IIASA

INTERIM REPORT   IR-98-73/November

Systems Analysis of Social Security in a Transition Economy: The Ukrainian case

Anton V. Dobronogov (dobron@iiasa.ac.at)

Approved by
Landis MacKellar (mckellar@iiasa.ac.at)
Leader, *Social Security Reform Project*

Contents

Abstract

This paper deals with a case study on the social security system in a transition economy in Ukraine. The severe socioeconomic crisis in Ukraine, including a huge decline of production, hyperinflation, and the informalization of the economy, caused both a substantial reduction of social security contributions and an increase in the number of people who need assistance. The creation of a new sustainable economic system in the country requires the development of a new model of social security suited to the realities of a market economy. The objective of this paper is to investigate the current situation, trends, and possible ways of reforms in the Ukrainian social security system, taking into account specific features of the national economy, in particular the informal sector. The analysis focuses on the key component of social security - the pension system - and combines both qualitative and model-based approaches.

Acknowledgments

About the Author

Anton Dobronogov is an Assistant Professor at the Institute for Applied Systems Analysis (Kyiv, Ukraine). He received his Masters degrees in applied mathematics and management science from the National Technical University of Ukraine KPI and candidate of science degree in systems analysis and optimal decisions theory from the V.M.Glushkov Institute of Cybernetics of the National Academy of Sciences of Ukraine. Dobronogov was a participant in IIASA's Young Scientists Summer Program in 1998 and a recipient of the Soros PhD Student grant from the International Science Foundation in 1997.

Systems Analysis of Social Security in a Transition Economy: The Ukrainian case

Anton V. Dobronogov

1. INTRODUCTION

The transition from a centrally planned to a market economy is an extremely complex process, comprising all spheres of society. It changes the society at every level – from the psychological to macroeconomic, it destroys the old social system and leads, through the severe socioeconomic crisis, to the creation of a new system. This process is most painful for the inactive part of the population (the elderly and disabled, the unemployed), for whom it is very hard to adapt to the new situation. Social security issues are therefore of great importance for a transition economy.

Social security systems serve two main functions: the redistributive function through the direct transfer of funds to the inactive part of the population, and the accumulative function through the creation of possibilities for workers to save money for the inactive periods of their lives. At the time of transition these functions are conflicting. Maintaining the redistributive function in a time of economic crisis requires very high social security taxes, which discourage private saving. These taxes, moreover, are one factor leading to an increase in the informal sector of the economy, which in turn diminishes the contribution base. The creation of a new sustainable economic system requires allocation of appropriate resources to adapt the social security system to the new socioeconomic context. The introduction of individual insurance principles in the social security system could increase personal interest and personal responsibility of a worker for his/her standard of living after retirement, stimulate private savings, and substantially promote economic development by eliminating the incentives to informalize production and employment (Corsetti and Schmidt-Hebbel, 1995). However, such social security reform is costly.

Informalization of the economy was mentioned twice in the previous paragraph, thus it is appropriate to discuss this phenomenon and its relationship to social security. Three basic types of informal activities can be mentioned. First, there are economic activities that are informal by their nature, as they are defined as criminal by society ("black markets"). Second, there are untaxed activities of small and large enterprises, which should have been taxed according to legislation (production of legal goods and services). Third, there are informal activities serving as a survival mechanism for the poorest part of the population (work on private land, etc.). Obviously, the first type

should not be used for any social security purposes. Other informal activities might be acceptable in a transition period, but should be eliminated in the future. The second type promotes economic development in the short term, while the new economic system has not yet been formed, but in long term it encourages corruption, slows down the development of the banking system, diminishes the state budget, and increases financial risks. The third type serves as a coping mechanism in periods of crisis, but represents an ineffective use of both capital and labor in the long term. Thus, in the long term the decrease of the informal sector in the economy might significantly improve the financial reserves of the social security system due to the direct expansion of the contribution base as well as an improvement of the general economic environment.

The Ukrainian social security system still maintains many features of the former Soviet Union and includes pensions, maternity and sickness benefits, unemployment benefits and job search assistance, allowances for families with children, and assistance for victims of Chernobyl accident. A huge drop of production in the national economy (according to the data of the State Committee for Statistics of Ukraine, the real GDP in 1997 decreased by 54.3% compared to 1990), hyperinflation (in 1991-95 the inflation index was between 280 and 10,260% per year), and informalization of the economy (according to different estimations, the informal sector comprises 40-60% of the economy) caused a substantial reduction of social expenditures. Now, as the worst part of the crisis is over and economic prospects are improving, the problem of the long-term stability of the key components of the national economy, including the social security system, is on the national agenda.

The objective of this paper is to investigate the current situation, trends, and possible ways of reforms in the Ukrainian social security system taking into account specific features of the national economy, in particular the informal sector. The analysis focuses on the key component of the social security, the pension system. Section 2 examines the current situation, trends and needs of reform in the system, focusing on the level of income and expenditures of the Pension Fund, current number of retirees and pension level, demographic trends in the country and their possible impact on future sustainability of the pension system, and equity and fairness issues. Section 3 discusses the methodology of model-based analysis of the pension system, including the definition of analysis targets, discussing assumptions on the development of the system's macroeconomic environment, and issues related to the adaptation of the model developed within the Social Security Reform project at the International Institute for Applied Systems Analysis (IIASA), to the Ukrainian case study. The latter topic includes, in particular, accounting of the informal sector of the economy and modeling governmental debt. Section 4 is devoted to the description of proposed scenarios, and presentation and analysis of simulation results. The conclusions and possible directions for further research are presented in the last section. The detailed description of the Ukrainian pension system (including the description of the administrative and legislative structure, particular types of pensions, criteria for pension assignment and social security taxes), model specification, and parameterization are provided in the appendices.

2. QUALITATIVE ANALYSIS OF THE UKRAINIAN PENSION SYSTEM

This section analyses the current state, trends, and needs for improvement in the Ukrainian pension system. A detailed description of the system is provided in Appendix 1. In brief, the Ukrainian pension system is based on a "pay-as-you-go" (PAYG) principle, according to which social security taxes contributing to the Pension Fund are paid out to retirees immediately. The social security tax ratio is 33% of wages, 32% of which are paid by the employers and 1% by the employees. Standard retirement age in Ukraine is 60 years for men and 55 years for women, the working record necessary to get full pension is 25 years for men and 20 years for women.

2.1. Income and expenditures of the Pension Fund of Ukraine

Despite the fact that the share of Pension Fund expenditures in GDP remained practically constant during the years of transition (Figure 1), the deep economic crisis taking place in Ukraine during the past several years made an inevitable impact on the financial state of the pension system. The drop of production resulted in a sharp reduction of the real budget of the Pension Fund (Figure 2). As a result of the informalization of the economy and delays in payment of wages, 7 million working people do not contribute or contribute later to the Pension Fund, and there are 929 retirees per 1,000 people contributing de-facto to the Fund (Libanova and Yatsenko, 1997).

Apart from "external" factors due to the general crisis of the national economy, there are also "internal" factors in the pension system. These factors have negative effects on the system's financial state, in particular, the proportion of time between the period of contribution to the Pension Fund and the period of pension payment (see Section 2.5).

At the same time, one of the disadvantages of the Ukrainian pension system is the very high level of contributions to the Pension Fund paid by the employers. These contributions are 32% of the total amount of wages, with 15.5% of this being paid to the employment fund, the social insurance fund, and the fund for the victims of the Chernobyl disaster. This makes employers informalize employment, which, in turn, has a negative impact on both the pension system and the national economy as a whole.

2.2. Pension level

A reduction of pension level has taken place (Figures 3, 4) as a result of the reduction in real contributions to the Pension Fund. In early 1997 the average pension (51.9 hryvnias; approximately USD 28) was about the same as the minimum cost of food (52.3 hrn), and 12.7 million retirees (87.6% of the total number) received a pension that was less than the minimum consumption level (70.9 hrn). The minimum old-age labor pension is 16.62 hrn. The above-mentioned delays in wage payments also caused non-
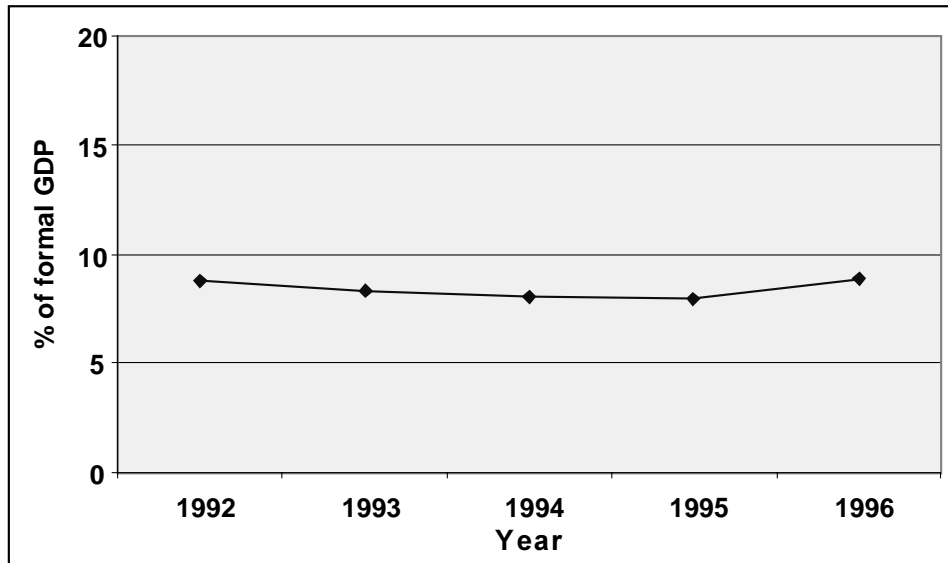
Figure 1. Expenditures of the Pension Fund of Ukraine (in % of formal GDP).

