire forecasting process defined as a sequence of subsequent stages – from the formulation of the forecasting task to the application of the forecast and then the evaluation of its accuracy.⁶ This is when a forecast may perform a preparatory function.⁷ The purpose of the ABM is to ensure the indexation of contributions and benefits in a non-financial defined contribution system at the level of the internal rate of return (*IRR*). In that case, *IRR* is the rate at which pension liabilities must be indexed to ensure that they grow at the same rate as assets [Settergren 2002]. The most important issue here, is to identify the determinants of the *IRR*. These are the factors, discussed in the previous item, that determine assets and liabilities. Thus, basing the indexation of contributions or benefits only on wage dynamics, inflation or GDP growth in disregard of demography or growing life expectancy, is a far-reaching simplification that in the long term leads to the imbalance of the PAYG system. The above factors of the value of assets and liabilities should be controlled on an ongoing basis and if the ABM functions in a given pension system, they should be integrated into that mechanism.

ABM should work in such a way as to balance the assets and liabilities of a system in a long-time span. Its construction should start with defining the monitoring indicator that serves for the evaluation of a system’s solvency (solvency indicator). Generally speaking, its value should indicate the relationship between the assets and liabilities of a system. The solvency indicator determines whether or not to trigger specific changes in given parameters of a pension system. This is due to the fact that its value in a given moment is treated as a warning qualitative forecast that informs of the future (in)solvency of a system. Importantly, the solvency indicator should be calculated at appropriate, not too long intervals so that assets and liabilities are balanced without unnecessary delays that put solvency at risk.

The ABM applied in Sweden is presented as an example, because it is the most widely discussed in literature. Even though it is not perfect and certain modifications were proposed in order to minimise the asymmetry of liabilities towards the young

⁵ A forecast performs an activating function if it encourages actions that support or prevent its realisation, depending on whether it is positive or negative [Cieślak 2001].

⁶ According to a scheme of sequential construction and application of forecasts [Dittmann 2003].

⁷ A forecast performs a preparatory function if it prepares other actions [Cieślak 2001].

generation and the old generation (see [Barr and Diamond 2011]), it is considered to be an efficient mechanism that ensures the long-term balance of an NDC system. In its unfunded part, the Swedish pension system is based on the defined contribution model (i.e. it is an NDC model). The solvency ratio SR is expressed by the following formula [Settergren 2001]:

$$SR = \frac{\text{Contribution asset} + \text{Buffer fund}}{\text{Pension liability}} .$$

$SR < 1$ signals the risk of future insolvency of the system, which triggers the ABM. It works mainly by limiting the growth of both current and future pension benefits, which means that the system is balanced on the side of liabilities rather than assets (contributions). In the case of current liabilities (pensions in payment), the point is to reduce the indexation of benefits, whereas in the case of future pension benefits, the point is to limit the current growth of accumulated capital, i.e. to index contributions. The former limitation affects the old generation, whereas the latter – the young generation. The balance index BI is based on the following formula:

$$BI_t = \frac{I_{t+i}}{I_{t+i-1}} SR_t ,$$

where I_t denotes the income index in year t . In a situation where the ABM is triggered and SR reaches a value above 1, the adjustment of both pension contributions and pension benefits will be higher than wage dynamics. This will remain so until $BI=I$. This means that after completion of the operation of the balance mechanism, a pension benefit will reach the same value it would have if there was no ABM. It is worth noting that, for example, in the German ABM model, apart from income dynamics the contribution base also provides for the relationship between the number of contributors and pensioners. The indicator that serves this purpose is called the “sustainability factor” and it redistributes the necessary adjustment caused by the change in the relation between contributors and pensioners between these two groups [Borsch-Supan, Wilke 2004].

Since in the case of ABM “only historic transactions are used to calculate the liability and assets” [Settergren 2002], one could doubt whether the idea of this adjustment mechanism indeed incorporates any forecast, if assets and liabilities are balanced only on the basis of past data. In fact, the ABM model is fully based on the adaptive expectations hypothesis, according to which the value of a given variable is forecasted only on the basis of past data for that variable [Snowdon, Vane, Wynarczyk 1998]. However, since the use of appropriate corrective indicators within the framework of ABM concerns the future (adjustment applies to future contributions or benefits), what we have is a forecast [Ambachtseer, Ezra 2001]. Thus the forecasting basis in the balance mechanism is fully passive with respect to the future. Besides, a certain systematic delay, usually equal to one year, is

embedded into it. However, the fact that the mechanism is quick to trigger, much faster than a relevant legislative process (such as a legal act modifying or suspending adjustment) as well as the evolving nature of demographic changes that determine the contributors' and retirees' base, compensate for the negative consequences of the above mentioned delay.

