# THE IMPACT OF POPULATION AGEING ON THE ECONOMIC DEVELOPMENT OF UKRAINE

by

Katerina Lisenkova

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**Abstract**

According to United Nations population projections, the share of pensioners in the Ukrainian population will increase from 21% in 2005 to 37% in 2050. At the same time the share of the working age population (aged 20-59) will decline from 57% to 46%. This dissertation examines the impact that the changing age composition of the population of Ukraine will have on its economic development. There are three main contributions.

First, an analysis of past demographic trends reveals that the current Ukrainian population structure is already "programmed" for population ageing and decline. Future demographic trends will only determine how quickly this will happen. Second, the changing age structure of the labour force will likely have an impact on the shape of the age-earnings profile. An econometric analysis of the Ukrainian Household Budget Survey reveals that, as in more developed market economies, the size of a cohort has a significant impact on the earnings of cohort members. The potential flattening of the age-earnings profile would disadvantage older workers belonging to larger cohorts. Third, a dynamic forward-looking Computable General Equilibrium (CGE) model is constructed to perform simulations of different demographic and labour market scenarios to investigate the impact of ageing on a wide range of macroeconomic variables. It is shown that, even under the most favourable scenario, changes in age structure will result in a significant negative impact on economy. Special attention is paid to the impact of ageing on the pension system. Three policy changes are modelled: an increase in pension age, an increase in pension contributions and a reduction in the replacement ratio. Individually these policy changes do not achieve sustainability, but combining an increase in pension age with higher effective pension contributions or a lower replacement ratio can bring stability to the system.

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# Chapter 1. Introduction

The process of population ageing, which both developed and many developing countries are experiencing, is a result of the so-called demographic transition. The demographic transition as a concept was developed during the first half of the $20^{th}$ century to explain the process of transformation of societies from high birth and high death rates to low birth and low death rates. In classical form, this process is divided into four stages. The first stage is characterized by high fertility, high mortality and stable population size. The second stage brings declining mortality rates and population growth increases, because fertility is still very high. During the third stage, fertility declines for a number of cultural and economic reasons and population growth declines. In the fourth and final stage, both fertility and mortality rates are low. The majority of population ageing occurs during the third stage, as large generations born during the second stage grow older and are replaced by smaller cohorts that are born during the third stage.

It was initially assumed that the process of demographic transition would result in an older, larger but stable population, as fertility was expected to stabilise at replacement level. However, the recent history of many developed and transition countries demonstrates that this assumption was incorrect. Some researchers call this process of further declining fertility and mortality rates the “fifth stage” of the demographic transition. Others, pointing to the fact that the reasons driving this process are quite different, refer to it as the “second demographic transition”. In any case, at the moment there is no comprehensive theory that would predict future stages of this process and its end-point.

Initially the process of demographic transition was described for developed countries. It was relatively slow, and started in some European countries in the $18^{th}$ century after the Agricultural Revolution. Many of the developing countries that started the process much later are moving through its stages much faster.

In the 1960s and 1970s, when many developing countries entered the second stage of the demographic transition, prevailing views were of the Malthusian type. That is overpopulation is one of the major challenges facing mankind, and explosive population growth will cause extreme poverty and famine. However, as time has shown, these predictions have not materialised, and the speed of demographic transition in developing countries has been much faster than expected.

Recently, the economic focus in demographic discussions has moved to the opposite process – population ageing and population decline. These issues have proved important, not only for developed countries but also for a number of developing and transition countries. In many countries, a decline in fertility happened much faster and dipped much further than was expected.

It is difficult to deduce when the process of demographic transition started in Ukraine, as reliable demographic data are only available starting from the beginning of the 20th century. However, it is known that, by the beginning of the century, the process of mortality and fertility reduction had already begun. Many of the socio-economic and political crises that the country experienced during the first half of the 20th century accelerated the process of demographic transformation. By the mid-1960s, the country had one of the highest life expectancies in the world and fertility close to replacement level. After that, twenty years of almost constant fertility and stagnating life expectancy followed. The new wave of demographic change started during the turbulent last decade of the 20th century. As a consequence of the politico-economic crisis, mortality has increased and fertility has sharply declined.

These demographic processes have led to population ageing in Ukraine. The share of population aged 60+ in Ukraine has increased 2.2 times over the past 50 years. According to the baseline projections presented in Chapter 2, it is going to increase by 67% over the next 45 years, reaching the level of 35% of the total population. On the other hand, during the next 50 years, the size of the working age population (aged 20-59) will shrink by 41%. However, Ukraine has not only an ageing but also a declining population. By 2005, the total population had decreased by 11% since 1993, when it reached its peak of 52.2 million. By 2050, it is projected to have decreased further, by 29% to 33.3 million.

Unlike most developed countries, Ukraine has not experienced improvement in life expectancy since the 1960s. The driver behind population ageing in Ukraine is very low fertility, which has been at or below replacement level since the 1960s. Currently, Ukraine belongs to the group of countries with so-called "lowest low" fertility (total fertility rate (TFR) below 1.3). In 2002, it had TFR of 1.1 – the lowest fertility level in Europe and the third lowest in the world, after Hong Kong and Macao (World Bank, 2008).