Source: Statistical Yearbooks of Ukraine, State Committee for Statistics of Ukraine, calculations made by the author.
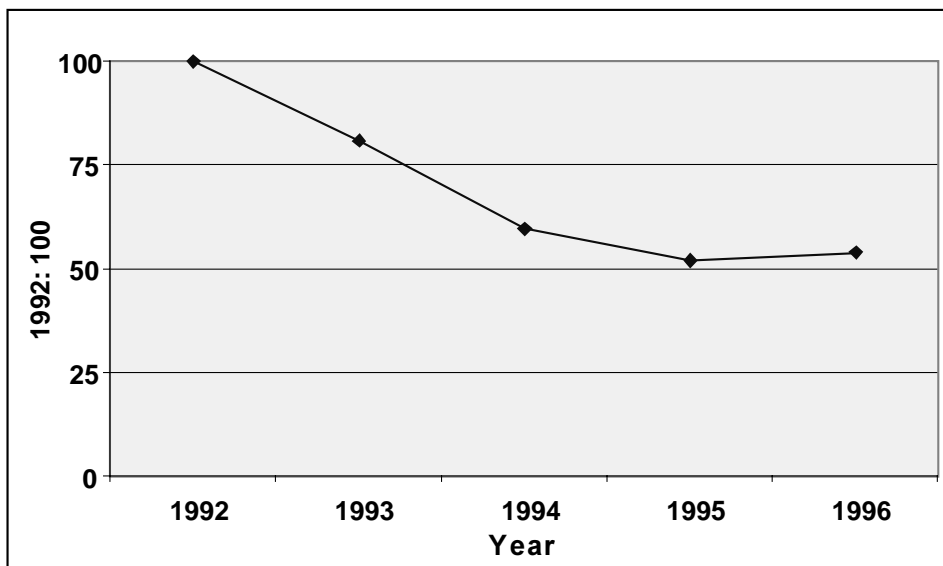
Figure 2. Expenditures of the Pension Fund of Ukraine (in real prices).

Source: Statistical Yearbooks of Ukraine, State Committee for Statistics of Ukraine, calculations made by the author.
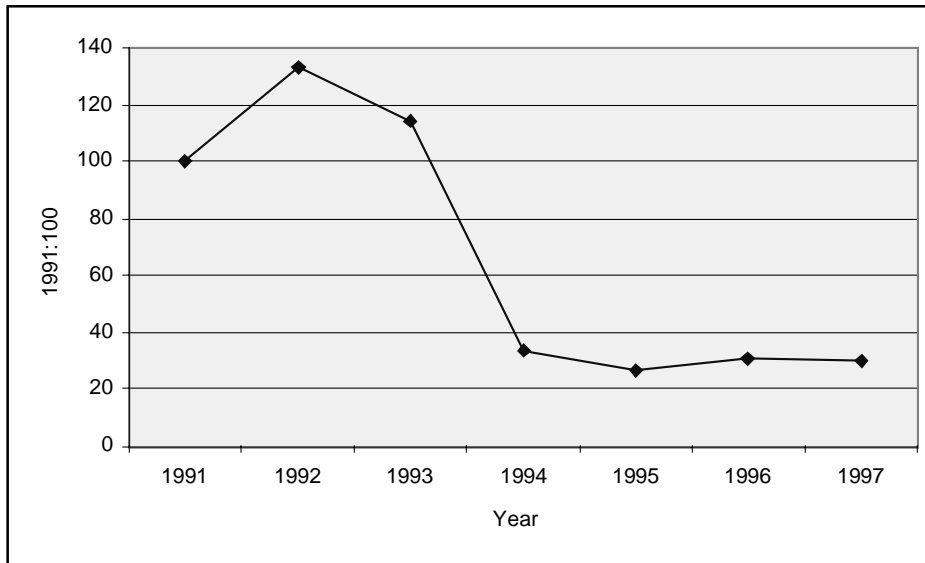
Figure 3. Average monthly pension in Ukraine (in real prices, at the beginning of the year).

Source: Statistical Yearbooks of Ukraine, State Committee for Statistics of Ukraine, calculations made by the author.

Figure 4. Average monthly pension in Ukraine (related to average wage, at the beginning of the year).

Source: Statistical Yearbooks of Ukraine, State Committee for Statistics of Ukraine, calculations made by the author.

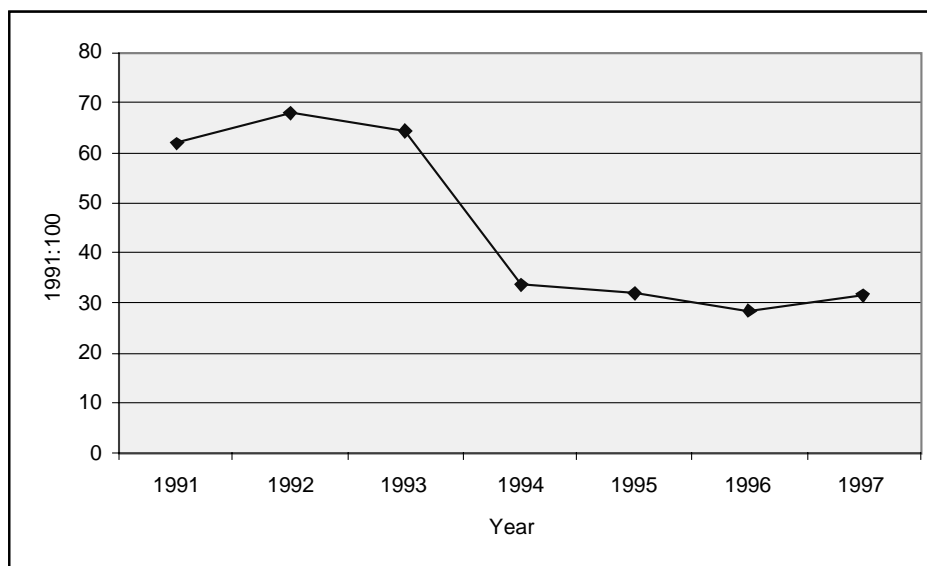payments to the Pension Fund and, as a result, a debt in pension payments, which amounted to 1.8 billion hrn in March 1998. Hence, the living standard provided by the Ukrainian pension system for the retirees can be judged as very poor.

2.3. Retirement age and working record

In the 1990s the Ukrainian parliament accepted a series of legislative acts that increased the number of people entitled to early retirement (representatives of about 20 professions have such an entitlement nowadays). As a result, the real average retirement age decreased to 58 years for men and to 54 years for women. The average working record (according to official data for 1996) was 36 years for men and 29 years for women, and the real average term of contributions to the Pension Fund was 30 years for men and 21 years for women. The life expectancy after the average retirement age is 15.1 years for men and 23.1 years for women. Taking into account that an average for a relatively short-term salary is used to calculate a pension, there is the possibility that an individual's pension would considerably exceed his/her contributions to the Pension Fund (Libanova and Yatsenko, 1997).

One of the ways to improve the situation could be to raise the retirement age. However, two factors need to be taken into account: first, as a result of the deteriorating economic and ecological conditions, the life expectancy for the Ukrainian population decreased by 3.4 years between 1990 and 1996, and was 67.1 years in early 1997 (men: 61.6, women: 72.8); second, there is a rising rate of unemployment in the country, and an increase in retirement age might strengthen this trend.

However, there is one more issue associated with the problem of real retirement age. According to Ukrainian law, working retirees keep receiving pensions. In 1997 there were 2147 thousand working retirees (14.8% of the total number). Among those, 918,400 received wages less than the average wage in Ukraine, 681,600 received between one and two average wages, and 162,900 received more than two average wages. The highest increase in the labor force participation rate was observed in early retirement age groups – for example, for population aged 60-64 the rates increased from 32% to 77% between 1989 and 1995 for men, and from 14% to 67% for women (Riboud and Chu, 1996). Due to the crisis in the financial state of the pension system it would probably be reasonable to change the legislative regulations in this respect.

2.4. Number of retirees and population aging: Contemporary status and trends

There was a clear trend showing an increase in the number of retirees in Ukraine in the first half of the 1990s (Table 1).

One of the reasons for this trend was the recently adopted laws, which decreased the real average retirement age. In addition, the increasing number of retirees in Ukraine is caused by a series of demographic factors making this development a long-term trend.

Table 1. Number of retirees in Ukraine (in thousands, beginning of the year).

	1986	1991	1992	1993	1994	1995	1996	1997
Old age retirees	8,541	9,713	10,294	10,737	10,865	10,668	10,615	10,587
Invalidity retirees	1,352	1,313	1,355	1,388	1,477	1,734	1,814	1,868
Survivor retirees	1,522	1,209	1,044	1,155	1,236	1,228	1,195	1,163
Years of service retirees	n.a.	n.a.	361	379	398	415	429	443
Social retirees	-	318	500	532	501	470	434	426
Total	12,038	13,084	13,554	14,191	14,477	14,515	14,487	14,487
% from total population	23.7	25.2	26.0	27.2	27.7	28.1	28.2	28.5

