Lisenkova, Katerina (2011) Pension reform in a rapidly ageing country : the case of Ukraine. Discussion paper. University of Strathclyde Business School, Department of Economics, Glasgow. ,

STRATHCLYDE

DISCUSSION PAPERS IN ECONOMICS

PENSION REFORM IN A RAPIDLY AGEING COUNTRY: THE CASE OF UKRAINE

BY

KATERINA LISENKOVA

NO. 11-26

DEPARTMENT OF ECONOMICS
UNIVERSITY OF STRATHCLYDE
GLASGOW

Pension reform in a rapidly ageing country: the case of Ukraine

Katerina Lisenkova

katerina.lisenkova@strath.ac.uk

Abstract

Ukraine has a rapidly ageing and declining population. A dynamic forward-looking Computable General Equilibrium (CGE) model with an explicitly modelled Pay-As-You-Go pension scheme is constructed to perform simulations of different pension reform scenarios and investigate the impact of population ageing on a wide range of macroeconomic variables. It is shown that, changes in age structure will result in a significant negative impact on the economy and stability of the pension system. Analysis of the potential changes to the pension system is limited to modelling an increase of the pension age, keeping either the workers' contribution rate or replacement rate constant.

Key words: Ukraine, CGE modelling, pension reform, ageing

JEL codes: J26, J11, C68

The author is grateful to Professors Mark Shafer and Robert Wright for their guidance and constructive comments.

1. Introduction

Ukraine has a rapidly ageing and declining population. By the beginning of 2010 the total population had decreased by 12% since 1993, when it reached its peak of 52 million. According to population projections, presented in this paper, the share of the pension age population will increase from 24% in 2005 to 38% in 2050. At the same time, the share of the working age population will decrease from 54% to 44%.

Such a significant and rapid change in population age structure will likely have a number of macroeconomic effects. It will change the demand composition, as consumption preferences vary by age. It will affect national savings, as at different stages in their life cycles people have different savings propensities. There will be significant impacts on the size, composition and productivity of the labour force, and potentially even the speed of technological progress.

This paper concentrates on the effect of the interaction of the declining labour force and the growing number of pensioners on the pension system. The topic is especially timely because of the revived discussion about pension reform in Ukraine. It has long been recognized that the current design of the pension system is subject to high demographic risk and its Pay-As-You-Go (PAYG) component is not sustainable in the long run. Nevertheless, all previous attempts at reforming the system were only half hearted and did not address its major problems. Major reasons for that were political instability in the country and the reluctance of the political elite to disturb pensioners – a large, growing and very politically active part of the population. However, recently a combination of economic crises and pressure from the IMF has resulted in more serious and bold discussion of pension reform than ever. Currently a new piece of legislation, changing the rules determining pension system participation and eligibility, is being discussed in Parliament. The biggest change proposed is an increase of pension age for females by 5 years over the next 10 years from current level of 55 years to 60 years. The pension age for males is supposed to remain unchanged at 60 years.

A dynamic applied CGE model is an ideal analytical tool for this type of problem. It provides deterministic numerical solution and allows for complex and realistic representation of the economy. Most commonly for analysis of demographic change an overlapping generations (OLG) CGE models are employed. The obvious reason for this is a reach demographic structure of the model. The model structure presented by Auerbach and Kotlikoff (1987) attracted many followers and today most of the OLG CGE models follow their basic approach.

In this paper a more simple structure of an intertemporal CGE model with a representative household is used. The model follows the basic intertemporal structure of the Ramsey-Cass-Koopmans growth model (Ramsey, 1928; Cass, 1965; Koopmans, 1965). The standard model is modified in such a way that during the simulation period different age groups of the population are allowed to grow (decline) at a different rate. In a steady state, however, all growth rates converge to the constant growth rate of the total population. One important degree of freedom that this model set up lacks is the possibility of age-specific household behaviour. This problem could be solved with the OLG structure of the household. However, OLG models are much more difficult, and present another challenge: inter-generational transfers. This question is very important in the case of Ukraine, where inter-generational transfers are very significant. At the same time, the assumption of aggregate household (household that includes all generations) optimisation is quite reasonable for Ukraine, where inter-generational ties within the family are much stronger than in the West.

The model also includes an explicitly modelled PAYG pension scheme. The effect of an ageing population structure is modelled by the interaction of three processes: a declining labour force (which affects labour supply), an increasing proportion of pension age population (which affects the size of the outstanding pension benefits) and a declining total population (which affects the size of the government consumption). The modelling in this framework is a two-stage process. During the first stage the population projections are produced. In the second stage the growth rates of different population groups are used as an exogenous demographic shock in the CGE model.

The model was calibrated on the basis of 2007 Social Accounting Matrix (SAM) for Ukraine. Simulations are extended to 100 years in order to allow time for the population structure to stabilise. Even though the results are reported for the full simulation period, closer attention is paid to the first 50 years.

Analysis of the potential changes to the pension system is limited to modelling an increase of the pension age, keeping either the workers' contribution rate or replacement rate constant. The main conclusion is that pension age increase is not only necessary but also inevitable. Increasing the pension age for females to 60 years has a positive effect on macroeconomic variables and the pension system, but it is insufficient to achieve the goal of balancing the PAYG pension scheme in the long run. On the other hand, increasing the pension age to 65 for both sexes provides desired stability to the system.

Previously the issue of the Ukrainian pension reform was studied by Dobronogov (1998) and Dobronogov and Mayhew (2000). They used the economic-demographic growth model that was developed by the Social Security Reform Project of the International Institute for Applied Systems Analysis (IIASA) (MacKellar and Ermolaeva, 1999). The IIASA model does not follow a conventional CGE approach although it is also based on neoclassical assumptions. It has some features of a recursive dynamic CGE model, but it also has detailed treatment of the age-specific stocks and flows similar to those of OLG models. However, this model lacks endogenous behaviour and relies instead on exogenous assumptions about age-specific behavioural parameters (like labour force participation and saving/consumption propensities). Nevertheless, an obvious advantage of this model is the extensive treatment of the pension system and informal sector (defined as a share of labour income, from which pension contribution are not paid). This previous work also emphasise importance of widening the pension contribution base and stresses that the pension reform has no chance to succeed unless the pension age is increased.

Previous CGE research in the post-Soviet countries was concentrated on international trade issues, more specifically, on the impact of the WTO accession. Jensen, Rutherford and Tarr (2004) studied the impact the WTO accession of Russia, Pavel and Tochitskaya (2004) of Belarus, Pavel et al. (2004) of Ukraine and Jensen and Tarr (2007) of Kazakhstan. The models used in these studies are static.

The research presented in this paper expands the existing literature in a number of ways. It proposes an innovative application of the intertemporal CGE structure for the study of population ageing. It presents a fully featured dynamic CGE model calibrated for transition economy. And it studies the urgent and important issues of population ageing and pension reform in Ukraine using the most recent data.

The rest of the paper is organized as follows. Section 2 presents an overview of the Ukrainian pension system. Section 3 gives brief descriptions of the model, calibration and data. Section 4 describes simulations, scenarios and presents results. Section 5 concludes with a discussion of the results and the policy implications.

2. Overview of the Ukrainian Pension System

2.1. Background

The Ukrainian pension system was created on the basis of the former USSR pension system. It was a one level system operating mostly on the Pay-As-You-Go (PAYG) principle: i.e. benefits of most of current pensioners are financed by contributions of current workers. Pensions or parts thereof of some categories of workers are paid out of the state budget. In 2003, Ukraine started the process of comprehensive pension system reform. One of the important reasons for this reform was anticipated population ageing and the view that a PAYG pension scheme is subject to very high demographic risk. The law "On Mandatory State Pension Insurance" has introduced the three-tier system recommended by the World Bank (1994) and supported by reforms in other transition economies (Kazakhstan, Hungary – 1998, Poland – 1999, Latvia – 2001, Croatia, Estonia, Russia – 2002).