To understand better current and future demographic processes, it is important to start with understanding past demographic trends. Demographic changes are comparatively slow and have a very long-term effect. Even short-term swings in fertility affect the structure of population at least for the life time of one generation, and in most cases the effect is much longer. The size of the next generation is affected, because for a given fertility rate, a larger population of fertile women will have more children. This effect is called a "demographic wave". From generation to generation, waves become smaller but they do not disappear for a very long time. Many current demographic trends have been "programmed" in the past. Thus, knowing what has already happened makes it easier to project the future.

Chapter 2 of this dissertation analyses past demographic trends in fertility, mortality and migration, and discusses potential future demographic developments based on population projections. The data were collected from different sources, and were analysed by the author using different methods to reveal the processes behind declining fertility and mortality.

Chapter 2 also presents a series of population projections. Two organizations that produce population projections for Ukraine are the United Nations Population Division and the Institute for Demography and Social Studies at the National Academy of Science of Ukraine. According to their projections, the population of Ukraine is expected to decline and age rapidly during the next 45 years.

In addition to these population projections, Chapter 2 includes alternative sets of projections performed by the author. The first set is a sensitivity analysis based on the Institute for Demography fertility and mortality assumptions and fixed net migration assumptions ranging from -10,000 to 100,000 per year. Also, long-term projections (until 2096) are presented, combining high dependency and low dependency assumptions. The latter set of population projections is used as an input in Chapters 3 and 4, which consider the impact of population ageing on macroeconomic situation in Ukraine.

Chapter 3 examines the labour market effects of population ageing. Population ageing not only affects the general structure of the total population, but also brings changes to the structure of the working age population by increasing the share of older workers and decreasing the share of younger workers. If older (more experienced) and younger (less experienced) workers are not perfect substitutes and perform different tasks, then population ageing leads to a big change in relative supply, which will have an impact on relative earnings. The lower the substitutability, the greater the change in relative earnings which will result from a given change in relative supply. Using an estimated age-aggregated earnings equation, Chapter 3 tests the hypothesis that cohort size affects the earnings of Ukrainian workers.

There is extensive literature studying the impact of cohort size on earnings in the developed countries. Original interest in this topic was sparked by an unusually large cohort of baby boomers. Two pioneering papers on US baby boomers by Freeman (1976) and Welch (1979) showed that members of unusually large cohorts suffer from depressed earnings in the early stages of their career.

The work presented in Chapter 3 makes several contributions to the cohort crowding literature. First, it expands applicability of the major finding that cohort size has a negative effect on earnings. This research expands validity geographically – providing evidence for a transition country in Eastern Europe and one of the post-Soviet republics – and demographically – providing evidence not linked to the labour market outcomes of baby boomers. Second, it modifies the model to include a quadratic interaction of cohort size with age, which is potentially important. Third, it uses technical advances in estimation techniques, some of which were not available before, like sampling weights, robust standard errors and the cluster-robust technique of simultaneous models estimation. Fourth and final, it combines the obtained results with population projections to estimate potential future age-earnings profiles.

Chapter 4 examines the macroeconomic impact of population ageing in Ukraine using the dynamic Computable General Equilibrium (CGE) model of Ukraine. It is a standard forward-looking model with intertemporal optimisation and perfect foresight with an explicitly modelled Pay-As-You-Go component of the pension system. The model is calibrated on the basis of the 2002 Ukrainian Social Accounting Matrix (SAM).

The effect of ageing population structure is modelled by the interaction of three processes: a declining labour force, an increasing proportion of pension age population and a declining total population. The period covered by simulations is 100 years. The baseline economic scenario is based on the baseline population projections presented in Chapter 2 and assumes no change in the pension system arrangement. Under these assumptions, the total population over the next 50 years is expected to decrease by 33% and the working age population by 45%, while the pension age population is expected to grow by 8%.

Under the baseline scenario, by 2060 consumption per capita will have declined by 19% and GDP per capita by 17%, relative to the benchmark with no change in population age structure. The share of government spending will increase from 24.4% of GDP in the first period to 29.4% by 2060, and the effective rate of workers' pension contributions will increase from 17% of the labour income at the beginning to 28% at its peak in 2054.

A sensitivity analysis shows that results are influenced significantly by demographic assumptions. However, even the most favourable demographic scenario does not change the qualitative picture. The finding remains that population ageing will have a deteriorating impact on the Ukrainian economy and pension system.

Analysis of the potential changes to the pension system is limited to two alternatives: increase of the pension eligibility age, keeping the workers' contribution rate or replacement rate constant. If the replacement rate is kept constant and the pension eligibility age is increased to 65 years for both sexes, then the effective rate of workers' pension contributions would have to increase from 17% to 20% at the highest point (around 2060). If, on the other hand, the workers' contribution rate is held constant and pension age is increased in the same way, then the replacement rate would drop from 33% to 22% by 2060.

According to population projections, over the next 50 years Ukraine will experience one of the most significant demographic transformations in Europe and in the world. There are a number of channels through which this will affect the economic development. This dissertation examines only some of them. It is important that other researchers and policymakers pay more attention to this process.