Source: Statistical Yearbook of Ukraine, State Committee for Statistics of Ukraine

n.a. - data not available

Since the 1960s the level of fertility in Ukraine has been below replacement level; this caused the development of the process of population aging (Figure 5). In 1959 the ratio between people older than the working age and people of working age was 0.227, in 1997 it reached 0.411. However, in the following years some improvement of this indicator is expected. This is due to the fact that only a small number of people born during World War II will reach their retirement age. As of 2005 the situation will start to deteriorate considerably. The generation born during the post-war "baby boom" period (1946-1960) will then be beyond working age, and the working age will be reached by the generation born in the 1990s, the period of essential reduction in fertility (Figure 6). We used the IIASA Population Projections model (Lutz *et. al.*, 1996) to simulate the demographic pressure ratio for the next 30 years. The results of the simulation show that the demographic pressure on the working age population will essentially increase (Figure 7). As shown in Riboud and Chu (1996), sustainability of the PAYG pension system under such conditions will decrease substantially in the long run.
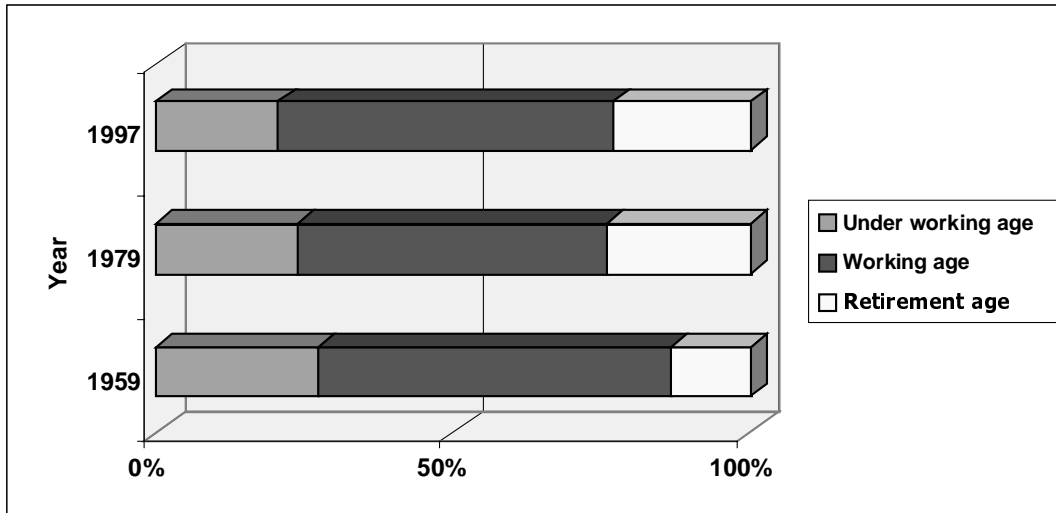
Figure 5. Age structure of the population of Ukraine (1959-1997).

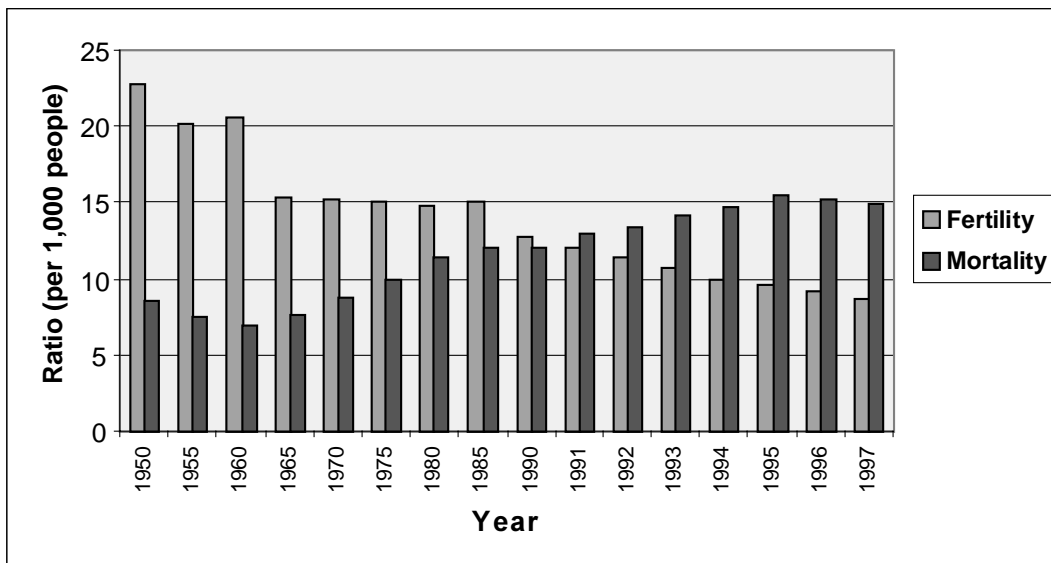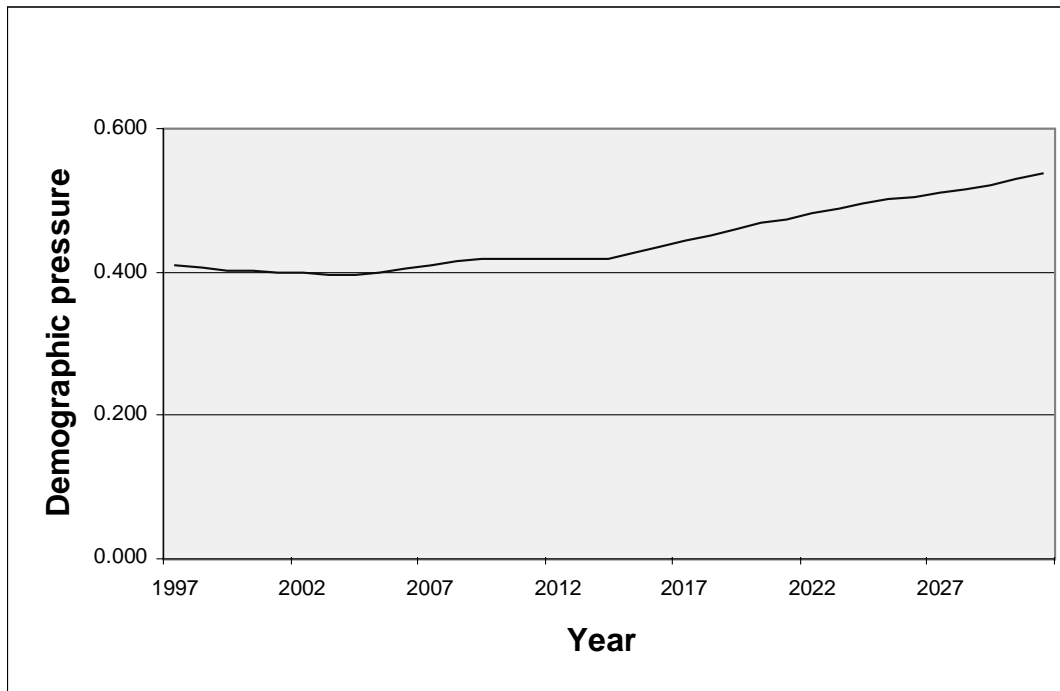*Source:* Statistical Yearbooks of Ukraine, State Committee for Statistics of Ukraine.

Figure 6. Fertility and mortality in Ukraine (per 1,000 people, 1950-1997).

Source: Statistical Yearbooks of Ukraine, State Committee for Statistics of Ukraine.

Figure 7. Forecast of demographic pressure ratio in Ukraine.

Source: see the text

2.5. Equity and fairness

The pension system of Ukraine has considerable disadvantages from the viewpoint of equity and fairness (UNDP, 1996, 1997). First of all, this system does not provide the necessary correlation between work itself and its benefits. There is only a 1% deduction from each person's earnings that goes to the Pension Fund. Moreover, there are no individual records for such payments. The working record requirements that should be fulfilled to get a full pension are too generous. To calculate a pension level, the average monthly wages over a short period of time are taken into account. There is a maximum pension level, but there is no maximum wage level above which earnings do not require contributions to the Pension Fund. The differentiation of pension levels is socially unfair: on the one hand, the disadvantages of legislation and the lack of money in the Pension Fund resulted in a very low maximum pension level and led to the situation where for most retirees the duration of their working record and their average wage level were not reflected in the pension level; on the other hand, according to "status" laws of Ukraine, certain categories of people can get pensions that are several times as higher than the usual maximum pension level.

The social unfairness of the pension system, together with its financial crisis, leads to the aggravation of the generations conflict. The current generation of retirees, who used to finance the old pension system during their working life, receive a pension of much lower purchasing power than in previous years. At the same time, the current

working population realize that in case the current pension system is maintained, they will most likely not have an opportunity to receive an appropriate pension, which leads to increasing reluctance of the taxpayers to finance this system.

2.6. Necessity and complexity of the pension reform

The existing Ukrainian pension system still maintains many features of the former Soviet system and has some essential disadvantages that make its effective functioning under present conditions impossible. The conservation of this system will lead to a series of negative consequences, including:

- A further deterioration of the living standards of retirees;

- The necessity of a further increase in social security taxes, and, as a result, the growth of expenses for the labor force, a reduction of the labor market, and an increase of the informal sector in the economy;

- The necessity to increase budget expenses for the pension system, and, as a result, an increase of the budget deficit, and a reduction of budget expenditures in other spheres such as health care, science, and education, which will lead to a deceleration of economic growth;

- The aggravation of the generations conflict.

Thus, there is a necessity to undertake pension reform in Ukraine. The introduction of insurance principles to the system would solve, at least partially, the above-mentioned problems. At the same time, there are further problems complicating these measures, such as

- The macroeconomic instability in the state, an insufficient development of financial institutions, and, as a result, absence of necessary mechanisms of saving;

- The low income of most people of working age, which does not give them an opportunity to save money for their future (UNDP, 1997);

- The lack of economic knowledge and skills in a considerable part of the population. Many people are certain that the state must provide pensions, do not have enough foresight to distribute their income throughout life, and are not able to estimate long-term solvency of pension funds;

- The low level of trust of the population to both state and private financial structures;

- The impossibility of insuring against many risks (inflation, economic recession, investment mistakes, long life etc.);

- The lack of professionals in the field of pension insurance.

Thus, planning and implementation of pension reform in Ukraine is a complex problem that involves searching for a compromise between necessary and possible ways.

3. METHODOLOGY OF THE MODEL-BASED ANALYSIS

3.1. The analysis targets

The analysis in the previous section of the recent trends and current situation in the Ukrainian pension system clearly shows that the country's policymakers will most likely have to solve in the nearest future the complex problem of the introduction of a "defined-contributions" component in the system. However, to stimulate development of this component the government should decrease the social security tax. However, a decrease of the social security tax rate will obviously lead to a decline of income of the current retirees. But this income is already so low that an attempt to reduce it even further will definitely lead to a failure of the reform. Therefore, the government should be ready to compensate the retirees for their losses during the reform, or, in other words, pay the costs of reform. The question is, where to get money for this endeavor? The government will most likely borrow money for this purpose, that is, it will increase the governmental debt. In this case the debt level, or, more exactly, the level of the interest payments that should be paid for this debt, will be an important indicator of success or failure of the reform.