The first tier is the mandatory PAYG component (the existing system repackaged), complemented by the mandatory funded second tier (operated by government) and voluntary funded third tier (privately operated). The third tier has been functioning since 2005, although the participation rate is very low. Introduction of the second tier is conditional on reforming the PAYG component and has been postponed several times. One of the reasons why the second tier still exists only on paper is the unbalanced PAYG component.

The reform that started in 2003 stalled in the run-up to the presidential elections in 2004, when pensions were increased sharply. After this increase, in 2005 the balance of the pension scheme turned negative (for the first time), with a deficit reaching 25%. According to the most recent data in 2010 the deficit of the pension scheme reached 17% of total expenditures. The main goal of the new round of pension reform in Ukraine, discussion of which started in 2010, is to achieve a balanced PAYG pension scheme.

2.2. Revenue side

The PAYG pension scheme in Ukraine has two major sources of income: workers' contributions and state budget contributions. In 2010, workers' contributions accounted for 72% of total revenues, state budget contributions accounted for 23% and the remaining 5% came from other sources. Government contributions cover the pensions of some categories of workers, e.g. retired military servicemen and judges. However, these state budget contributions do not include deficit financing, which is also covered from the state budget and, as was mentioned before, in 2010 amounted to 17% of total expenditures.

Workers' contributions consist of two parts. An employer pays the largest part: 33.2% on top of the gross wage. An employee pays 2% of their gross wage. The employee's contributions are subtracted from the gross wage, while the employer's contributions are calculated on top of the gross wage; i.e. total labour cost for an employer including pension contributions is 133.2% of the gross wage.

2.3. Expenditure side

The current old-age pension age in Ukraine is 55 years for females and 60 for males. The pension age was set when the pension system of the USSR was developed in the middle of the 20th century, and it has not been changed since then. Other former USSR republics, with the exception of Russia, Belarus and Tajikistan, have increased the pension age. The pension age in most OECD countries is 65 years. Australia, Denmark, Germany, Iceland, Ireland, Israel, Norway, the United Kingdom and the United States have a normal pension age above 65 years for both sexes. Estonia, France, Slovak Republic and Slovenia have pension ages between 60 and 65 years for both sexes and Chile, The Czech Republic, Italy, Poland and Switzerland for females only (OECD 2011).

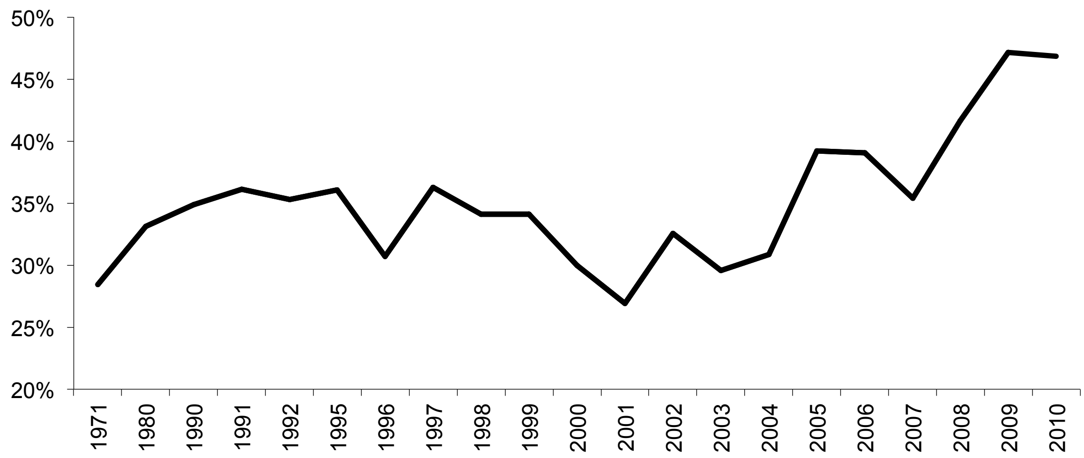
The common argument against an increase in pension age of males is very low life expectancy. It is true that the life expectancy at birth for males is very low: in 2005 it was only 62.2 years, compared with 74 for females (a difference of almost 12 years). However, this can be partially explained by very high mortality among working age males, and at the age of 60, male life expectancy in 2005 was 14.2 years, only 5.3 years below the life expectancy of females. If an increase in pension age for males is somewhat controversial, then the pension age for females is clearly much too low. In 2005, life expectancy for females at age 55 was 23.4, which is higher than the minimal required number of contribution years – 20 years. This means that, after contributing for only 20 years, a woman on average can expect to receive benefits for 23.4 years.

Two mechanisms of pension indexation are in place. A portion of the pension that does not exceed the minimum level is indexed to inflation. The total value of the pension is also partially indexed to wages, and this indexation should be no less than 20% of the average wage increase in the previous year, provided that pensions were growing more slowly than wages.

The replacement rate of average pension to average wage is presented in Figure 1. For most of the period, it fluctuated at around 33%. However, starting from 2005 when pensions were increase for political reasons for the first time, the replacement rate has increased significantly.

Most pensioners receive pensions that are not substantially higher than the minimal level. Lack of differentiation is exacerbated by indexation rules, as only the part that does not exceed the minimal level is indexed fully. However, some categories of workers are entitled to privileged pensions that are regulated by special legislation and significantly exceed the minimal level (e.g., people’s deputies, state officials, judges, public prosecutors, investigators, scientists and journalists).

Figure 1. Replacement rate



Source: State Statistical Committee of Ukraine, own calculations

Such an arrangement creates incentives for participants to pay the minimal possible contributions for a minimal possible period. An illegal but widespread method of avoiding paying pensions contributions (and other social security payments) is to pay a fraction of the wage "in an envelope", i.e. unregistered and without paying contributions on this amount. Because both employers and employees are not interested in making high contributions to the pension system, such illegal practices persist. As the result of this, in 2007 the effective workers' contribution rate was 23%[1], while the standard rate was 35.2% (33.2%+2%) of gross wage.

2.4. Proposed changes

The most important of the changes proposed in a current round of pension reform are the following:

- increase in female pension age from current level of 55 years to 60 years during the next 10 years (by half a year ever year)

[1] This is calculated based on the size of workers' pension contributions, taken from the Balance of the PAYG pension scheme, and employees' compensation, taken from the Social Accounting Matrix (SAM).

- increase in minimal required working records for males/females from 20/25 years to 30/35 years
- restriction of maximum pension size to 12 times the minimum pension
- introduction of the second tier of the pension system – mandatory funded component – starting from the year in which PAYG system will be balanced. All workers younger than 35 years old will be paying contributions to individual accounts. The contributions will be redirected from the PAYG tier, starting from 2 percentage points and increasing by 1 pp every year until they reach 7 pp of gross wage.

The current government aims to balance the PAYG scheme by 2015.

3. Model Description and Calibration

3.1. Model description

The model developed for simulations is an intertemporal dynamic CGE model of a small open economy. There is perfect foresight and no money illusion. The model does not include monetary variables and all value variables are in relative prices. There are four agents: the household, the firm, the government and the rest of the world (ROW). The discounted utility of the infinitely living household is maximized by choosing the optimal level of consumption and investment. The description of the main features of the model is provided below. For the complete listing of model equations see Appendix.

The household has an additive utility function, which it maximizes over the infinite time horizon

$$U = \sum_{t=1}^{\infty} \frac{(1+\mathrm{g}_t)^{t-1}}{(1+\rho)^t} \cdot \log(C_t)$$

subject to the following budget constraint for each period

$$A_{t+1} = (1+r_t)A_t + Y_t - P_t C_t$$

where subscript t indicates time period, C_t is the aggregate consumption, $log(C_t)$ is the annual utility level, g is the rate of population growth, ρ is the rate of time preference, P_t is the price of Armington composite, A_t is the asset level, r_t is the interest rate and Y_t is household income.