# Chapter 2. Past and Future Ukrainian Demographic Trends

## 2.1. Introduction

The Ukrainian population is going through the process of age structure transformation. The share of older age groups is increasing and the share of younger age groups is decreasing. This process is often called "population ageing". It has important consequences for economic development through different channels, such as the labour market and provision of pensions.

To understand better current and future demographic processes, it is important to start with understanding past demographic trends. Demographic processes are relatively slow and have a significant momentum. Past demographic trends have a major influence on future population structure and dynamics. Thus, many current and future demographic trends have been "programmed" in the past, and understanding this can help one to project the future.

Past demographic statistics in Ukraine are not readily available. Demographic records before the collapse of the Soviet Union are especially patchy. One of the main reasons for this is the high sensitivity of demographic data during the Soviet era. Demographic records covering many years were destroyed during the 1930s and 1940s in order to hide evidence of repression. In later periods, other reasons were relevant. For example, in the 1970s and 1980s mortality data were not widely published, to conceal the fact that life expectancy was falling.

To start the analysis in this chapter of past demographic trends, the data were collected from different sources. These include not only official data but also estimates. In case of different sources providing different data, all are presented (as with migration estimates). After combining all sources, a long series of fertility, mortality and migration data were constructed. The collected data were analysed by the author using different methods to reveal the processes behind declining fertility and mortality.

In the second part of the chapter, a series of population projections are presented. Two organizations that produce population projections for Ukraine are the United Nations Population Division and the Institute for Demography and Social Studies at the National Academy of Science of Ukraine (Institute for Demography, hereafter). According to their projections, the population of Ukraine is expected to decline and age during the next 45 years.

In addition to these population projections, the chapter includes alternative sets of projections performed by the author. The first set is a sensitivity analysis based on the Institute for Demography fertility and mortality assumptions and fixed migration assumptions ranging from -10,000 to 100,000 per year. Also, long-term projections (until 2096) are presented combining high dependency and low dependency assumptions. The latter set of population projections is used as an input in Chapters 3 and 4 which study the impact of population ageing on the macroeconomic situation in Ukraine.

The rest of the chapter is organized as follows. Section 2.2 presents analysis of past demographic trends. Section 2.3 describes demographic assumptions and different scenarios of population projections. The conclusions follow in Section 2.4.

## 2.2. Demographic Past

To understand current demographic trends and make well-grounded projections of the future, one has to start with an analysis of the demographic past. Population change can be disaggregated into three components: fertility, mortality and net migration. In this section, past trends in each of these will be discussed first, and then the resulting population structure will be presented.

Demographic processes can be significantly influenced by the political and economic situation in the country. During the past 100 years, Ukraine has experienced many traumatic events that have left marks on its population structure. A series of disasters that struck the USSR had a profound effect on Ukraine. The 1917 Revolution and the 1917-1920 Civil War, the famine of 1921-23, the Great Famine of 1932-1933 during the collectivization of agriculture and industrialization, World War II followed by the famine of 1947, all had a great and devastating impact on Ukraine. These events were accompanied by several waves of repressions and mass deportations during the 1930s and 1940s.

According to estimates presented in Valin *et al.* (2002), during the interwar period culminated by the famine of the 1933, total population losses in Ukraine amounted to 4.6 million; 0.9 million of this total are attributed to forced migration, 1 million were caused by deficit of births (a lower number of births resulting from exceptionally low fertility) and 2.6 million resulted from exceptionally high mortality. Other estimates of losses range from hundred thousands to 10 million. Differences arise from methodology; mainly what is counted as losses caused by famine. However, some sources that quote numbers at the extremes are not very trustworthy and serve political interest of the group that they represent. In the recent years this issue became much politicized and created a lot of tension between Ukraine and the Russian Federation. Ukraine insists that the Great Famine was genocide of Ukrainian people and Russia refuses to accept this term.

Valin *et al.* (2002) also estimate that, during the later period between 1939 and 1949, owing to Soviet repressions, the Second World War and the famine of the 1947, Ukraine lost another 13.8 million of its population, including 2.3 million as a consequence of negative net migration, 4.1 million caused by a deficit of births and 7.4 million because of exceptional mortality. For a country with a population of about 40 million, this is an massive loss.

Demographic data were highly political in the Soviet Union. During the 1930s and 1940s, virtually no vital statistics were published at all (Valin *et al.*, 2002). The results of the 1937 Census, which revealed a significant decline in population after the Great Famine and the Great Terror, were dismissed. The conductors were declared "enemies of people" and prosecuted. After the collapse of the Soviet Union, some of the statistics from the state archives became available. However, the statistical picture before the 1960s is still incomplete and some of the available data are of questionable quality. For that reason, much of the analysis of these early years (presented below) relies on estimated data.

One also has to remember that Ukraine in its present borders was formed only in 1954. The largest change in the territory occurred in 1939 after the beginning of World War II (WWII). According to the Molotov-Ribbentrop pact, Western territories joined Ukraine after the agreement between the Soviet Union and Germany about the division of Poland. The total population of Ukraine increased after the annexation by 10.4 millon, from 30.9 million to 41.3 million (Meslé and Vallin, 2003). All the statistics before 1939 refer to old territory that does not include the Western region of Ukraine.