One more significant question is which factors might influence the success or the failure of the reform? As was discussed previously, one of the reasons for the crisis in the current pension system is the huge share of the informal sector in the economy. What impact will the informalization of the economy have on the pension reform? Is it possible to undertake the reform if the informal sector's share will remain the same? If not, by how much should it be decreased to make the reform possible? These questions will be the focus of our simulations. Composing the scenarios for these simulations, we shall also take into account two more factors. First, the government might use different strategies regarding the term of reforms. On the one hand, a slow decrease of the social security tax will place less pressure on government finances then a fast one, which is due to the prolongation of the period of paying the cost of the reform. But, on the other hand, because the current tax rate is too high, it will slow down economic development. Which term of the reform is possible for different assumptions on changes in the informal sector's share? Second, the issue that is discussed now in the country is an increase of the retirement age. Obviously, the raising of the retirement age will have a significant financial impact on the stability of the public PAYG system. Moreover, as was shown before, most people do not give up their jobs until the age of 65, so even the cancellation of pensions for working people will de-facto mean a considerable increase of the retirement age. However, under conditions of decline in life expectancy and after the loss of savings by the oldest part of the population due to hyperinflation, for political reasons the policymakers will be very cautious with any decisions in this direction (people in the retirement age bracket constitute 40% of the present electorate). Another important question is the relative impacts on the pension system of changes in the retirement age and changes in the share of the informal sector in total economic activity.

3.2. Assumptions on the macroeconomic environment

The starting point of the analysis is the current situation. The macroeconomic environment can be described as follows: hyperinflation has been stopped (annual inflation was about 25% in 1997), the budget deficit is expected to be about 3% of formal GDP, the formal GDP declined until 1997, but a modest increase was observed in the first half of 1998. Regarding structural reforms, most domestic prices have been liberalized, trade has been liberalized, and most small-scale privatization has been completed.

The basic assumption for the following years is that the government will continue its efforts on reforming the economy. The budget deficit will be maintained at the same level, inflation will decline, and structural reforms will be continuously implemented, including progress in privatization, gradual reduction in the size of the budgetary sector, and full liberalization of trade. Under these assumptions Ukraine could resume economic growth (Riboud and Chu, 1996), which is assumed to be 3-6% during the next 10 years. Analyzing the results of simulations, we should realize that these assumptions are rather optimistic. However, since the sustainable development of the fully funded defined-contribution pension system is impossible in conditions of economic stagnation, it seems reasonable to use them.

3.3. Adaptation of the IIASA SSR model for the case study

3.3.1. Model description

The adapted variant of the IIASA SSR model (MacKellar and Reisen, 1998b; specified in Appendix 2) was used for the simulations.

Age-specific saving and labor force participation rates are exogenous; thus, the IIASA model in its present form is essentially an accounting model. For a given population size, the age structure has three effects on per capita income: first, through the labor force as it affects the number of workers relative to nonworkers; second, through capital formation, as it affects the number of savers relative to dissavers; and, third, through capital formation, as it affects the wage rate and rate of return to capital, which in turn determine the income streams that give rise to saving. Concentrating on relatively detailed age-structure effects, the model is based on analyses (e.g., Cutler *et al.*, 1990; Börsch-Supan, 1996), where the impact of population aging is mediated through the life cycle hypothesis (LCH) of household consumption. Given theoretical ambiguities, a simple accounting model with ample demographic detail provides a useful benchmark for work with more economically sophisticated, but demographically sparse, models.

As illustrated in Table 2, the model tracks receipts and disbursements, and thus net savings, by institutional sector (households, firms, government). Capital consists of

Table 2. Sources of savings.

Households

1. Population in working age

Receipts
  Compensation of employees
  Entrepreneurial income (net of depreciation and indirect tax)
  Imputed housing services (net of depreciation and indirect tax)
  Transfers incl. bequests (from pop. in retirement age)

Disbursements
  Direct tax
  Workers' social security contributions
  Employers' social security contributions
  Workers' contributions to private pension plans
  Employers' contributions to private pension plans
  Consumption
    From after-tax compensation of employees
    From after-tax entrepreneurial income
    Imputed housing services
    From transfers incl. bequests

3. Private Pension System (PPS)

Receipts
  Dividends distributed from profits on capital
  Workers' contributions to PPS
  Employers' contributions to PPS

Disbursements
  Annuity payments to retirees

2. Population in retirement age

Receipts
  Compensation of employees
  Annuity payments from PPS and OIs
  Social security benefits

Disbursements
  Direct tax
  Workers' social-security contributions
  Employers' social-security contributions
  Workers' contributions to private pension plans
  Employers' contributions to private pension plans
  Consumption
    From after-tax compensation of employees
    From annuity income
    From social security benefits
  Transfers incl. bequests (to pop. aged 15-59)

4. Other Institutions (OI)

Receipts
  Dividends distributed from profits on capital
  Capital returns to residential capital and capital
  operated by PUEs (portion owned by retirement age
  population only)

Disbursements
  Annuity payments to population in retirement age
  Capital operated by firms
  Residential capital and capital operated by PUEs

Net savings of households (sum of receipts minus disbursements over 1-4)

Firms

Receipts
  Profits on capital

Disbursements
  Direct tax to government
  Dividends distributed to holders of claims

Net savings of firms

Government

Receipts
Direct taxes
Indirect taxes
Employers' contributions to social security
Workers' contributions to social security

Disbursements
Government consumption
Social security benefits

Net savings of government

residential capital, capital operated by private unincorporated enterprises (PUEs), and capital operated by firms (i.e., corporate enterprises). Imputed rents (in the case of residential capital) and the profits of PUEs accrue directly to households. Firms earn profits, pay taxes, and distribute dividends to holders of claims.

These claims are held on behalf of households by two financial intermediaries: the fully funded defined-contribution pension system (DCPS) and other institutions (OIs). When receipts and expenditures are summed across households of working age, households of retirement age, the DCPS, and OIs, cancellations result in the net household savings accounting concept, which is used in national accounts. The DCPS represents fully funded, defined-contribution pension plans. OIs include banks, insurance companies, mutual funds, and other financial intermediaries apart from pension funds. Implicitly, OIs also include individual households, to the extent that the latter hold financial claims directly.

Flows of income from capital must ultimately be allocated to households. The capital stock as a whole is divided into portions owned by the working-age and retirement-age population. The shares used to apportion the capital stock between the working- and retirement-age populations are functions of the age distribution of the population, the rate of economic growth, and the rate of return to capital (MacKellar and Reisen, 1998b).

The important feature of the articulation of savings is that the model is able to track the downward pressure on household saving and capital accumulation that is expected as the baby boomers begin to retire (Schieber and Shoven, 1994). Persons in the working age bracket do not consume out the dividends that are distributed from earnings on the capital they own (i.e., the DCPS and OIs that hold claims on behalf of persons in retirement age brackets do not pass them on to the claimants). Persons in retirement age, whether they are still working or not, are assumed to annuitize their portion of the capital stock, meaning that they receive (from the DCPS and OIs) an annuity that depends on the current rate of return to capital, the amount of capital they own, and life expectancy at retirement age. In the case of capital operated by firms, the DCPS and OIs receive dividends on, and pay out the annuity value of, the retirement-age population´s assets. In the case of assets consisting of residential capital and capital operated by PUEs, it is similarly assumed that the OIs play the intermediary role.

Persons of working age earn wages, out of which they and their employers make pension and social security contributions; they also earn profits on PUEs and receive imputed services from their share of the stock of owner-occupied housing. Persons in the retirement age bracket, in addition to receiving wages (if they work), receive annuity income from the DCPS and OIs based on their assets, and receive social security benefits.

Persons of retirement age transfer unspent income from all sources to the population of working age; in this way, the model "annualizes" bequests.

The public social security system is assumed to be a balanced PAYG system, i.e., social security contributions collected from workers are spread over the elderly population. Intrafamily transfers from children to parents, which may be an important part of old-age support, are implicitly included under the public PAYG pension system.

3.3.2. Taking into account the informal sector of the economy

The best way to take into account the informal sector of the economy would be the development of a two-sectoral model with separate production functions for the formal and the informal sector. However, the implementation of such an approach needs a lot of data on parameters of the informal sector of the economy that we do not have at the moment. Therefore, we used a one-sector model, but included the production of the informal sector in the GDP:

GDP(t)=OfficialGDP(t)/(1-InformalSectorShare(t))

and adjusted tax rates, including the social security tax rate, to reflect the share of the formal sector in the economy.

DirTaxRate(t)=OfficialDirTaxRate(t)*(1-InformalSectorShare(t))

IndirTaxRate(t)=OfficialIndirTaxRate(t)*(1-InformalSectorShare(t))

SocSecurityTaxRate(t)=OfficialSocSecurityTaxRate(t)*(1-InformalSectorShare(t))

3.3.3. Modeling governmental debt

The model was also modified to take into account the fiscal implications of the social security reform.