Solving consumer intertemporal optimization problem using first order conditions and applying transversality condition we arrive at the conventional Euler equation:

$$\frac{P_t C_t}{P_{t-1} C_{t-1}} = \frac{(1+r_t)(1+g_t)}{1+\rho}$$

There are five main sources of household income: labour income, dividends, pension benefits, other transfers from government and transfers from the ROW. The total income in each period is divided amongst income tax, consumption and household savings.

The firm belongs to the household, and produces one product. The firm uses two primary production factors (capital and labour) in the production process. Output is produced by a Cobb-Douglas aggregation of capital and labour. The technology exhibits constant returns to scale.

$$XD_t = aFK_t^{\alpha} L_t^{1-\alpha}$$

where XD_t is the level of output, aF is efficiency parameter, K_t is the capital and α is the share of capital in the value of the output.

We assume that the firm finances investments by issuing new shares. The value of the company is the net present value of the future dividends less the value of the new shares. The firm chooses the level of investment to maximize the value of the company

$$V = \sum_{t=1}^{\infty} \prod_{s=1}^{t} \left(\frac{1}{1+r_s} \right) \cdot (DIV_t - V_t^N)$$

subject to the capital accumulation constraint

$$K_{t+1} = (1-\delta)K_t + INV_t$$

where DIV_t are dividend payments, V_t^N is the value of the new shares, INV_t is the level of investment and δ is the depreciation rate. The value of the new shares is equal to the value of investment.

The dividends are given by

$$DIV_t = (1 - tp_t)PD_t XD_t - PL_t L_t - \varphi P_t \frac{INV_t^2}{K_t}$$

where *tp* is the indirect tax rate, *PD* is the price of output, the last expression on the right hand side is the capital adjustment cost and φ is the adjustment cost parameter. Adjustment cost implies that the firm loses part of its production due to the investment process. This results in gradual adjustment of the capital stock to its desired level.

By solving the producer problem with first order conditions we get the investment demand function, the Euler equation for the shadow price of capital (or Tobin's q) and the capital accumulation equation.

$$\frac{P_t INV_t}{K_t} = \frac{\lambda_{t+1} - P_t}{2\varphi}$$

$$(1-\delta)\lambda_{t+1} = (1 + r_t)\lambda_t - \frac{\alpha PD_t XD_t}{K_t}(1 - tp_t) - \varphi P_t \left(\frac{INV_t}{K_t}\right)^2$$

$$K_{t+1} = (1-\delta)K_t = INV_t$$

where λ_t is a shadow price of capital

The trade between the domestic market and **the ROW** is driven by the imperfect substitution between domestic and foreign goods. Based on the small country assumption, the country is a price taker in international trade. The final product is allocated between domestic sales (XDD_t) and exports (E_t) through a constant elasticity of transformation (CET) function.

$$XD_t - \varphi \frac{INV_t^2}{K} = aT\left[\gamma T \cdot E_t^{\frac{\sigma T - 1}{\sigma T}} + (1 - \gamma T) XDD_t^{\frac{\sigma T - 1}{\sigma T}}\right]^{\frac{\sigma T}{\sigma T - 1}}$$

where aT is the efficiency parameter and γT is the distribution parameter and σT is the elasticity of transformation.

Domestic consumption is an Armington composite (X_t) of domestically consumed domestic output and import (M_t) aggregated by a constant elasticity of substitution (CES) function:

$$X_t = aA\left[\gamma A \cdot M_t^{\frac{\sigma A-1}{\sigma A}} + (1-\gamma A)\cdot XDD_t^{\frac{\sigma A-1}{\sigma A}}\right]^{\frac{\sigma A}{\sigma A-1}}$$

where aA is the efficiency parameter and γA is the distribution parameter and σA is the elasticity of substitution.

And finally the balance of payments states that current account is equal to the capital account.

The government accumulates revenues from taxes (income and indirect tax) and transfers from the ROW, and spends them on goods and services (government consumption), investment, transfers to the household and government pension contributions. The government balances its budget every period by adjusting the indirect tax rate. Both government consumption and transfers to the household grow at the rate of population growth. Government pension contributions constitute a constant share of the total pension payments.

The PAYG component of the **pension system** is explicitly modelled**.** Pension revenues are financed from labour income (workers' pension contributions) and government budget (government pension contributions). The two policy parameters of the pension system are replacement rate (relative size of average pension to average wage) and effective workers' pension contribution rate. Fixing one of them determines the value of the other, given the number of pensioners.

If replacement rate is fixed, the PAYG scheme is described by the following equations:

$$PF_t = \frac{PL_t L_t}{lpop_t} repr \cdot ppop$$

$$GPC_t = PF_t \cdot GPCshare$$

$$PPC_t = PF_t - GPC_t$$

$$pc_t = \frac{PPC_t}{PL_t L_t}$$

where PF_t is the amount of the outstanding pension benefits, GPC_t and PPC_t are the government and the workers' pension contributions, *GPCshare* is the share of the government pension contributions, $lpop_t$ and $ppop_t$ is the size of the labour force and the number of pensioners respectively[2], $repr_t$ is the replacement rate and pc_t is the effective workers' pension contribution rate.

If the effective rate of worker's pension contributions is fixed, the PAYG scheme is described as follows:

$$GPC_t = PF_t \cdot GPCshare$$

$$PPC_t = PL_t L_t \cdot pc$$

$$PF_t = PPC_t + GPC_t$$

$$repr_t = \frac{PF_t / ppop_t}{PL_t L_t / lpop_t}$$

In each period, the model has to reach equilibrium in product and factor markets, given assumptions about exogenous variables (discussed below with scenarios). It is assumed that markets are perfectly competitive and there is a full employment.

The model is calibrated on the basis of the 2007 Ukrainian Social Accounting Matrix (SAM) constructed by the Institute for Economic Research and Policy Consulting (Ukraine). The calibration is based on the assumption that the initial data point is on a steady state growth path. In the final period of the simulation, the model has to return to a steady state. This is ensured by the use of terminal conditions. On a steady state,

[2] The size of the labour force and the number of pensioners is taken from the population projections and is adjusted to match observed replacement rate.

the economy grows at the rate of population growth, and capital stock grows at the rate of population growth, plus depreciation.

4. Simulations, Scenarios and Results

4.1. Simulations

Simulations are performed as a two-step process: the first is population projections, the results of which are "fed" into the CGE model in the second stage.

Population ageing is introduced in the CGE model by three growth rates obtained from population projections:

- growth rate of the labour force, which together with capital stock determines output. Includes all people aged 20 to pension age (different in different simulations) and working pensioners. The number of working pensioners is calculated based on the assumption of constant age-specific share of working pensioners (2004 share) (State Statistics Committee of Ukraine);
- growth rate of the pension age population, which together with replacement rate and workers' pension contribution rate determines the size of the pension payments;
- growth rate of the total population, which determines government consumption and transfers, and influences household consumption (through Euler's equation).

In the steady state these three growth rates are equal. However, during the transition period they are allowed to diverge. In the context of the representative household CGE model it means that this "representative household" has the same age structure as population as a whole. This assumption is less problematic in Ukraine where intergenerational links within extended household are still very strong. In this case, the age structure of extended household should more closely approximate that of the total population.

The results of simulations are presented relative to the base run with no population ageing (an approach similar to the one used by Fougère et al., 2009). In the base run, the total population is the same as in the simulation scenario but the age structure of the population is fixed, i.e. each age group declines at the same rate as the total population.