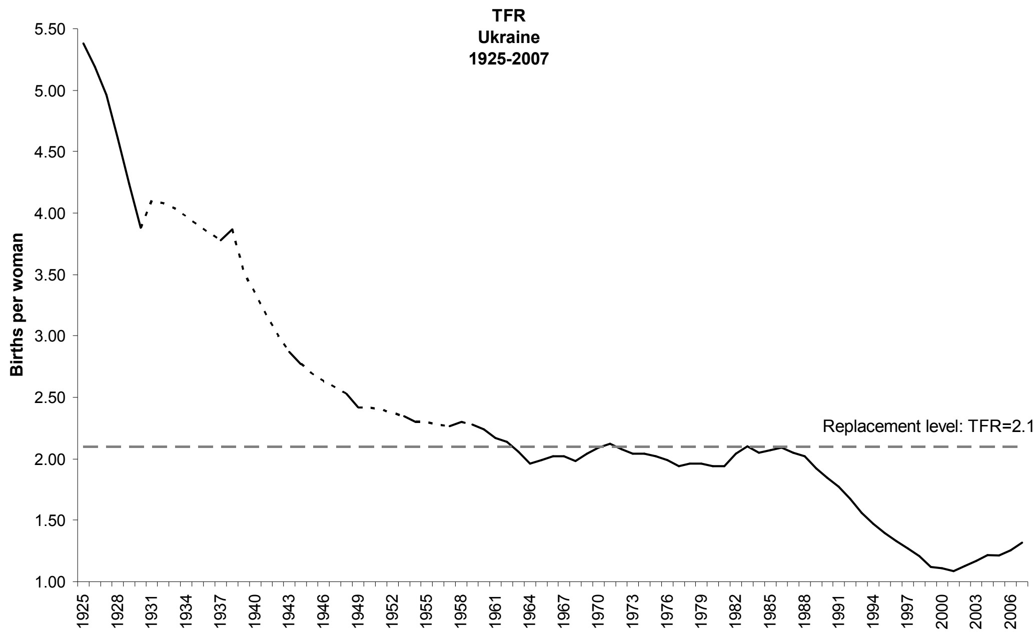
### *2.2.1. Past trends in fertility*

Ukrainian fertility history is very distinctive. At the beginning of the 20th century, fertility in Ukraine was among the highest in Europe. According to the estimates of Kuczynski (1969), the total fertility rate (TFR) at that time was around 7.5 births per woman. The TFR is a period fertility measure. It is the average number of children a group of women would have if they experienced the age-specific fertility rates of the calendar year in question throughout their childbearing lifespan.

Figure 2.1 presents the TFR in Ukraine from 1925 to 2007. The figure combines several sources of information. For the first part until 1986 the data are from Lutz *et al.* (1990). The dotted sections represent periods for which official data were not available. Between 1930 and 1960, only four data points were available (1938, 1949, 1954, 1958), and the authors estimated missing data, using an elaborate technique applying model fertility schedules. The data after 1986 is from the World Bank and the State Statistics

Committee of Ukraine.

**Figure 2.1. Total fertility rate in Ukraine, 1925-2007**




Source: Lutz *et al.* (1990) for 1925-1986, WDI, World Bank (2008) 1987-1989, State Statistics Committee of Ukraine for 1990-2007

Several observations can be made based on this graph. First of all, one notices a very sharp decline in fertility between 1925 and 1930. During this five-year period, TFR declined from 5.4 to 3.9. Between 1930 and 1938 (the next year for which official data is available) according to the estimates of Lutz *et al.* (1990), fertility remained virtually constant. However, it is highly likely that fertility declined significantly during the Great Famine of 1932-1933. The estimation technique used by Lutz *et al.* (1990) simply could not account for that acute crisis.

The next sharp drop in fertility occurred during WWII and during the economically and politically difficult years immediately after it. Between 1938 and 1949, TFR declined from 3.9 to 2.4. Then the decline slowed down, but nevertheless, by 1963 TFR in Ukraine fell below replacement level of 2.1 births per woman and stayed at the level of about 2 births per woman for the next 20 years.

Ukraine did not experience a post WWII baby boom like most of the European countries. Most of the European countries experienced unexpectedly high fertility levels at some time between 1946 and 1966. For example, in France TFR increased from 2.2 in 1939 to 3.0 in 1946 (Meslé *et al.,* 2005). In UK in 1964 – the peak year of the baby boom – TFR reached 2.95 and after that declined to below 2 by the beginning of the 1970s (ONS). In the US, the baby boom lasted for 2 decades: from 1946 to 1966. The maximum TFR of 3.7 was reached in 1957. TFR preceding and following the baby boom was 2.2 and 1.7 respectively.