The governmental debt for year t is calculated as the sum of the debt and deficit for the previous year:

GovDebt(t) = GovDebt(t-1) + GovDeficit(t-1)

The governmental deficit is the difference between disbursements and receipts of the government:

GovDeficit(t)=GovDisbursements(t)-GovReceipts(t)

The disbursements of the government are the sum of government consumption, social security payments, targeted income support transfers designed to return to retirees their losses incurred by the decrease of the social security tax rate, and interest payments:

Disbursements(t)=GovConsumption(t)+SocSecBenefits(t)+TargIncSupTrans(t)+

+IntPayments(t)

The targeted income support transfers are calculated as the difference between total average pension in the case of reform (which includes two components: one provided by the PAYG pension system and one from the defined-contribution pension system) and average social security pension in the "no reform" case, multiplied by the number of people in the retirement age brackets:

TargIncSupTrans(t)=PopRet(t,Reform)*(AvSocSecPension(t,Reform)+

+AveAnnDCPS(t,Reform) - AvSocSecPension(t,NoReform))

The average pensions are calculated according to formulae:

AvSocSecPension(t,Reform) = SocSecTaxe(t,Reform)/PopRet(t,Reform)

AvSocSecPension(t,NoReform) = SocSecTaxe(t,NoReform)/PopRet(t,NoReform)

AveAnnDCPS(t,Reform) = AnnDCPS(t,Reform)/PopRet(t,Reform)

The average pension provided by the PAYG pension system is likely to decrease during the reform due to a decrease in the social security tax rate (however, this effect may be partially compensated owing to economic growth, if any). The defined-contribution component of the pension is supposed to increase due to the development of this type of pension system. A difference between the number of people in the retirement age brackets in the case of reform and no reform may appear if the reform includes changes in the retirement age.

The receipts of the government are calculated as the sum of direct tax, indirect tax, and social security contributions:

GovReceipts(t) = DirTax(t) + IndirTax(t) +SocSecContr(t)

The interest payments to be paid in year t are calculated as a multiplication of the interest rate in year t and the governmental debt in year t-1.

IntPayments(t)=r(t)*GovDebt(t-1)

4. SIMULATIONS

4.1. Scenarios

Scenarios are defined according to three criteria:

The first criterion is the share of the informal sector in the economy. We assumed that the share of the informal sector is currently 0.5 and proposed three groups of scenarios:

- The share of the informal sector will remain 0.5 during the next 30 years;

- The share will decrease to 0.3 during this period;

- The share will decrease to 0.2.

The second criterion is the duration of the reform. It was assumed that during 15 years of reform total contributions of employers and employees to a defined-contribution pension system would increase from 0% to 7% of the total wage bill. Three groups of scenarios were generated based on the assumption that the government will decrease twice the rate of the social security tax related to the PAYG system, moving it close to the average in industrialized countries:

- During 5 years;

- During 15 years;

- During 25 years.

The last criterion for generating the scenarios is retirement age. Two groups of scenarios were based on assumptions that

- The retirement age will remain the same (55 years for women and 60 years for men;

- The retirement age will be increased to 65 years for both men and women during the first 10 years of the reform.

Thus, in total there are 18 scenarios (Table 3). Obviously, they do not cover all the possible variants of pension reform in the country, and different scenarios have different probabilities of realization (for instance, the scenario where the social security tax is declining slowly and the share of the informal sector in the economy is shrinking fast has a lower probability than one where these parameters decline synchronously, since high taxes are one of the main reasons for informalization of the economy). However, this set of scenarios allows us to investigate the dependency of the success of the reform on those factors, which, as was shown in the previous chapter, are most significant for reform.

4.2. Results

The simulations were made for a period of 30 years with the reform starting in the year 2000 (the choice of the year, however, is arbitrary and delaying implementation by a few years would not affect the results drastically). We focused on the level of interest payments on the governmental debt related to the formal GDP for the period of reform.

Obviously, if the payments for some scenario exceed 20% of the formal GDP (share of government consumption in GDP for industrialized countries), this is likely to cause a collapse in the economy, and, therefore, the implementation of this reform scenario is impossible. Table 3 shows the results of the simulations.

Table 3. Interest payments for the governmental debt for different scenarios of the pension reform.

#	Share of informal sector	Term of reform	Retirement age (female/male)	Interest payments (% of formal GDP)			
				2000	2010	2020	2030
1	Decreases to 20% during 30 years	25 years	65/65	9.55	8.14	3.35	0.99
2			55/60	9.55	13.04	13.70	>20
3		15 years	65/65	9.55	10.19	8.47	6.96
4			55/60	9.55	17.71	>20	>20
5		5 years	65/65	9.55	>20	>20	>20
6			55/60	9.55	>20	>20	>20
7	Decreases to 30% during 30 years	25 years	65/65	9.55	9.92	6.27	3.89
8			55/60	9.55	16.43	>20	>20
9		15 years	65/65	9.55	12.24	14.22	>20
10			55/60	9.55	>20	>20	>20
11		5 years	65/65	9.55	>20	>20	>20
12			55/60	9.55	>20	>20	>20
13	Remains 50%	25 years	65/65	9.55	14.73	>20	>20
14			55/60	9.55	>20	>20	>20
15		15 years	65/65	9.55	>20	>20	>20
16			55/60	9.55	>20	>20	>20
17		5 years	65/65	9.55	>20	>20	>20
18			55/60	9.55	>20	>20	>20

4.3. Analysis of the results

The results of the simulations show that, first, the share of the informal sector in the economy plays an enormous role in success or failure of the reform. One can see that for scenarios where the share of the informal sector in the economy decreases to 20%, the interest payments for the governmental debt do not exceed 20% of the formal GDP in 2 out of 6 cases; for those where the share decreases to 30% in 1 case; and for those where the share remains 50% in 0 cases. For the latter even in the most favorable case (scenario # 13), where the decline of the social security tax takes place during 25 years and the retirement age is increased, the interest payments, according to our simulations, have a clear trend towards growth (Figure 8), i.e. the pension reform is impossible if the informal sector comprises 50% of the economy.
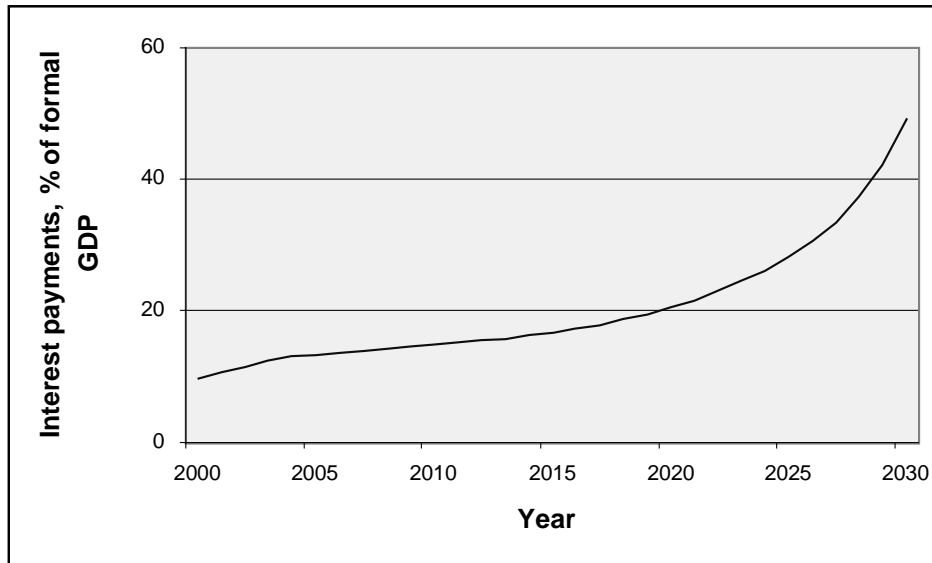
Figure 8. Dynamics of the interest payments on the governmental debt for scenario #13.

Second, the results show that a reduction of the social security tax in 5 years is impossible in any case, in 15 years is possible in 1 out of 6 cases, and in 25 years is possible in 4 out of 6 cases. Undertaking the pension reform over 15 years does not lead to huge governmental debt if the retirement age is increased and the share of the informal sector in the economy declines to 20% (scenario #3, Figure 9).

Finally, according to our simulations, the pension reform is unlikely to be possible without change of the retirement age in any case and only possible with an increase of retirement age in 3 out of 9 cases. Figure 10 shows the difference in interest payment dynamics for scenarios 1 and 2 where the informal sector decreases to 20% of the economy, the term of reform is 25 years, and the retirement age, correspondingly, is decreased and remains the same. Let us note that as discussed previously, a situation when the taxes (in particular, the social security tax) are being changed slowly and the informal sector in the economy is shrinking rapidly, is unlikely to take place in reality. For any other situation changes in the retirement age are causing an even wider difference.
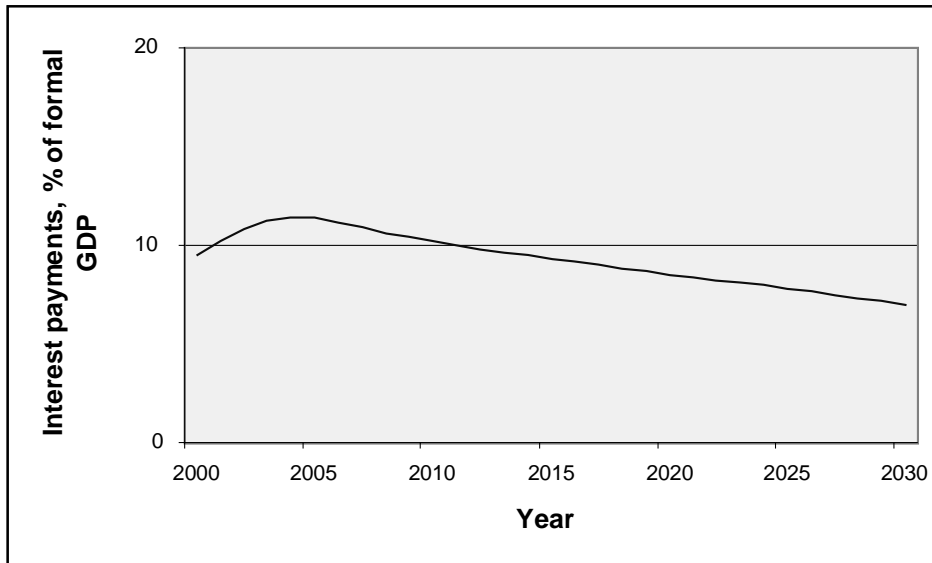
Figure 9. Dynamics of interest payments on the governmental debt for scenario #3.
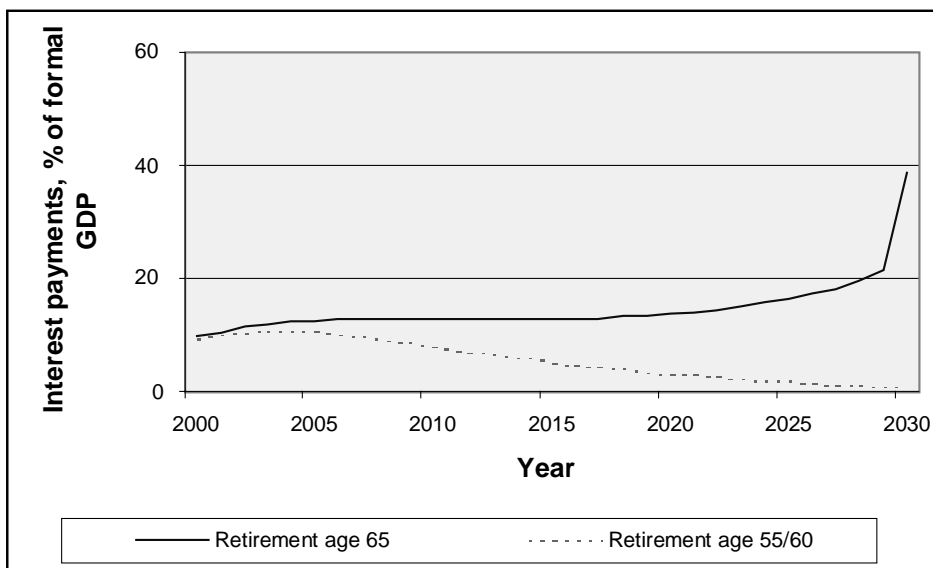