Using a stable population as a benchmark is useful because it allows the isolation of the effect of changing age structure from the effect of population decline. In most cases it is equivalent to analysing the results in per capita terms. However, this approach is superior to per capita representation for several reasons. First, it allows reporting changes in variables that do not make much sense in per capita terms (e.g. labour supply). Second, in simulations with increase in pension age there is a corresponding increase in the working age population in the stable population scenario, which keep comparison consistent. Finally, this approach removes a question about technological progress, assuming that it is not age-specific and is equal in ageing population and stable population scenarios.

4.2. Population projections

The population projections used in these simulations are based on the assumptions of the Institute for Demography and Social Studies at the National Academy of Sciences of Ukraine (2006). The variant used in this paper is based on medium fertility and mortality assumptions and zero migration assumption. According to the medium fertility assumption total fertility rate (TFR) will gradually increase from 1.21 in 2005 up to 1.50 in 2025 and will stay at about this level thereafter. According to the medium mortality assumption male life expectancy will increase from 62.2 in 2005 up to 71.5 in 2050 and female life expectancy will increase from 74.0 up to 79.5. Zero migration is close to the low migration scenario of the Institute for Demography and reflects recent trends. An inflow of working-age migrants would improve the situation. However, it is unadvisable to base long-term economic analysis on hopes for high immigration. It is especially difficult to project migration flows for countries like Ukraine, where past trends show a mixed picture and future trends will depend on the results of economic transition, which is still in progress. Thus, depending on whether one believes that Ukraine will attract migrants in the future or lose population as a result of emigration, the results discussed below present a lower or upper boundary of potential outcomes. Table 1 summarizes the changes in selected age group according to presented population projections.

Table 1. Changes in selected population groups

Scenario		Natural change only
Population 0-19	2005	10689
	2050	5936
	% Δ	-44%
Population 20-64	2005	28904
	2050	18853
	% Δ	-35%
Population 65+	2005	7507
	2050	8483
	% Δ	13%
Total population	2005	47100
	2050	33273
	% Δ	-29%

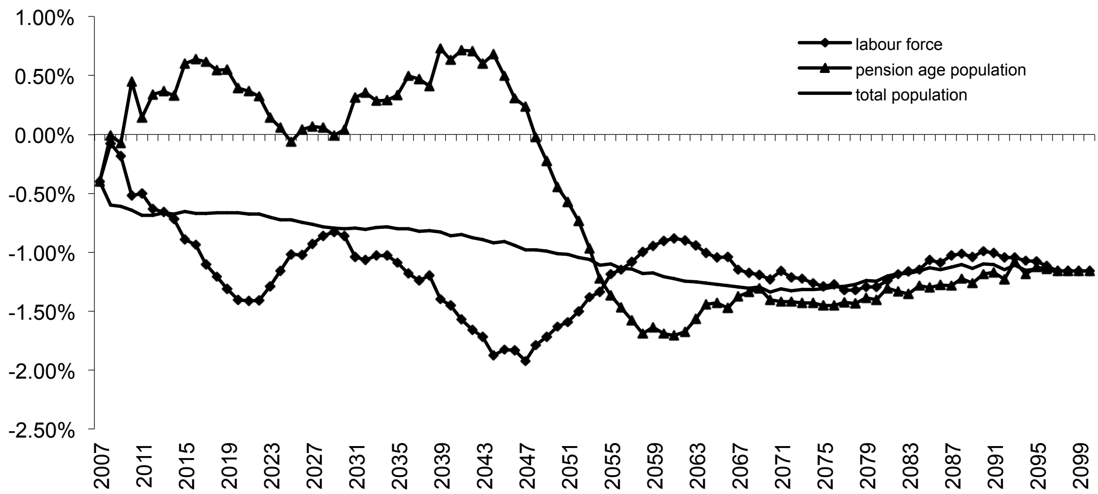
For the type of CGE model that is employed here it is required that in the initial and final periods the economy be in a steady state. This means that key economic variables grow at the same rate: the population growth rate and therefore per capita variables do not change[3]. A steady state is only possible if all population groups grow at the same rate: i.e. population age structure does not change. This was obviously not the case in Ukraine in 2007. Assuming this, however, is a necessary and useful starting point. Starting from this point, we will track changes associated with the "additional" population ageing that will happen after 2007. This assumption is only critical during the calibration stage when the level of initial capital stock and depreciation rate are calculated.

To ensure that in the final period of simulations a steady state is achieved, population projections have to be extended until the moment when Ukraine reaches a stable population. This can be called the "demographic steady state", as age structure of the population is constant and each population group grows at the same rate, which is

[3] There is no productivity growth in this model. If it had been included, then, in a steady state, variables would grow at the rate of the population growth plus total factor productivity growth, and per capita variables would growth at the rate of total factor productivity growth.

equal to the growth rate of the total population. A population with any age structure will reach stable state in about a lifetime of one generation if it experiences stable fertility and mortality rates, and if there is no migration or if the age structure of migrants corresponds to the age structure of the population. To ensure that in the final year of simulations Ukraine will reach a stable population, population projections were extended for another 45 years under the assumption that, after 2050, fertility and mortality rates will not change and there will be no migration. Growth rates of the key population groups, with some smoothing in the initial and final years, are presented in Figure 2.

Figure 2. Projected growth rates of population groups 2007-2100



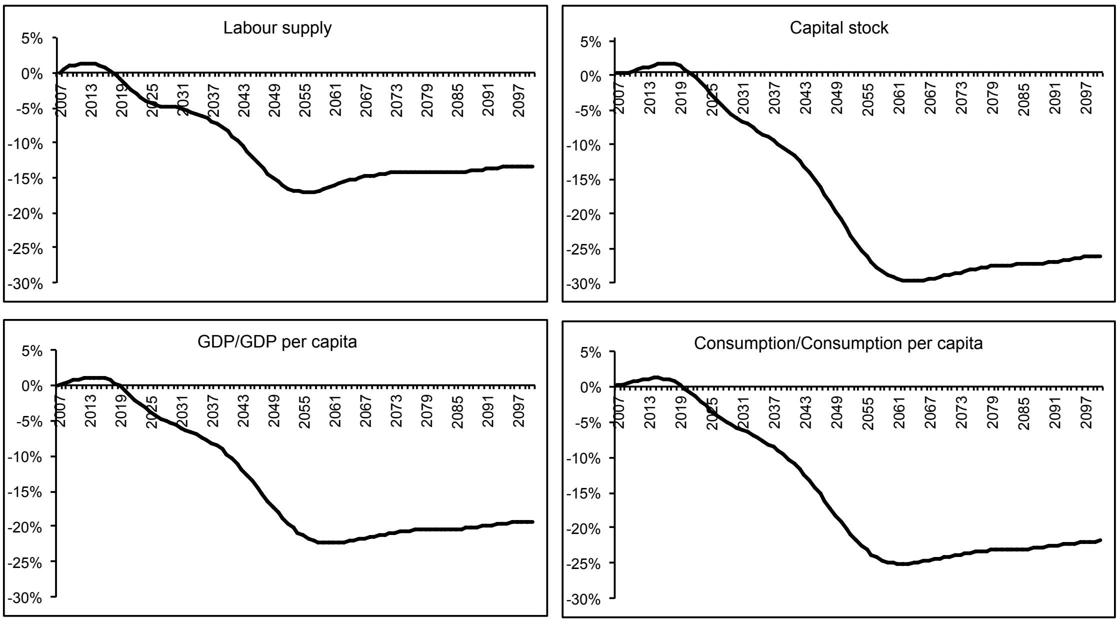
Source: own projections

One has to keep in mind that population projections were extended for 100 years only for analytical reasons (requirements of the model set-up). It is impossible to say anything credible about what will happen with the demographic situation in Ukraine (like in any other country) in such a distant future. Thus, although the results will be reported for the whole simulation period, closer attention should be paid to the first part of the simulation period.