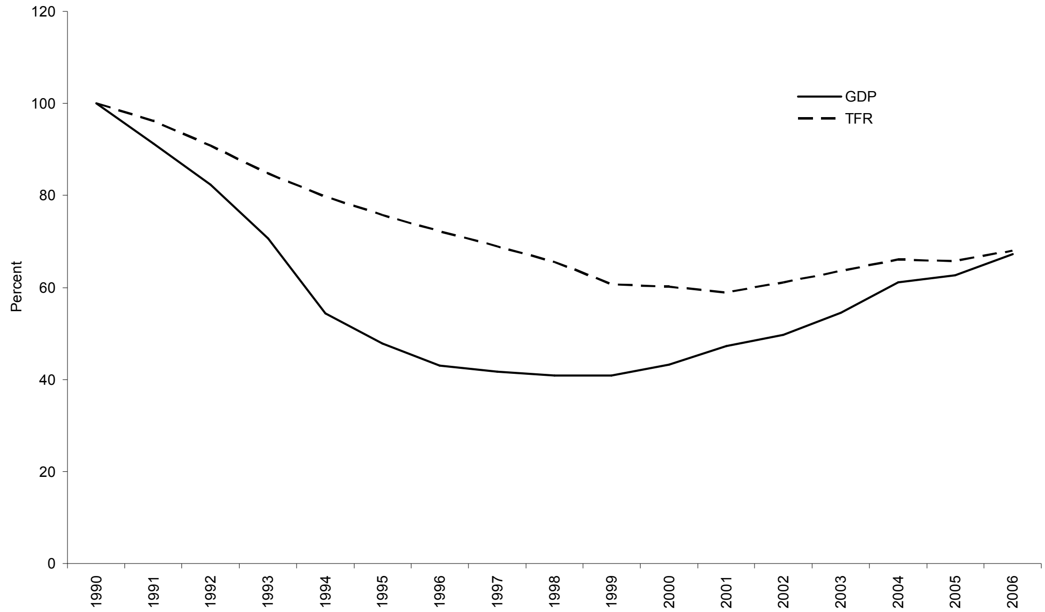
Political instability in the late 1980s and the economic crisis of the 1990s brought up another period of fast and deep fertility decline. Between 1986 and 2001, TFR decreased by 48% – from 2.1 to 1.1. Based on data available for 213 countries in the World Development Indicators (WDI) database created by the World Bank (2008), at its minimum in 2000-02 Ukraine had the third lowest fertility level in the world, after Macao (0.9) and Hong Kong (0.9). After reaching its minimum in 2001, fertility started to recover. However, so far this recovery has been modest.

To be able to project future fertility trends, it is important to understand what has happened in recent years. Which factors were responsible for the very sharp and deep decline and what caused the observed recovery? The period after 1986 was dominated by the events preceding and following the collapse of the Soviet Union. Drastic political, economic and social changes had a profound effect on fertility behaviour. It is impossible to disentangle the specific effects of different factors because of their simultaneity. Nevertheless, most of them pushed fertility in one direction – down.

It is not surprising that periods of high uncertainty and socio-economic crisis have a negative effect on fertility. Figure 2.2 shows the GDP and TFR change, starting from 1990. Deep recession was accompanied by a fast fertility decline. In 1999, at its lowest, GDP dropped to only 41% of its 1990 level. TFR reached its lowest level two years later, and by that time constituted 58% of the 1990 level.

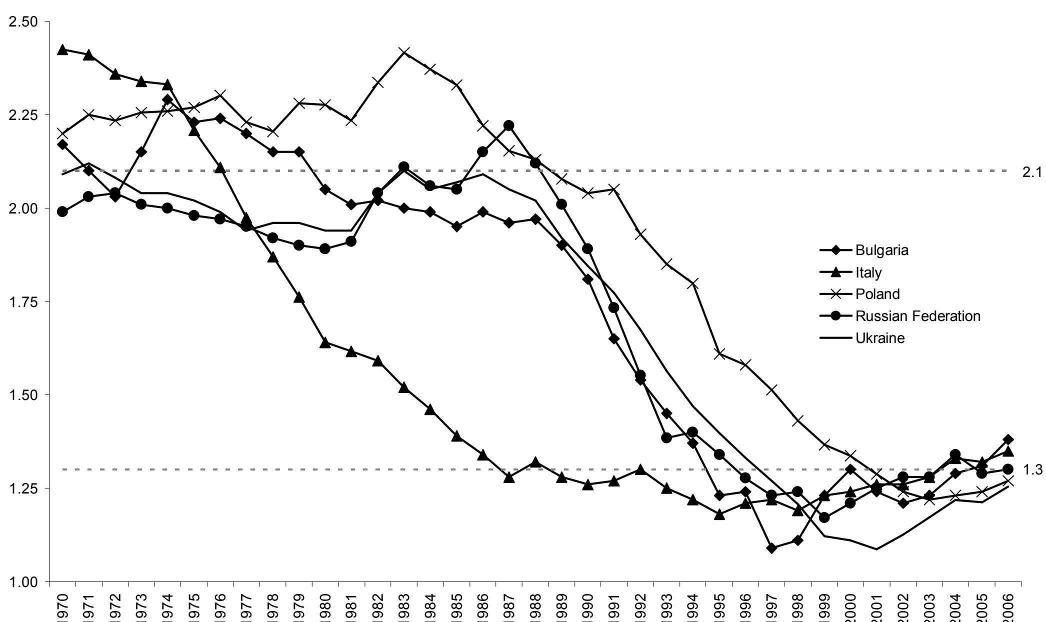
Ukraine, however, is not the only country to see a sharp fertility decline at the end of the 20th century. Figure 2.3 compares TFR in Ukraine with that of several other European countries. The chart also provides two reference lines: the first one is replacement TFR (2.1) and the second one is the threshold of the so-called lowest low fertility rate (1.3). The term "lowest low fertility" was coined by Kohler *et al.* (2002) to differentiate between relatively high sub-replacement fertility in Western and Northern Europe and extremely low fertility in Southern, Central and Eastern Europe.