Figure 10. Dynamics of interest payments on the governmental debt for scenarios #1 and #2.

5. CONCLUDING REMARKS

Due to the severe economic crisis and major changes in the economy, the social security system in Ukraine based on PAYG principles works extremely ineffectively. The trend towards an aging population will place an additional pressure on the system after the turn of that millenium. In such conditions reform based on the introduction of a defined contribution component to the system looks highly desirable. However, since the economy is not mature enough, the implementation of such a reform is an extremely complicated task.

One of the main factors complicating the reform is the huge share of the informal sector in the economy. The simulations show that if present conditions are maintained, when the informal sector comprises about 50% of the economy, implementing the reform will be impossible. With a decrease of the informal sector's share, the probability of success of the reform will rapidly increase. Thus we can draw the conclusion that informalization of the economy has an enormous impact on the social security system.

Simulations show that under present conditions it is unlikely that the social security reform in Ukraine can be completed in a short time period.

The reform is unlikely to be successful unless the retirement age is changed.

For more detailed investigations of the interdependencies between the informal economy and the social security system, it would be reasonable to develop a two-sectoral model of the economy, including formal and informal sectors. Since the informalization of the economy is typical of all transition countries, the development of such a model would be important for the analysis of this significant phenomenon.

REFERENCES

Börsch-Supan, A. (1996). The Impact of Population Aging on Savings, Investment and Growth in the OECD Area, in OECD (ed.), *Future Global Capital Shortages: Real Threat or Pure Fiction?* OECD, Paris.

Corsetti, G., and K.Schmidt-Hebbel (1995). Pension Reform and Growth. *World Bank Working Paper,* WPS 1471, Washington, DC.

Cutler, D., J. Poterba, L. Sheiner and L. Summers (1990). An Aging Society: Opportunity or Challenge? *Brookings Papers on Economic Activity*, 1990:1.

Hnybidenko, I. and M.Soldatenko (1997). Conceptual directions of social policy in Ukraine. *Ukraine: Aspects of labor.* 1997, p. 25-28

Libanova, E. and V.Yatsenko (1997). Demographic crisis in Ukraine and its influence on stability of the pension system. *Ukraine: Aspects of labor.* 1997, p. 29-32.

Lutz, W., Sanderson, W.C., and S. Scherbov (1996). Probabilistic World Population Projections Based on Expert Opinion. *IIASA Working Paper* WP-96-017, Laxenburg, Austria.

MacKellar, F.L. and H. Reisen (1998a). A Simulation Model of Global Pension Investment. *OECD Development Centre Technical Paper No. 137*, OECD, Paris.

MacKellar, F.L. and H. Reisen (1998b). International Diversification of Pension Assets is No Panacea for Population Aging. *IIASA Interim Report* IR-98-034, Laxenburg, Austria.

Riboud, M. and H. Chu (1996). Pension Reform and Growth in Ukraine: An Analysis focusing on Labor Market Constraints. . *World Bank Working Paper,* Washington, DC

Schieber, S. and J. Shoven (1994). The Consequences of Population Aging on Private Pension Fund Saving and Asset Markets, *NBER Working Paper*, No. 4665.

State Committee for Statistics of Ukraine (1980-1997). Statistical Yearbooks of Ukraine, 1980-1997.

UNDP (1996). Ukraine: Human Development Report 1996. UNDP, Kyiv.

UNDP (1997). Ukraine: Human Development Report 1997. UNDP, Kyiv.

APPENDIX 1. DESCRIPTION OF THE UKRAINIAN PENSION SYSTEM

Administrative and legislative structure of the pension system

The legislative base of the Ukrainian pension system was formed in a period of socioeconomic crisis. This resulted in a series of laws that aimed to "catch up with the situation", which caused the pension system to become more complicated and unclear for the citizens. The assignment and payment of pensions is based on the Law of Ukraine "On Pension Maintenance" accepted in 1991, and on some other laws regulating payment of pensions for certain categories of people (laws "On the Status of People Deputy", "On the State Service", "On Status of Judges", "On the Public Prosecutor's Office", "On Pensions of Servicemen and the Officers and Men of the Agencies of Internal Affairs", "On the Status of War Veterans and Guarantees of their Social Security", "On the Basic Principles of Social Security of Labor Veterans and Other Elderly Citizens", Custom Code of Ukraine). Funding of the pension system is regulated by the Law of Ukraine "On Tax for Obligatory State Pension Insurance" adopted in 1997.

In April 1998 the president of Ukraine affirmed Basic Principles of Pension Reform in Ukraine. Aiming at their implementation, the cabinet of ministers submitted to the parliament drafts of the Laws of Ukraine "On Obligatory Pension Insurance" and "On Non-State Pension Funds".

According to the Basic Principles, the main tasks of the pension reform in Ukraine are as follows:

- To realize the constitutional rights of citizens to social security;

- To create conditions for the development of insurance principles in the pension system;

- To increase the personal interest and personal responsibility of the worker for his/her living standard after retirement;

- To more seriously take into account the results of a worker's career to determine the pension level;

- To reduce demographic pressure on the financial basis of the pension system;

- To introduce a non-state pension insurance.

The Basic Principles stipulate the multistage introduction of a multipillar pension system in Ukraine. The pension reform is expected to have three stages.

In the first stage it is planned to carry out the reform of an obligatory pension insurance, decrease the number of preferential treatments and compensations in the pension system, divide financial sources for different types of pensions, liquidate debts in pensions payments, and develop a system of the minimum state social standards.

During the second stage the reform of the administrative structure of the pension system should be maintained, an additional non-state pension should be introduced,

social pensions should be transferred to the system of social assistance, and in favorable conditions the defined-benefit pension system should be introduced.

The third stage stipulates providing the minimum social standards for the population and full realization of the multipillar pension system.

The administrative structure of the pension system includes three organizations.

The Ministry of Labor and Social Policy is responsible for setting state policy and developing drafts of laws in the field of the pension system, assignment and calculating the pension level according to legislative regulations, controlling the use of the funds of the Pension Fund of Ukraine, development of international cooperation in the field of the pension system, and promotion of the development of non-state pension systems.

The Pension Fund collects the social security contributions into the fund through its regional branches and keeps them on account in a special postal-pension bank.

The ministry of communications provides pension payments through the local post offices.

According to the Basic Principles of Pension Reform in Ukraine, the functions of assignment and paying of state labor pensions are expected to be fulfilled by the Pension Fund of Ukraine after the implementation of individualized registration of contribution for obligatory state pension insurance.

Types and criteria of pension assignment and pension level calculation

According to the Law of Ukraine "On Pension Maintenance", there are two basic types of pensions: labor pensions and social pensions.

Labor pensions include four types of pensions: old-age pensions, invalidity pensions, survivor pensions, and time of service pensions.

Old-age pensions are assigned to people who have reached retirement age and have the necessary working record. The level of an old-age pension is 55% of the average monthly wage, but cannot be less then the minimum pension. The pension is to be increased by 1% each full year of service, but this increment cannot be more than 75% of the pension. The minimum pension is defined by the parliament, the maximum is three times (for representatives of some professions and persons having suffered from the Chernobyl disaster – four times) more than the minimum pension. If the working record is not sufficient, the level of pension is pro-rata-tempore of the full pension, but not less then 30% of the minimum old-age pension.

Invalidity pensions are assigned to people who have partially or totally lost their working capacity. To be eligible for invalidity pensions one should have a working record of 1 - 15 years depending on age. Depending on the degree of capacity loss, disabled persons are categorized into three groups. The invalidity pension level is for group 1, 70% of earnings; for group 2, 60% of earnings; and for group 3, 40% of earnings. The minimum labor invalidity pension is equal to the social pension for the respective disability group; the maximum pension is three (four) minimal ones.

Survivor pensions are assigned to disabled dependents of the deceased worker. The level of pension is 30% of the worker's earnings, but not less than the social pension for respective category of disabled.

The years of service pensions are assigned to people whose professions might cause the loss of their working capacity prior to their normal retirement age. The service pension level is determined analogously with the age pension level.

Average monthly wages for determining the levels of labor pensions are calculated (according to the choice of the person, requesting a pension) either over the last 24 months of work without interruption before retirement, or over 60 months of work without interruption during the whole working career. Earnings exceeding 10 minimum wages are not considered for the pension level determination. That part of the earnings which is not higher than four minimum wages is taken into full account, the fifth minimum wage is calculated with a coefficient 0.85, the sixth minimum wage with a coefficient 0.7, the seventh with 0.55, the eighth with 0.40, the ninth with 0.25, and the tenth with 0.15.