4.3. Baseline scenario

The baseline scenario is essentially a status quo situation with no changes to the pension system arrangements. The first tier of the pension system is financed on a PAYG basis, except for the constant fraction of government pension contributions, fixed at the 2007 level (26%, obtained from the PAYG pension scheme balance). The replacement rate is constant at the 2007 level (35%). It shows what would happen if no actions were taken and the demographic situation develops according to the presented population projections. The results of the baseline scenario are summarized in Figures 3-5. All results are presented as a percentage difference with the stable population scenario, unless specified otherwise.

Figure 3. Results for base line scenario (1)



The first panel (Figure 3) presents four macroeconomic variables, one of which is exogenously given labour supply. These results show the general macroeconomic effect of population ageing. All variables in this panel increase in the initial periods owing to a more favourable population dynamic during those years, and then decline rapidly after 2019. By 2057 the labour supply decreases by 17% compared to the scenario with no population ageing. The capital stock adjusts in line with labour supply, but much more smoothly, because investments are subject to quadratic adjustment cost. It also drops lower than the labour supply because of the sort-run interest rate fluctuation during the simulation period that influences the level of investment. By 2057 it decreases by 28% relative to stable population scenario.

GDP per capita by 2057 declines by 22% – the value in between the labour force and capital stock decline. The level of import, export and foreign savings (not presented on the chart) change in exactly the same way as GDP. Consumption does not follow the path of GDP, because according to Euler equation it depends on the rate of population growth and short-run interest rates. By 2057 it decreases by 24% compared with the situation with no change in population age structure.

The situation with government finances is presented on the second panel of the graphs (Figure 4). Government spending is equal to government revenues in each period. The indirect tax rate adjusts to keep the government budget balanced. Government spending grows primarily due to growing pension contributions because government contributes a fixed share of the total pension contributions. The second, much smaller, reason for government spending increase is that government consumption changes proportionally to total population change, which decreases more slowly than the labour force. To keep up with growing government spending, the indirect tax rate increases from 13% in the first period to 23% in 2057, levelling off later at 21%.

Figure 4. Results for base line scenario (2)

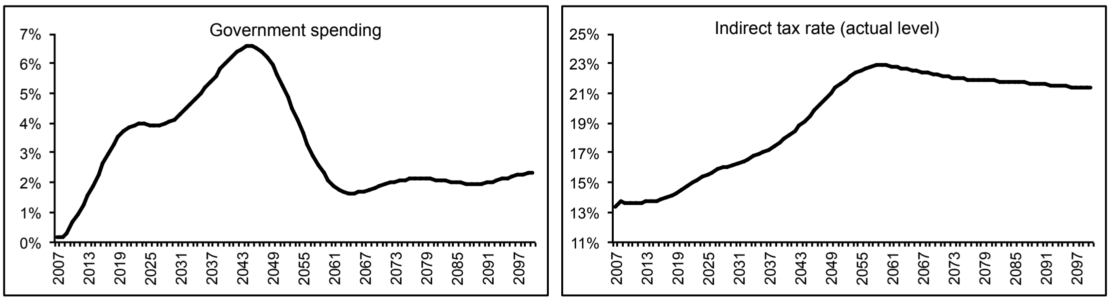
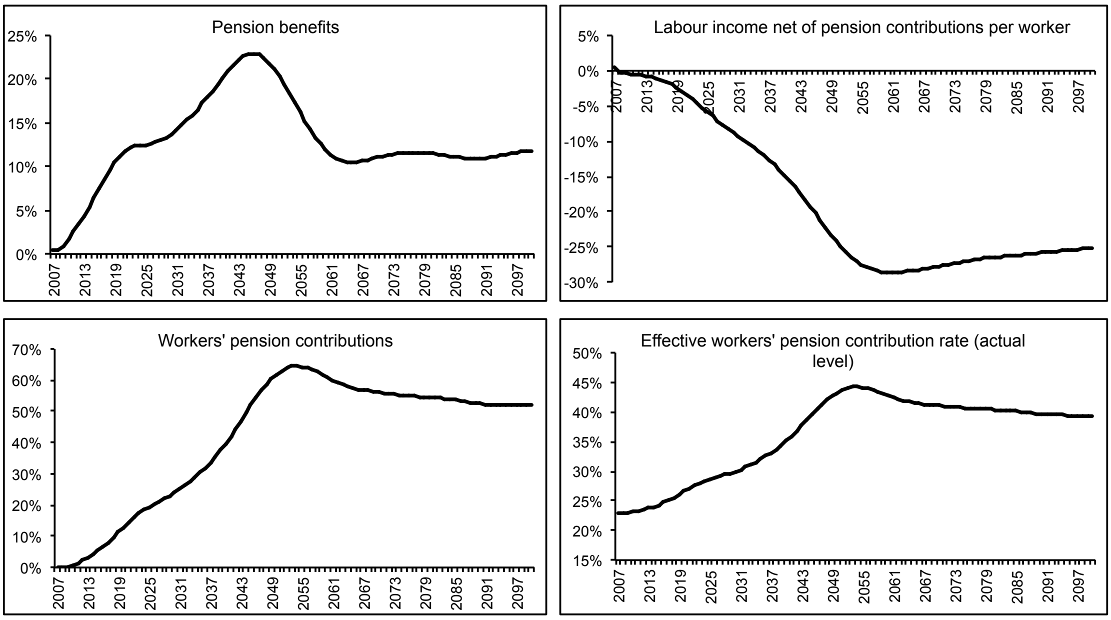


Figure 5 presents the third panel of results of the baseline simulation. In this group of charts, the exogenous variable is the aggregated level of pension benefits. It depends on two variables: the number of pensioners and workers' pension contribution rate.

Figure 5. Results for base line scenario (3)



As the population ages, the total amount of pension payments increases compared with the stable population scenario, exceeding it by 23% at it's peak in 2045. At the end of the simulation period, they reach a new long-run level. Although, owing to the changes in age structure of the population, it is 12% above the stable population level.

In the baseline scenario, 74% of pension payments are financed on a PAYG basis. The remaining 26% are financed by government. To finance benefits paid out to a proportionately increasing number of pensioners, workers have to contribute a growing proportion of their labour income. The effective rate of workers' pension contributions increases from 23% of the gross wage at the beginning, to 39% at the end of simulation period, peaking at 44% in 2054[4].

The baseline scenario shows that population ageing may lead to a significant decline in GDP and consumption per capita, higher taxes and an increase in the pension system burden on the economy.

[4] Please note that here the same convention of expressing the level of pension contributions is followed as the one currently used in Ukraine, i.e. 2% of gross wage are contributed by workers and are subtracted from the gross wage and the rest is paid by the employer and added on top of the gross wage.

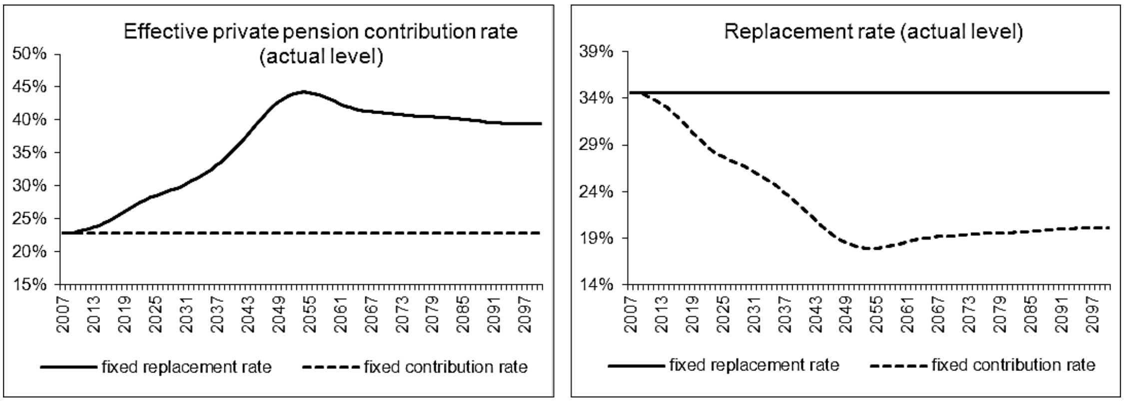
4.4. Modelling the pension system

Three variables determine the size of the contributions and the size of the benefits in the PAYG pension scheme: workers' pension contribution rate, replacement rate and pension age. Fixing any two of these determines the size of the third one. In the following sections, the simulation results for different pension system scenarios are presented.