**Figure 2.2. GDP and TFR, Ukraine, 1990=100**




Source: State Statistics Committee of Ukraine

**Figure 2.3. TFR in selected European countries, 1970-2006**




Source: WDI, World Bank (2008)

At the beginning of the period, all of the selected countries had a fertility rate close to the replacement rate. Italy was one of the first countries in Europe to undergo a sharp fertility decline. It reached the lowest low fertility level in 1987. East European countries experienced a fertility decline of comparable magnitude 10-15 years later.

**Table 2.1. The progression of the lowest low fertility**

| Country | The year when TFR decreased below 1.3 for the first time | The year when TFR exceeded 1.3 | TFR, 2006 |
|---|---|---|---|
| Italy | 1987 | 2004 | 1.35 |
| Germany | 1992 | 1997 | 1.34 |
| Spain | 1993 | 2004 | 1.36 |
| *Hong Kong* | *1995* | *N/A* | *0.97* |
| Slovenia | 1995 | 2006 | 1.32 |
| Czech Republic | 1995 | 2006 | 1.33 |
| Bulgaria | 1995 | 2005 | 1.38 |
| *Macao* | *1995* | *N/A* | *0.89* |
| Latvia | 1995 | 2005 | 1.36 |
| Russia | 1996 | 2004 | 1.30 |
| Belarus | 1997 | N/A | 1.28 |
| Estonia | 1997 | 2000 | 1.55 |
| **Ukraine** | **1998** | **2007*** | **1.32*** |
| Greece | 1998 | 2006 | 1.38 |
| Hungary | 1999 | 2005 | 1.35 |
| Slovakia | 2001 | N/A | 1.24 |
| Poland | 2001 | N/A | 1.27 |
| Romania | 2001 | 2005 | 1.31 |
| Bosnia and Herzegovina | 2002 | N/A | 1.18 |
| *Singapore* | *2003* | *N/A* | *1.26* |
| *Japan* | *2003* | *2006* | *1.32* |
| Moldova | 2005 | N/A | 1.25 |

Source: WDI, World Bank (2008)
* State Statistical Committee of Ukraine
in italic highlighted non European countries

Table 2.1 provides information on all countries to have experienced lowest low fertility so far. The table reveals that lowest-low fertility is predominantly a Southern, Central and Eastern European phenomenon (with the exception of several Asian countries, which are highlighted in italics in the table). At the beginning of the $21^{st}$ century, in most of the countries presented in the table the fertility rate started to recover and exceeded 1.3 births per woman by 2006.

There is a growing body of literature which is trying to explain the reasons behind the lowest low fertility. Most researchers explain it in terms of quantum (level) and tempo (timing) effects. The tempo effect is the change in TFR caused by the adjustment in timing of births. The argument is that TFR as a period measure fails to describe adequately the real fertility behaviour of the cohorts when timing of birth changes and thus, declining TFR could be explained, at least partially, by postponement of childbearing. The quantum effect is the decline in fertility that would have been observed in the absence of tempo distortions (Bongaarts and Feeney, 1998). Changes in the quantum of fertility can be explained by changes in norms, economic conditions, spread of contraception, etc. There is also an interaction of tempo and quantum effects – significant postponement of childbearing can result in a lower number of births than desired, owing to biological limitations relating to childbearing.

Many researchers agree that exceptionally low fertility in Southern, Central and Eastern European countries can be explained by changing age patterns of fertility, i.e. by tempo effect (see Lesthaeghe and Willems, 1999; Philipov and Kohler, 2001; Kohler *et al.,* 2002; Sobotka, 2004). The argument is that when the adjustment of the age pattern of fertility finishes, the TFR will recover. However, many authors point out that even after tempo adjustment, fertility rates in CEE countries are much lower than in Western and Northern European countries. For discussion see Sobotka (2004).

In their pioneering work, Bongaarts and Feeney (1998) suggested the way to measure the tempo-adjusted TFR, which represents the quantum of fertility. Later more sophisticated methods of fertility adjustment were developed (Kohler and Philipov, 2001; Kohler and Ortega, 2002). However, these methods require more data which are often not available, and most researchers still use the simple Bongaarts and Feeney (1998) adjustment technique. The adjusted TFR (adjTFR) in a year $t$ for birth order $i$ is computed as follows:

$$adjTFRi(t) = TFRi(t) / (1-ri(t)) \qquad (2.1)$$

where $ri(t)$ is the change in the mean age at childbearing of birth order $i$ between the beginning and the end of year $t$, which is estimated as follows:

$$ri(t) =[MACi(t+1) - MACi(t-1)] / 2 \qquad (2.2)$$

where $MACi(t)$ is the mean age at childbearing of order $i$. The tempo-adjusted TFR for all birth orders is computed as the sum of the adjusted order-specific total fertility rates.