According to the laws of Ukraine, there is an exception for some state workers whose pensions are placed at the level of 50% to 90% of their earnings without a maximum limit.

War veterans and persons having special labor services are entitled to receive an increment for their pension at a level from 50% to 400% of the minimum labor age pension.

Social pensions are assigned to invalids, persons having reached retirement age, and children who lose the working parent's income if they do not have an entitlement to labor pensions. The social pension level for different categories of beneficiaries are from 30% to 200% of the minimum old-age pension.

Retirement age and working record

The retirement age in Ukraine is 60 years for men and 55 years for women. The working record necessary to get a full pension is 25 years for men and 20 years for women. For people with dangerous jobs, the retirement age is decreased to 55 years for men and 50 years for women, and the necessary working record is decreased to 20 and 15 years for men and women, respectively. According to the Ukrainian laws, the periods when a person does not contribute to the Pension Fund (military service, studying at the university, childcare) are also included in the working record. People who reach retirement age have a right to pension payment regardless of whether they continue to work or not.

Social Security taxes and expenses of the Pension Fund

According to the law, employers must contribute 32% of the total wages of their companies to the Pension Fund (if employees of the company have a right to preferential treatment, this rate is higher), employees contribute 1% of the wage, and self-employed workers and lawyers pay 32% of their earnings (until February 1996 -

9%). The reserves of the Pension Fund are not included in the state budget, other budgets, and funds. The only admissible operation directed toward reproduction of the fund reserves is a purchase of state securities.

Funds of the Pension Fund are spent as follows:

- Payment of the labor and social pensions specified in the laws;

- Child care assistance and under-age child assistance, defined by the law;

- Additional monetary payments to the retirees due to retail price increases;

- Realization of the state programs in the field of social support of retirees, disabled, children, and other categories of people;

- Organization of current activities, supply of equipment, maintenance of managerial structures of the Fund, and providing population with information about activities of the Fund.

APPENDIX 2. MODEL SPECIFICATION

This model is based on MacKellar and Reisen (1998a, 1998b). Unless required for purposes of clarity, the time argument is suppressed.

Population, labor force, employment, and households

The population is divided into three age groups: population under the working age (0-14 years), the working-age population, and the retirement-age population:

$$Pop^* = Pop^{0-14} + Pop^{work} + Pop^{ret}$$

Age-specific labor-force participation rates are exogenous assumptions:

$$LabForce^* = LabForce^{work} + LabForce^{ret}$$

$$LabForce^{work} = Pop^{work} \, LabForcePartRate^{work}$$

$$LabForce^{ret} = Pop^{ret} \, LabForcePartRate^{ret}$$

as are age-specific unemployment rates:

$$Emp^* = Emp^{work} + Emp^{ret}$$

$$Emp^{work} = LabForce^{work} \left(1 - UnEmpRate^{work}\right)$$

$$Emp^{ret} = LabForce^{ret} \left(1 - UnEmpRate^{ret}\right)$$

Output and rates of return to factors

Gross domestic product (GDP) is given by a Cobb-Douglas production function and rates of return to factors are neoclassical:

$$GDP = \alpha \, (1 + g)^t \, K^{\beta} \, EMP^{*(1-\beta)}$$

$$R = \beta \, \left(GDP \, / \, K\right)$$

$$W = (1 - \beta) \left(GDP \, / \, EMP^*\right)$$

where g is the rate of total factor productivity growth; R is the gross profit rate, including depreciation and indirect taxes net of subsidies; and W is the rate of employee compensation, including social insurance contributions (workers and employers contributions to PAYG and defined-contribution pension schemes). In order to net depreciation and indirect taxes out of the rate of return to capital, we define

$$r = R - \frac{\left[(IndTaxRate)(GDP)\right]}{K} - \delta$$

where *IndTaxRate* is defined with respect to GDP and δ is the depreciation rate

The structure of capital, its location, and the nature of claims

Capital is either residential (Res) or nonresidential (NonRes); the latter is further subdivided into capital operated by private unincorporated enterprises (PUEs) and capital operated by firms, i.e., corporate enterprises. Residential capital and capital operated by PUEs are held by households directly. Financial claims on this capital are held on behalf of households by institutions that collect dividends and pay out annuities.

These institutions are subdivided into those that comprise the fully funded defined-contribution pension system (DCPS) and other institutions (OIs) such as banks and mutual funds. Firms in the model operate capital, either distributing or reinvesting earnings that accrue; they do not own shares in other firms. In summary,

$$K = K\operatorname{Re}s + KPUE + KDCPS + KOI$$

The age structure of capital ownership. Ideally, each cohort should be tracked as it accumulates capital during its working life and draws it down during retirement. An expedient measure is to share down the aggregate capital stock by age of owner. The assumption is made that the age structure of all forms of capital (residential and nonresidential; operated by firms and PUEs; held by the DCPS and OIs) is identical. Assuming that persons under 15 do not own capital, for all types of capital we have:

$$K^{work} = K^* KShare^{work}$$

$$K^{ret} = K^* (1 - KShare^{work})$$

This leaves us with the problem of estimating the share variable. In MacKellar and Reisen (1998a), a model from demography is presented that results in the following expression:

$$KShare^{work}(t) = \frac{Pop^{work}(t)}{POP^{work}(t) + 0.25 \frac{(1+r(t))^{(RetAge-A_W)}}{(1+g(t))^{(A_R-A_W)}} POP^{ret}(t)}$$

where A_R is the average age of the population over retirement age, and A_W is the average age of the population in working age.

Income, outlay, and net saving of households

Income, outlay, and net saving of the population in working age. Persons of working age receive wage income, entrepreneurial income in the form of profits from PUEs, imputed rental services of residential capital, and transfers from persons aged over retirement age. Pre-tax income in this age group is thus:

$$YPop^{work} = WageYPop^{work} + EntrYPop^{work} + \mathrm{Re}ntYPop^{work} + TransPop^{ret,work}$$

Income, outlay, and net saving related to wage income. Out of pre-tax wage income, persons of working age pay direct taxes and social insurance contributions, the latter consisting of contributions to the public PAYG social security system and the DCPS.

$$WageYPop^{work} = W \ Emp^{work}$$

$$DispWageYPop^{work} = WageYPop^{work} - DirTaxWageYPop^{work} - SocInsContrWageYPop^{work}$$

The direct tax rate is defined with respect to income:

$$DirTaxWageYPop^{work} = DirTaxRate \ W \ Emp^{work}$$

The direct tax rate is assumed to apply equally to all factor incomes. Social insurance contributions consist of contributions to the public PAYG defined-benefit public pension system and the DCPS:

$$SocInsContWageYPop^{work} = SocSecContWageYPop^{work} + DCPSContWageYPop^{work}$$

PAYG and DCPS contributions are taken out of gross compensation of employees. The contribution rate is assumed to be the same for both age groups; therefore, it is not indexed by age. It is also assumed to be the same for both wage income and entrepreneurial income:

$$SocSecContWageYPop^{work} = SocSecContRate \; WageYPop^{work}$$

$$DCPSContWageYPop^{work} = DCPSContRate \; WageYPop^{work}$$

Consumption of disposable wage income is calculated by means of an exogenous age-specific share:

$$ConsWageYPop^{work} = ConsShareWageYPop^{work} \; DispWageYPop^{work}$$

and what is left over is net saving:

$$NetSvngWageYPop^{work} = DispWageYPop^{work} - ConsWageYPop^{work}$$

Income, outlay, and net saving related to KPUE^{work}. The treatment of entrepreneurial income derived from PUEs is identical:

$$EntrYPop^{work} = r \; KPUE^{work}$$

Income, outlay, and net saving related to KRes^{work}. Imputed rents to residential housing are taxed similar to any other form of income; the residual is consumed, so there is no net saving out of this income stream.

Income, outlay, and net saving related to transfers/bequests. All income not consumed by persons over retirement age is transferred to those of working age. This includes the annuity value of the wealth of the population in retirement age; in this way, bequests are "annualized":

$$ConsTransPop^{ret,work} = ConsShareTrans^{ret,work} \; TransPop^{ret,work}$$

$$NetSvngTransPop^{ret,work} = TransPop^{ret,work} - ConsTransPop^{ret,work}$$

Total net savings. Total net savings are equal to the sum over net savings from the various income streams:

$$NetSvngPop^{work} = NetSvngWageYPop^{work} + NetSvngEntrYPop^{work} +$$

$$+ NetSvngTransPop^{ret,work}$$

Income, outlay, and net saving of the population in retirement age. Persons over retirement age receive wage income if they are still employed, annuity income derived from their capital assets, and benefits from the public PAYG social security system. The level of social security benefits is dictated by current revenues flowing into the system (i.e., we assume that no surplus is accumulated and there is no deficit financed from general revenue). In order to simplify accounting, persons are assumed to start receiving social security benefits at retirement age regardless of labor-force status.

For the same reason, annuitization of assets is assumed to commence at retirement age whether the individual is retired or not. The retirement age population´s claims on all forms of capital is translated into annuity income based on the prevailing rate of return to capital and life expectancy at retirement age.

Total pre-tax income in this age group is:

$$YPop^{ret} = WageYPop^{ret} + AnnYPop^{ret} + SocSecBen$$

We proceed to look at each of these components and expenditures out of each income stream.

Income, outlay, and net saving related to wage income. Wage and entrepreneurial income of the retirement age population is treated no differently from that of younger persons.