No change in pension age

If pension age is not increased, there are two options for keeping the pension scheme balanced without an increase in the share of government contributions: increase workers' pension contributions (baseline scenario) or decrease the replacement rate. Figure 6 summarizes these two options. In the former case, the effective rate of workers' pension contributions would have to be increased from 23% to 44% by 2050. In the latter case, the replacement rate would have to decrease from 35% to 18% by the same period.

Figure 6. Scenarios with no change in pension age



From the perspective of political economy, both of these options are infeasible. These hypothetical scenarios are presented here to illustrate the extent of the problem. It is obvious that an increase in pension age is not only necessary but also inevitable.

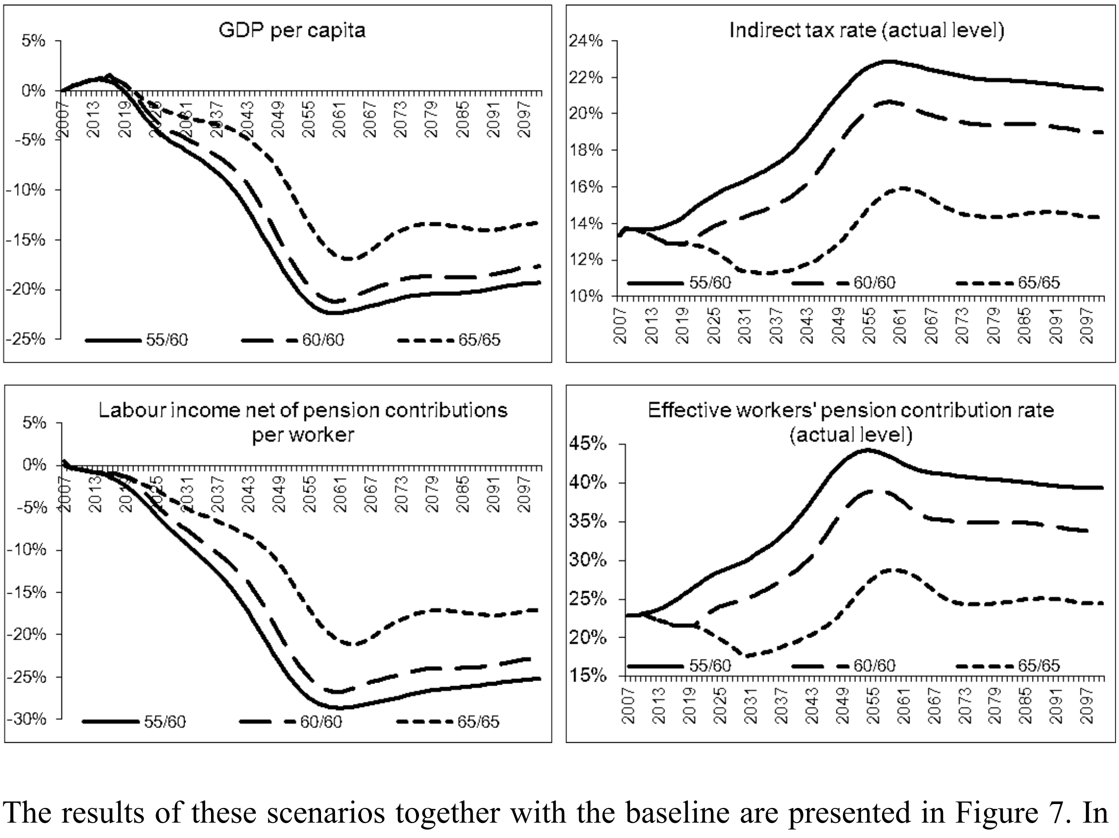
Increase in pension age

Two types of scenarios of increase in pension age are modelled:

- Increase of pension age for females to 60 (as envisaged in current pension reform);
- Increase of pension age for males and females to 65.

In each case, the pension age increase starts in 2011. In each case, pension age is increased gradually by half a year each year: i.e. for the first scenario, it takes 10 years for the female pension age to increase from 55 to 60 years. In the second scenario, pension age for males starts to increase after pension age for females reaches 60 years, i.e. in 2021.

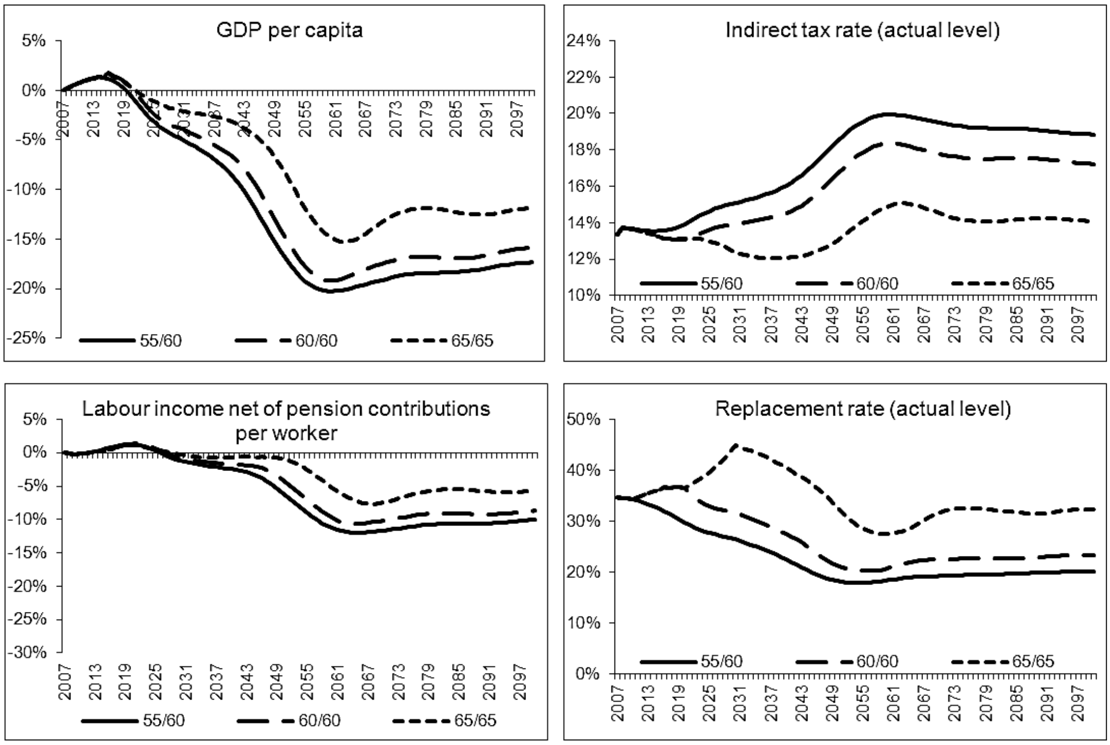
Figure 7. Scenarios w/ increase in pension age (fixed replacement rate)



The results of these scenarios together with the baseline are presented in Figure 7. In all of these simulations, the replacement rate is held constant. An increase of pension age for females to 60 years has only a small positive effect on the pension system, and macroeconomic variables.