4. Pension indexation in the Polish NDC model and its solvency

The reform of the Polish pension system in 1997-1999 was, alongside the Chilean solution, modelled on the Swedish experience. The same as in Sweden, in Poland, too, the NDC model was applied in the first pillar. The indexation of contributions and benefits in the Polish pension system is performed according to three main schemes. The first two concern the accumulation phase and the third – the decumulation phase. In the accumulation phase, the two main methods of indexation concern the basic account (where 12.22% of wages are deposited) and the subaccount (where, after the recent changes, 2.92% of wages may be transferred). Contributions on the basic account are indexed based on the total consumer price index in the calendar year preceding the date of indexation compared to the previous year, increased by the real growth of the sum of pension contributions due in the calendar year preceding the date of indexation compared to the previous year. However, the indexation rate may not be lower than the total consumer price index in the calendar year preceding the date of indexation compared to the previous year. Also, the account balance may not be reduced as a result of indexation. The second indexation – concerning the ZUS subaccount – is based on an index equal to the average annual GDP growth in current prices in the period of five years preceding the indexation. Here, too, the account balance may not be reduced as a result of indexation. The last type of indexation concerns pension benefits, i.e. the decumulation phase. The pension indexation rate is equal to the average annual consumer price index in the previous calendar year increased by at least 20% of the real growth in average wage in the previous calendar. This index is every year negotiated within the framework of the Trilateral Commission for Social and Economic Affairs.

It could be questioned whether such indexation methods guarantee the long-term balance of the NDC system. Despite the common view that introducing the defined contribution (DC) model in the 1st pillar would guarantee the automatic balancing of the system, the hypothesis cannot be considered to be true. This is due to a number of reasons:

- even though indexation on the basic account was linked with the dynamics of pension contributions, which takes into account both wage dynamics and the labour market situation (including leaving the labour market and joining the pensioner population), it was assumed that indexation could not be negative, which in the case of negative wage dynamics or growth in unemployment could result in the decrease of contributions at zero (rather than negative) indexation;

- a similar problem concerns the subaccount, because it cannot be guaranteed that Polish GDP growth will be positive in every 5-year period. For example, according to Eurostat data, between 2008 and 2012, Estonia's economy shrank by 3.85%, Ireland's – by 7.29%, Latvia's – by 12.59% and Greece's – by 20.03% (in real terms);
- the pension indexation rate was linked with inflation, which is of course justifiable, however, it must exceed inflation by at least 20% of real wage growth. Also, the final amount of indexation is not unaffected by political factors, as it is the result of negotiations within the framework of the Trilateral Commission;
- in the decumulation phase, the indexation method does not in any way take into account life expectancy dynamics;
- none of the adjustment indices takes into account the relationship between the number of beneficiaries and the number of contributors.

Given the goal of the long-term solvency of the Polish Social Insurance Institution (ZUS), indexation mechanisms were founded on the following assumptions as to the future that are not justified by any reliable forecasts: there will be no deflation⁸, the amount of contributions will not decrease (despite the ageing society), there is no way for the GDP to decrease during any future period of five subsequent years, and life expectancy will not grow.

It is due to the lack of any links between the principles of indexation and the real conditions in which the NDC model functions that, for example, between 2007 and 2009 the Polish GDP grew by 26.7 % in nominal terms, while indexation increased the liabilities of ZUS by 40.7 % [Otto, Wiśniewski 2013]. Even though ZUS develops a long-term forecast of the inflows and outflows of the pension fund within the Social Insurance Fund, the forecast (multi-variant) does not automatically trigger actions aimed at balancing the system's assets with its liabilities. It does not perform the desired activating function. Probably, this is mainly due to political factors.

5. Conclusions

The need to use forecasts in the NDC pension system solvency management process does not raise any doubt. However, the condition to use demographic or economic forecasts, as well as any other forecasts, is their adequate reliability and the resulting trust in a forecast. It transpires that long-term forecasts of the respective factors of pension system solvency and thus the forecasts of solvency itself are characterised by very low reliability. This of course does not undermine the validity of constructing this type of forecasts or financial plans with a long time horizon. However, their function

⁸ This is contrary e.g. to the data of the Central Statistical Office of Poland (GUS) for July 2014, when consumer prices dropped by 0.2% compared to the previous month. Also, for example the Polish Monetary Policy Council sees the risk of deflation in 2014. Thus, deflation is not an abstract phenomenon in Polish reality and, although its risk in an annual scale is not high, it is not improbable.

is more informative than activating or preparatory. The systematic balancing of the assets and liabilities of a system based on reliable information requires appropriate actions in a short time horizon. This is enabled by the ABM, whose many advantages include one that is very important – relative resistance to political factors.