Income, outlay, and net saving related to $KDCPS^{ret}$, KOI^{ret}, $KPUE^{ret}$, and $KRes^{ret}$. Persons over retirement age derive annuity income from the DCPS and OIs, which hold financial claims on their behalf, and this annuity income is assumed to be untaxed.

$$DispAnnYPop^{ret} = AnnValKDCPS^{ret} + AnnValKOI^{ret} + AnnValKPUE^{ret} + AnnValK\operatorname{Re}s^{ret}$$

These annuities for all types of the capital are calculated according to the formula:

$$AnnValK^{ret} = K^{ret} \frac{r}{1+r - \left(\frac{1}{1+r}\right)^{LifeExp \, \mathrm{Re}\,tAge}}$$

No distinction is made between the propensity to consume out of various annuity streams:

$$ConsAnnYPop^{ret} = ConsShareAnnYPop^{ret} \, DispAnnYPop^{ret}$$

$$NetSvngAnnYPop^{ret} = DispAnnYPop^{ret} - ConsAnnYPop^{ret}$$

Income, outlay, and net saving related to social security benefits. Social security benefits are assumed to be untaxed.

$$ConsSocSecBen = ConsShareSocSecBen \, SocSecBen$$

$$NetSvngSocSecBen = SocSecBen - ConsSocSecBen$$

Transfers/bequests. Transfers/bequests from the population of retirement age to the population of working age are calculated as the residual left after consumption has been deducted from disposable income; i.e., as the sum of net saving from all disposable income flows:

$$TransPop^{ret} = NetSvngWageYPop^{ret} + NetSvngAnnYPop^{ret} + NetSvngSocSecBen$$

Net saving. Given the calculation of transfers/bequests, net saving of the population aged over retirement age is by definition zero.

Total private consumption. Total consumption in each age group is the sum over all consumption streams:

$$Cons^{work} = ConsWageYPop^{work} + ConsEntrYPop^{work} + Cons\,\mathrm{Re}\,ntYPop^{work}$$
$$+ ConsTransPop^{ret,work}$$

$$Cons^{ret} = ConsWageYPop^{ret} + ConsAnnYPop^{ret} + ConsSocSecBen$$

and total private consumption in the economy is:

$$\Pr ivCons^{*} = Cons^{work} + Cons^{ret}$$

Income, outlay, and net savings of the DCPS and OIs. The DCPS and OIs are dummy sectors in that they merely hold assets on behalf of households. The DCPS receives workers´and employers´ contributions and dividends distributed by firms. Since corporate profits are taxed when earned, these dividends are assumed to be untaxed. Disposable income of the DCPS is thus

$$DispYDCPS = DCPSContWageY^{*} + DCPSContEntrY^{*} + DivDistYFirmsKDCPS$$

The DCPS pays out annuities to retirees; what is left over comprises the net savings of the pension system:

$$NetSvngDCPS = DispYDCPS - AnnValKDCPS^{ret}$$

OIs receive dividends in the same way as the DCPS. Because OIs are assumed to intermediate retirees´ annuitization of their holdings of KPUE and KRes, they are credited with income streams from these assets:

$$DispYOI = DivDistYFirmsKOI + r\ KPUE^{ret} + r\ K\operatorname{Re}s^{ret}$$

Like the DCPS, OIs pay out annuities, and what is left over comprises net savings:

$$NetSvngOI = DispYOI - AnnValKOI^{ret} - AnnValKPUE^{ret} - AnnValK\operatorname{Re}s^{ret}$$

Net saving of households. Because saving of the population in retirement age is zero after transfers and bequests have been taken into account, total net saving from household income is

$$NetSvngHH = NetSvngPop^{work} + NetSvngDCPS + NetSvngOI$$

Income, outlay, and net savings of firms

Firms operate capital, earn profits, and pay out direct taxes and dividends. Earnings of firms are:

$$YFirmsKDCPS = r\ KDCPS^*$$

$$YFirmsKOI = r\ KOI^*$$

Direct taxes are paid to the government:

$$DirTaxYFirmsKDCPS = DirTaxRate\ YFirmsKDCPS^*$$

$$DirTaxYFirmsKOI = DirTaxRate\ YFirmsKOI^*$$

Dividend distributions are made out of pre-tax earnings:

$$DivDistYFirmsKDCPS = DivDistRate\ YFirmsKDCPS^*$$

$$DivDistYFirmsKOI = DivDistRate\ YFirmsKOI^*$$

Net savings of firms. Net savings of firms are:

$$NetDomSvngYFirms_1 = NetSvngYFirms\ KDCPS + NetSvngYFirmsKOI\ ,$$

where

$$NetSvngYFirmsKDCPS = YFirms\ KDCPS - DirTaxYFirmsKDCPS - DivDistYFirmsKDCPS$$

$$NetSvngYFirmsKOI = YFirmsKOI - DirTaxYFirms\ KOI - DivDistYFirmsKOI$$

Income, outlay, and net saving of government

Government receives direct taxes, indirect taxes, and contributions to the public social security system:

$$YGov = DirTaxWageYPop^* + DirTaxEntrYPop^{work} + DirTax\mathrm{Re}\,ntYPop^{work}$$
$$+ DirTaxYFirms + IndTax + SocSecContrWageYPop^* + SocSecContrEntrYPop^*$$

Indirect taxes are calculated as:

$$IndTax = IndTaxRate\ GDP$$

Government expenditure consists of government consumption and social security benefits, and income minus expenditure gives government net savings as:

$$NetSvngGov = YGov - GovCons - SocSecBen$$

Because the public social security system is assumed to be PAYG, social security outlay is equal to social security revenue:

$$SocSecBen = SocSecContrWageYPop^* + SocSecContrEntrYPop^*$$

In other words, net saving of the public pension system is assumed to be zero. Government consumption is calculated by means of an exogenous share coefficient:

$$GovCons = GovConsShare\ GDP$$

Sharing out saving into investment

A major simplifying assumption is that investment is constrained by the supply of capital, i.e., that investment always equals the amount of savings made available. The approach followed is to share out available savings into different types of investment, some mobile and some immobile.

Total net savings are:

$$NetSvngTot = NetSvngHH + NetSvngFirms + NetSvngGov$$

Residential and nonresidential investment are calculated from savings by means of an exogenous share coefficient:

$$dK\operatorname{Re}s = \operatorname{Re}sInvShare \quad NetSvngTot$$

$$dKNon\operatorname{Re}s = (1 - \operatorname{Re}sInvShare)NetSvngTot$$

Investment in PUEs is estimated as a share of nonresidential investment (apart from reinvestment of FDI earnings):

$$dKPUE = PUEInvShare \quad dKNon\operatorname{Re}s$$

Total investment minus residential investment minus investment in PUEs equals investment in capital operated by firms; claims on these are by definition held either by the DCPS or by OIs.

We assume that change in capital claimed by the DCPS is equal to net savings of this sector, which is sensible as we have more or less enumerated all the sources and uses of funds for this sector. The residual, i.e., investment from all savings not mediated through the DCPS, is assigned to OIs:

$$dKDCPS = NetSvngDCPS$$

$$dKOI = dKNon\operatorname{Re}s - dKDCPS$$

Calculation of capital stocks

Capital stocks are cumulated year by year. For any type of capital

$$K(t) = K(t-1) + dK \quad .$$

APPENDIX 3. MODEL PARAMETERIZATION AND ASSUMPTIONS

Demographic assumptions

According to the central scenario developed by the IIASA Population Project for European exUSSR countries (Lutz *et al.*, 1996), we assumed that fertility in Ukraine will increase to 17 per 1,000 people, and the life expectancy will increase to 67.1 years for men and 78.8 for women by the year 2030. The IIASA population projection model was used to provide assumptions on the age structure of the population.

The average age of the working-age population was 35 in 1996. We assume this will remain constant. The average retirement age can be estimated to be 57, and the life expectancy at 57 can be estimated to be 19.6 years in 1995. Based on ILO estimates, the labor age participation rate for the working age population is assumed to be 0.75. The labor force participation rate for the retired population was 0.15 in Ukraine in 1996. We assume that due to the stabilization of the economy it will decrease to 0.07 in 2040.

The production function

The β coefficient in the Cobb-Douglas production function was assumed to be 0.33. The 1996 formal per capita GDP level was 1575 Ukrainian Hryvnias. However, this does not include the informal sector of the economy, which has approximately the same size as the official one. To take this sector into account, we will assume that the real per capita GDP level is twice as high as the official one, while real tax rates and the government consumption rate are assumed to be two times lower than the official ones (real values given in brackets).

Social security contribution rates

Contributions to DCPS are assumed to be 0 in 1996. The social security contribution rate was 33% (16.5%); the employers share was 0.97.

Consumption/saving rates

According to national accounts of Ukraine, the savings of households were about 2.2% of their income. Taking into account this information, we assume that for the working-age population's propensity to consume, the disposable wage income, entrepreneurial income, and transfers/bequests was 0.99, 0.7, and 0.7, respectively, in 1996, which will decrease to 0.95, 0.5, and 0.5, respectively, by 2027. For the retirement age population we assume that all income was consumed in 1996, and the consumption rate of wage income is assumed to decrease to 0.95 in 2027.

Taxes and government consumption

According to data of the State Committee for Statistics of Ukraine, the direct tax rate (relative to wages and profits) was 0.19 (0.095) in 1996. The indirect tax rate (relative to GDP) was 0.10 (0.05). We assume that due to the decrease of the informal sector's share in the economy, the real values of these parameters will increase to 0.15 and 0.075 by 2040 and then remain constant. Government consumption was 32% (16%) of GDP in 1996. With the same reasoning we assume that the formal government consumption rate will decrease to 0.2 in 2027 and will then remain constant.

Residential investment and investment in PUE

The share of net domestic savings allocated to residential investment is assumed to be 20%. The share of private unincorporated enterprises in total investment is assumed to be 20%.

Initializing capital stocks

According to data of the State Committee for Statistics of Ukraine, the total capital was 762 billion hryvnias in 1996, and the residential capital was 124 billion hyrvnias (18.5%). The capital of private unincorporated enterprises can be estimated as 76 billion hryvnias (10%), and the capital of the fully-funded, defined-contribution pension system is assumed to be 0. Therefore, the capital of other financial institutions is assumed to be 562 billion hryvnias (71.5%). We assume that all capital is installed in Ukraine.