A gradual increase of pension age to 65 years for both sexes has a greater positive impact. GDP per capita by 2057 declines by 15% compared with 22%, if the pension age is not changed. The indirect tax rate exceeds the initial level for only 20 years (and only starting from 2054). The labour income net of pension contributions per worker declines by 19% by 2057 compared with 28% in the baseline case. The effective rate of workers' pension contributions increases to 29% at the highest point, and at the beginning of simulation period it can be reduced.

Figure 8. Scenarios w/ increase in pension age (fixed contribution rate)



The results for the same three scenarios with a fixed contribution rate are presented in Figure 8. The dynamics of the GDP per capita is very similar with a small variation due to the difference in the short-term interest rates and resulting investment level. The indirect tax rate is lower in all three scenarios, as government spending is lower as a result of lower state pension contributions. The labour income net of pension contributions per worker declines much less: by 10% at the lowest point, if the pension age is not changed, or by 8% if the pension age is increased to 65 years for both sexes. The replacement rate in the baseline scenario decreases from 35% to 18% by 2057. If the pension age for females is increased to 60 years it decreases to 20%, and if the pension age is increased to 65 years for both sexes to 27% during the same period, after the initial significant increase.

5. Conclusions and policy implications

The work undertaken in this paper is an attempt to model the demographic change in Ukraine with special focus on the pension system. The chosen intertemporal CGE approach proved useful for evaluating expected changes and broad quantification of the impact. The model developed is rather simple, but provides very important first results. As was mentioned earlier OLG CGE framework is superior for analysing these type of problems, however it is also more involved and would require much more resources and data. Also the size of the demographic shock is so large that the change in the model structure is unlikely to change the results dramatically. The biggest drawback of the chosen approach compared with the OLG is inability to differentiate between different generations of households and observe their welfare changes.

According to population projections, the Ukrainian population is going to decline and age rapidly during the next 50 years. This will have important consequences for the Ukrainian macroeconomic outlook. The Ukrainian pension system, which at the moment is organized on the PAYG principle, will be especially vulnerable as the number of contributors declines and the number of beneficiaries increases.

The simulations presented in this paper model only the first tier of the three-tier pension system that has to be implemented in Ukraine, according to current legislation. They give an insight into which measures should be taken in order to stabilize the existing PAYG system before the second funded tier can be introduced. One obvious conclusion is that the pension age has to be increased. The currently proposed increase in female pension age by 5 years to match that of males has a small positive effect on the pension system and the wider economy. According to the presented calculations it is enough to balance the PAYG pension scheme by 2015 (which is the ambition of the current government) while keeping both the replacement rate and effective pension contributions at their 2007 level. If the replacement rate is kept constant, then by 2015 effective workers' pension contributions rate can be decreased from the 2007 level of 23% to 22%. Alternatively, if the effective workers' pension contribution rate is kept constant then the replacement rate can increase from 33% to 36%. However, if the actual increase in the replacement rate since 2007 – to 47% in 2009-10 – is preserved, then according to presented simulations, the PAYG pension scheme will be unbalanced in 2015. Yet CGE models by their nature are less suitable for short-run simulations, and more attention should be paid to longer-term results. Here the picture is clear that increasing pension age for females to 60 years is not enough to sustain the balance of the PAYG pension scheme without significant change to current pension system parameters. By 2057 the effective workers' contribution rate would have to increase to 39% or the replacement rate would have to decrease to 20%.

An increase in pension age to 65 for both sexes significantly improves the stability of the pension system, and has a large positive impact on other macroeconomic parameters. It is virtually enough to keep the PAYG pension scheme with the current replacement and contribution rates.

The second tier of the pension system will be financed by diverting some of the contributions that are currently directed to the PAYG scheme. However, the model shows that, if anything, the workers' pension contribution rate has to be increased to keep the benefits at the current level. However, these two contradictory requirements can be met at the same time. At the moment contributions to the PAYG pension scheme are not paid from all of the labour income and a large portion of the economy is in the shadow. As a result, while the standard pension contributions in 2002 were 34% of the gross wage, the effective rate, calculated from the SAM and PAYG pension scheme balance, was only 20%. Thus, it should be possible to decrease the contributions rate to the PAYG scheme for those who pay contributions at the moment, and compensate for it by broadening the contribution base, through a reduction in the size of the shadow economy and equal treatment of all labour income.

However, this will only be possible if public trust in the pension system is restored. At the moment, with almost flat benefits, there is little incentive to participate in the system beyond minimal contributions. On top of this, the strong link between the level of pension benefits and the political cycle further decreases this motivation.

In other CEE countries, the introduction of the funded component into the pension system helped to restore its popularity. Plans for similar pension reform have been discussed in Ukraine for many years. Implementation of the reforms is essential, and time is of crucial importance, as the process of population ageing will accelerate in the future. It is important to determine a long-term strategy for a pension system with stable rules, and consistently implement it. The practice that exists now, with *ad hoc* decisions connected to the political cycle, make the system unstable and decrease the incentives for workers to participate in it.

References

Auerbach, A., and Kotlikoff, L. (1987) *Dynamic Fiscal Policy,* Cambridge, Cambridge University Press

Cass, D. (1965), "Optimum Growth in an Aggregative Model of Capital Accumulation" *Review of Economic Studies,* Vol. 32, No. 3, pp. 233-240

Dobronogov, A. (1998) *System Analysis of Social Security in a Transition Economy: The Ukrainian Case*, Interim Report IR-98-73, Laxenburg, IIASA

Dobronogov, A. and Mayhew, L. (2000) *Pension Reform in a Highly Informalized Post-Soviet Economy*, Interim Report IR-00-41, Laxenburg, IISAS

Fougère, M., Harvey, S., Mercenier, J., and Mérette, M. (2009) "Population Ageing, Time Allocation and Human Capital: A General Equilibrium Analysis for Canada", *Economic Modelling*, Vol. 26, No. 1, pp. 30-39

Jensen, J. and Tarr, D. (2007) *The Impact of Kazakhstan Accession to the World Trade Organization: A Quantitative Assessment*, World Bank Policy Research Working Paper 4142, Washington, World Bank

Jensen, J., Rutherford, T. and Tarr, D. (2004) *Economy-Wide and Sector Effects of Russia's Accession to the WTO*, Washington, World Bank

Institute for Demography and Social Studies at the Academy of Science of Ukraine (2006) *Comprehensive Demographic Projections of Ukraine until 2050*, Kiev, Ukrainian Centre for Social Reforms, in Ukrainian

Koopmans, T. (1965) "On the Concept of Optimal Economic Growth," in *The Economic Approach to Development Planning*, Amsterdam, Elsevier

MacKellar, L., and Ermolieva, T. (1999) *The IIASA Social Security Reform Project Multiregional Economic-Demographic Growth Model: Policy Background an Algebraic Structure*, Interim Report IR 99-007, Laxenburg, IIASA

OECD (2011) *Pensions at a Glance 2011: Retirement-Income Systems in OECD and G20 Countries*, Paris, OECD

Pavel, F. and Tochitskaya, I. (2004) *The Economic Impact of Belarus' Accession to the WTO: A Quantitative Assessment*, Working paper PP/14/04, Minsk, IPM Research Centre

Pavel, F., Burakovsky, I., Selitska, N. and Movchan, V. (2004) *Economic Impact of Ukraine's WTO Accession. First Results from a Computable General Equilibrium Model*, Working Paper No. 30, Kiev, Institute for Economic Research and Policy Consulting

Ramsey, F.P. (1928), "A Mathematical Theory of Saving," *Economic Journal,* Vol. 38, No. 152, pp. 543-559

World Bank (1994) *Averting the Old Age Crisis: Policies to Protect the Old and Promote Growth*, Policy Research Working Papers, Washington, World Bank

Appendix 1. Algebraic Description of the Model

List of parameters

Exogenous parameters

ρ	Time preference	0.05
adjsh	Share of adjustment costs out of investment	0.01
σT	elasticity of transformation in CET function	-6
σA	elasticity of substitution	6