The difference between the conventional TFR and the adjusted one represents the tempo effect. Unfortunately, the Ukrainian statistical office does not provide fertility statistics by birth order, and thus direct estimation of the postponement effect is not possible.

The joint team of the Vienna Institute of Demography and the International Institute for Applied System Analysis made an effort to estimate tempo-adjusted TFRs for all European and Caucasus countries (European Demographic Data Sheet, 2008). For countries that did not have detailed fertility data by order of birth, they applied a simplified Bongaarts and Feeney formula using conventional TFR and mean age at childbearing (MAC) for all births.

$$adjTFR(t) = TFR(t) / (1-r(t)) \qquad (2.3)$$

where

$$r(t) = [MAC(t+1) - MAC(t-1)] / 2 \qquad (2.4)$$

To be able to use these aggregated formulas, they had to make several assumptions. They assumed *"... that fertility quantum is low, say below 2.0, and therefore the impact of the fall in higher-order fertility is low as well; that it does not change considerably during the period under consideration; that all MACi change in a uniform way; and that these changes are rather small, say an increase of not more than 0.2 per year."* (Vienna Institute of Demography, 2008).

The results of their work are presented in Table 2.2. The countries for which adjusted TFR was estimated using the simplified formula are highlighted in italics. The countries in the table are sorted by the size of the tempo effect. At the top of the table there are CEE countries that are quickly catching up with Western and Northern European countries which started their fertility timing adjustment a long time ago. However, at the bottom of the table, one can see not only countries that almost finished their fertility adjustment (like Spain, Finland and France), but also countries that are just starting this process – Ukraine and Turkey. The Ukrainian tempo effect was estimated using a simplified formula and its accuracy is conditional on rather strong assumptions. Thus we should look for other evidence that the postponement of fertility in Ukraine is just starting.

**Table 2.2. Total fertility rates, tempo-adjusted total fertility rates and estimated tempo effect for European and Caucasus countries**

| | TFR, 2006 | adjTFR, 2003-2005* | Tempo effect |
|---|---|---|---|
| *Georgia* | *1.39* | *1.85* | *-0.46* |
| Czech Republic | 1.33 | 1.76 | -0.43 |
| Romania | 1.32 | 1.75 | -0.43 |
| FYROM | 1.46 | 1.88 | -0.42 |
| Slovakia | 1.24 | 1.66 | -0.42 |
| Hungary | 1.34 | 1.75 | -0.41 |
| Lithuania | 1.31 | 1.68 | -0.37 |
| Cyprus | 1.44 | 1.79 | -0.35 |
| *Montenegro* | *1.62* | *1.97* | *-0.35* |
| Bulgaria | 1.38 | 1.70 | -0.32 |
| Poland | 1.27 | 1.58 | -0.31 |
| Estonia | 1.55 | 1.85 | -0.30 |
| Portugal | 1.36 | 1.65 | -0.29 |
| *Armenia* | *1.34* | *1.62* | *-0.28* |
| Ireland | 1.90 | 2.17 | -0.27 |
| *Germany* | *1.33* | *1.59* | *-0.26* |
| Serbia | 1.42 | 1.68 | -0.26 |
| Austria | 1.40 | 1.64 | -0.24 |
| Latvia | 1.35 | 1.59 | -0.24 |
| Slovenia | 1.31 | 1.55 | -0.24 |
| Croatia | 1.38 | 1.61 | -0.23 |
| Russia | 1.29 | 1.52 | -0.23 |
| *Switzerland* | *1.44* | *1.65* | *-0.21* |
| *Malta* | *1.39* | *1.58* | *-0.19* |
| *Luxembourg* | *1.64* | *1.82* | *-0.18* |
| *Belarus* | *1.29* | *1.47* | *-0.18* |
| Denmark | 1.85 | 2.00 | -0.15 |
| Iceland | 2.08 | 2.22 | -0.14 |
| Maldova | 1.22 | 1.36 | -0.14 |
| UK | 1.84 | 1.98 | -0.14 |
| *Italy* | *1.35* | *1.48* | *-0.13* |
| Belgium | 1.74 | 1.86 | -0.12 |
| Greece | 1.40 | 1.52 | -0.12 |
| Norway | 1.90 | 2.01 | -0.11 |
| Sweden | 1.85 | 1.96 | -0.11 |
| Netherlands | 1.72 | 1.82 | -0.10 |
| ***Ukraine*** | ***1.33*** | ***1.43*** | ***-0.10*** |
| France | 1.98 | 2.07 | -0.09 |
| Finland | 1.84 | 1.91 | -0.07 |
| *Turkey* | *2.18* | *2.19* | *-0.01* |
| Spain | 1.38 | 1.39 | -0.01 |

Source: European Demographic Data Sheet, 2008
*For some countries, different periods were used owing to limited availability of the most recent data. For detailed information about data sources and country-specific definitions see www.populationeurope.org
Countries for which simplified adjustment formula was used are highlighted in italics.