The 1st pension pillar in Poland definitely needs the ABM. At present, it has an embedded automatic insolvency mechanism, regardless of whether an evaluation takes into account payments from the old system (DB) or only from the new system (DC). Thus it is worth constructing and monitoring on an ongoing basis indicators that predict accurately the solvency of a system rather than to base the principles of indexation only on GDP growth (as is the case of the ZUS subaccount), or to assume in advance the impossibility of negative indexation, which is not reflected by financial data.

The forecasting properties of the ABM are mainly reflected in its short-term but systematic balancing activity, which has an anticipatory character, even though it is fully based on historical information and does not contain any elements of extrapolation into the future. The ABMs function as adaptive models which in each subsequent step take into consideration newly incoming past data. Nonetheless, relatively short intervals between respective monitoring activities (usually equal to one year) enable relevant modifications in the value of pension system parameters (especially adjustment) with the shortest possible delay. Thus, even if there is an imbalance between the assets and liabilities of a system, it should be temporary.

Literature

- Ambachtsheer K.P., Ezra D.D., 2001, *Fundusze emerytalne. Jak efektywnie pomnażać majątek ich członków?*, Oficyna Ekonomiczna, Kraków.
- Barr N., 1993, *Ekonomika polityki społecznej*, Poznań.
- Barr N., Diamond P., 2006, *The economics of pensions*, Oxford Review of Economics Policy, vol. 22, no. 1.
- Barr N., Diamond P., 2011, *Improving Sweden's automatic pension adjustment mechanism*, Center for Retirement Research at Boston College, no. 11-12.
- Blake D., 2006, *Pension Economics*, West Sussex.
- Borsch-Supan A., Wilke Ch., 2004, *The German public pension system: How it was, how it will be?*, NBER Working Paper 10525, National Bureau of Economic Research, Cambridge.
- Cieślak M. (red.), 2001, *Prognozowanie gospodarcze. Metody i zastosowania*, Wydawnictwo Naukowe PWN, Warszawa.
- Diamond P., 2004, *Social security*, American Economic Review, vol. 94, no. 1.
- Dittmann P., 2003, *Prognozowanie w przedsiębiorstwie*, Oficyna Ekonomiczna, Kraków.
- European Parliament, 2011, *Pension Systems in the EU – contingent liabilities and assets in the public and private sector*, Brussels.
- Góra M., 2003, *System emerytalny*, Polskie Wydawnictwo Ekonomiczne, Warszawa.
- Góra M., 2011, *Dyskusja dotycząca systemu emerytalnego. Błędna identyfikacja problemów, błędna diagnoza*, Analizy BAS, nr 2(46).
- Hill M., 2010, *Polityka społeczna we współczesnym świecie. Analiza porównawcza*, Difin, Warszawa.

- Ministerstwo Pracy i Polityki Społecznej, Ministerstwo Finansów, 2013, *Przegląd funkcjonowania systemu emerytalnego. Bezpieczeństwo dzięki różnorodności*, Warszawa.
- National Research Council, 2000, *Beyond Six Billion: Forecasting the World's Population, Panel on Population Projections*, [in:] J. Bongaarts, R.A. Butatao (eds), *Committee on Population, Commission on Behavioural and Social Sciences and Education*, National Academy Press, Washington, D.C.
- Otto W., Wiśniewski M., 2013, *ZUS - równowaga to mit*, tryb dostępu: [<http://www.ekonomia.rp.pl/artukul/1029930.html>], data wejścia: 22.01.2014].
- Settergren O., 2001, *The automatic balance mechanism of the Swedish pension system – a non-technical introduction*, *Wirtschaftspolitische Blätter*, no. 4, pp. 339-349.
- Settergren O., 2002, *Financial and Intergenerational Balance? An introduction to how the new Swedish pension system manages conflict ambitions*, *Scandinavian Insurance Quarterly*, no. 2, pp. 99-114.
- Settergren O., Mikula B., 2005, *The rate of return of pay-as-you-go pension systems: a more exact consumption-loan model of interest*, *Journal of Pension Economics and Finance*, 4(02), pp. 115-138.
- Snowdon B., Vane H., Wyncarczyk P., 1998, *Współczesne nurty teorii makroekonomii*, Wydawnictwo Naukowe PWN, Warszawa.
- Vidal-Melia C., Boado-Panas M., Settergren O., 2009, *Automatic balance mechanisms in pay-as-you-go pension systems*, *The Geneva Papers on Risk and Insurance Issue and Practice*, vol. 34.
- Whitehouse E., 2007, *Life-expectancy risk and pensions: who bears the burden?*, *OECD Social, Employment and Migration Working Papers* no. 60, OECD, Paris.
- ZUS, 2013, *Prognoza wpływów i wydatków funduszu emerytalnego do 2060 roku*, Warszawa.