Calibrated parameters

ty	Income tax rate
io	Leontief technical coefficients
α	Capital value share in production function
aF	Efficiency parameter in the production function
δ	Depreciation rate
φ	Adjustment cost parameter
INVGshare	Share of government investment in GDP
GPCshare	Share of government pension contributions
aT	efficiency parameter in CET function
γT	distribution parameter in CET function
aA	efficiency parameter of ARMINGTON function
γA	CES distribution parameter in ARMINGTON function

Exogenous demographic variables

g_T	Total population growth rate
$popgcum_T$	Cumulative growth of total population between T_0 and T

$tpop_T$	Total population size
$lpop_T$	Labour force size
$ppop_T$	Pension age population size

List of variables

r_T	Interest rate
λ_T	Lagrange multiplier of the firm
L_T	Labour demand
K_T	Capital stock
INV_T	Investment demand
C_T	Consumption demand
CE_T	Consumption expenditures
Y_T	Household income
LS_T	Labour supply (exogenous)
DIV_T	Total dividends
GDP_T	Gross domestic product
S_T	Total savings
SH_T	Household savings
SF_T	Foreign savings
FD_T	Foreign debt
$TAXR_T$	Total tax revenues
tp_T	Indirect tax rate
CG_T	Government commodity demand
TRF_T	Government transfers to household
$GREV_T$	Government revenues
$GSPEND_T$	Government spending
$INVG_T$	Government investment

PF_T	Outstanding pension benefits
PPC_T	Workers' pension contributions
GPC_T	Government pension contributions
pc_T	Workers' pension contribution rate
$repr_T$	Replacement rate
ER_T	Exchange rate
PL_T	Wage rate
PD_T	Output Price
PDD_T	Price of domestic production delivered to domestic market
P_T	Price of composite goods (Armington)
PE_T	Price of exported goods in domestic currency
PM_T	Price of imported goods in domestic currency
PWE_T	Price of exported goods in US$
PWM_T	Price of imported goods in US$
XD_T	Domestic output
XDD_T	Domestic production delivered to domestic markets
X_T	Domestic sales Armington composite
E_T	Exports
M_T	Imports

Subscripts

T	Time period
T_0	First time period
TLAST	Last time period
ss	Steady state

The model

Firm and Consumer. Intertemporal optimization

$$\lambda_{T+1} = P_T + \frac{2*\phi*PD_T*INV_T}{K_T}$$

$$\frac{\alpha K}{K_T}\left(PD_T*XD_T - io*XD_T*P_T\right)*(1-tp)+\phi*PD_T*\left(\frac{INV_T}{K_T}\right)^2 - (1+r_T)*\lambda_T + (1-\delta)*\lambda_{T+1} = 0$$

$$K_{T+1} = (1-\delta)*K_T + INV_T$$

$$\frac{P_T C_T}{P_{T-1}C_{T-1}} = \frac{(1+r_T)*(1+g_T)}{(1+\rho)}$$

Terminal conditions

$$INV_{TLAST} = (g_{SS} + \delta)*K_{TLAST}$$

$$\lambda_{TLAST} = P_{TLAST} + 2*\phi*PD_{TLAST}*\frac{INV_{TLAST}}{K_{TLAST}}$$

$$r_{TLAST} = \rho$$

Intra-temporal optimization and income definitions

$$XD_T = aF_T*K_T^{\alpha}*L_T^{1-\alpha}$$

$$PL_T*L_T = (1-\alpha)*(PD_T*XD_T-io*XD_T*P_T)*(1-tp)$$

$$DIV_T = (1-tp)*(PD_T*XD_T - io*XD_T*P_T) - phi*P_T\frac{INV_T^2}{K_T} - PL_T*L_T$$

$$Y_T = DIV_T + PL_T*LS_T + TRF_T + PF_T + TRHROW_T$$

$$NETLY_T = L_T * PL_T - PPC_T$$

$$CE_T = P_T * C_T$$

$$SH_T = (Y_T - PF_T) * (1 - ty) + GPC_T - CE_T$$

$$FD_{T+1} = FD_T + SF_T$$

$$GDP_T = XD_T * PD_T - XD_T * P_T * io$$

Market equilibrium

$$LS_T = L_T$$

$$X_T = C_T + INV_T + io * XD_T + CG_T$$

$$S_T = P_T * INV_T$$

$$S_T = SH_T + INVG_T + SF_T$$

Government

$$TAXR_T = ty * (Y_T - PF_T) + tp * (XD_T * PD_T - XD_T * P_T * io)$$

$$GREV_T = TAXR_T + TRGROW_T$$

$$CG_T * P_T = CG_{T_0} * P_{T_0} * popgcum_T$$

$$TRF_T = TRF_{T_0} * popgcum_T$$

$$INVG_T = GDP_T * INVGshare$$

$$GSPEND_T = P_T * CG_T + TRF_T + GPC_T + INVG_T$$

$$GSPEND_T = GREV_T$$

Pension Fund

$$GPC_T = PF_T * GPCshare$$

$$PF_T = \frac{L_T * PL_T - PPC_T}{lpop_T} * repr_T * ppop_T$$

$$GPC_T = PF_T * GPCshare$$

$$PPC_T = PF_T - GPC_T$$

$$pc_T = \frac{PPC_T}{L_T * PL_T}$$

or

$$GPC_T = PF_T * GPCshare$$

$$PPC_T = L_T * PL_T * pc_{T_0}$$

$$PF_T = PPC_T + GPC_T$$

$$repr_T = \frac{\dfrac{PF_T}{ppop_T}}{\dfrac{L_T * PL_T - PPC_T}{lpop_T}}$$

Foreign sector

$$PE_T = PWE_T * ER_T$$

$$E_T = \frac{XD_T - \varphi * \dfrac{INV_T^2}{K_T}}{aT} * \left(\frac{\gamma T}{PE_T}\right)^{\sigma T} * \left[\gamma T^{\sigma T} * PE_T^{(1-\sigma T)} + (1-\gamma T)^{\sigma T} * PDD_T^{(1-\sigma T)}\right]^{\left(\frac{\sigma T}{(1-\sigma T)}\right)}$$

$$XDD_T = \frac{XD_T - \varphi * \frac{INV_T^2}{K_T}}{aT} * \left(\frac{1-\gamma T}{PDD_T}\right)^{\sigma T} * \left[\gamma T^{\sigma T} * PE_T^{(1-\sigma T)} + (1-\gamma T)^{\sigma T} * PDD_T^{(1-\sigma T)}\right]^{\left(\frac{\sigma T}{(1-\sigma T)}\right)}$$

$$PM_T = PWM_T * ER_T$$

$$M_T = \frac{X_T}{aA} * \left(\frac{\gamma A}{PM_T}\right)^{\sigma A} * \left[\gamma A^{\sigma A} * PM_T^{(1-\sigma A)} + (1-\gamma A)^{\sigma A} * PDD_T^{(1-\sigma A)}\right]^{\left(\frac{\sigma A}{(1-\sigma A)}\right)}$$

$$XDD_T = \frac{X_T}{aA} * \left(\frac{\gamma A}{PDD_T}\right)^{\sigma A} * \left[\gamma A^{\sigma A} * PM_T^{(1-\sigma A)} + (1-\gamma A)^{\sigma A} * PDD_T^{(1-\sigma A)}\right]^{\left(\frac{\sigma A}{(1-\sigma A)}\right)}$$

$$M_T * PWM_T - PWE_T * E_T = (SF_T + TRHROW_T + TRGROW_T)/ER_T$$

Zero profit Armington and CET

$$P_T * X_T = PM_T * M_T + PDD_T * XDD_T$$

$$PD_T * XD_T - PD_T * \varphi * \frac{INV_T^2}{K_T} = PE_T * E_T + PDD_T * XDD_T$$