Perelli-Harris (2005), in her in-depth study of reasons behind the lowest-low fertility in Ukraine, used not only official fertility data but also qualitative data from interviews and focus-groups and the 1999 Ukrainian Reproductive Health Survey (URHS). Her analysis fails to find any significant increase in mean age at first birth (MAFB) before 1999 – which is the standard measure of fertility postponement. Her hypothesis is that the main factor in the sharp fertility decline was postponement or elimination of the higher order births. Using survey and interview data, she finds that Ukrainian fertility behaviour is characterised by very early and almost universal childbearing. URHS data reveal that nearly 90% of women had their first birth by the age of 30.

Qualitative data from the interviews also presented no evidence of first child postponement. Most of the respondents suggested that the ideal age for childbearing is between 20 and 25, and almost all said that "*in any case, a woman should give birth to her first child by the age of 30"*. Other factors quoted as reasons for early childbearing are health and physiological factors, traditions and social pressure. Financial and other support from older generations for young couples, which is very usual in Ukraine, also encourages young childbearing. One respondent commented: "*For us, there is a tradition of marrying early, having a child, then throwing the child onto the parent's neck, and going out again and having a good time.*"

**Table 2.3. Mean age of mother at first birth, selected European countries, 2006**

| Rank | Country | MAFB, 2006 (years) |
|---|---|---|
| 1 | Switzerland | 29.4 |
| 2 | Spain | 29.3 |
| 3 | Netherlands | 29.0 |
| 4 | Sweden | 28.8 |
| 5 | Ireland | 28.7 |
| | EU-27 | 27.7 |
| 31 | Bulgaria | 24.9 |
| 32 | Belarus | 24.2 |
| 33 | Russia | 24.2 |
| 34 | Moldova | 23.8 |
| **35** | **Ukraine** | **23.7** |

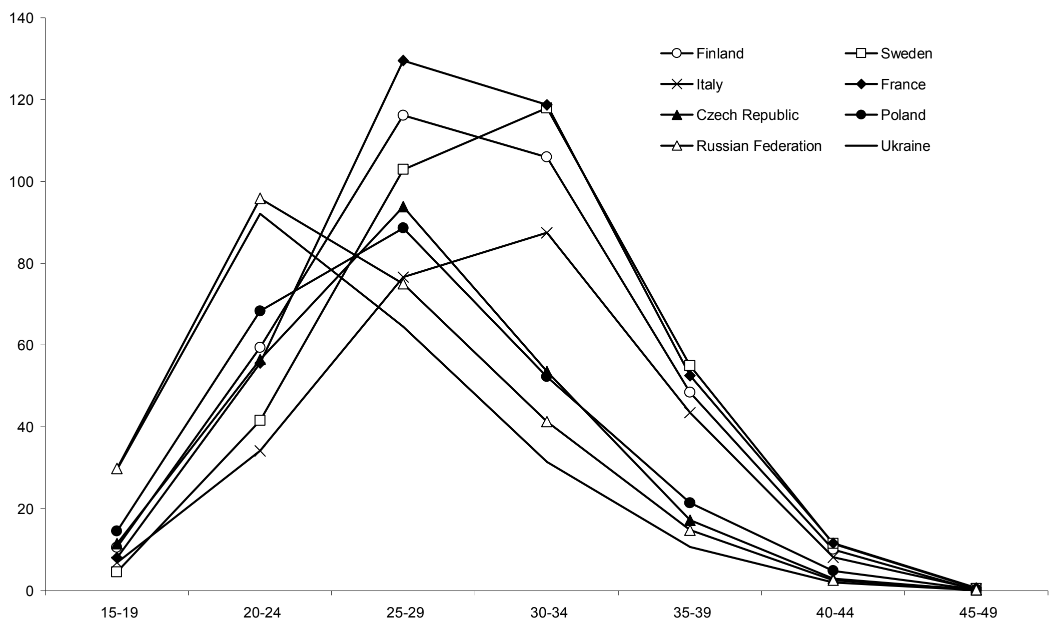
Source: European Demographic Data Sheet, 2008

To illustrate the prevalence of early childbearing in Ukraine, Table 2.3 compares MAFB in European countries. The table shows the top five and the bottom five countries by MAFB in 2006. According to these data, in 2006 Ukraine had the lowest MAFB in

Europe, of only 23.7 years. By contrast, Switzerland had the highest MAFB of 29.4.

The striking contrast between the age pattern of fertility in Ukraine and that of other European countries can be seen in Figure 2.4. The Ukrainian fertility pattern is very similar to that of Russia, and in both countries the fertility schedule reaches its peak in the age range 20-24. Poland and the Czech Republic are among CEE countries that undergo significant fertility postponement, and their fertility peaks in the age range 25-29, the same as in France and Finland (although the level of fertility in France and Finland is much higher). Finally, in Sweden and Italy, the fertility schedule attains its highest point in the age range 30-34. In Ukraine, about 80% of childbearing occurs before the age of 30. In Poland this measure is 70% and in Sweden 45%.

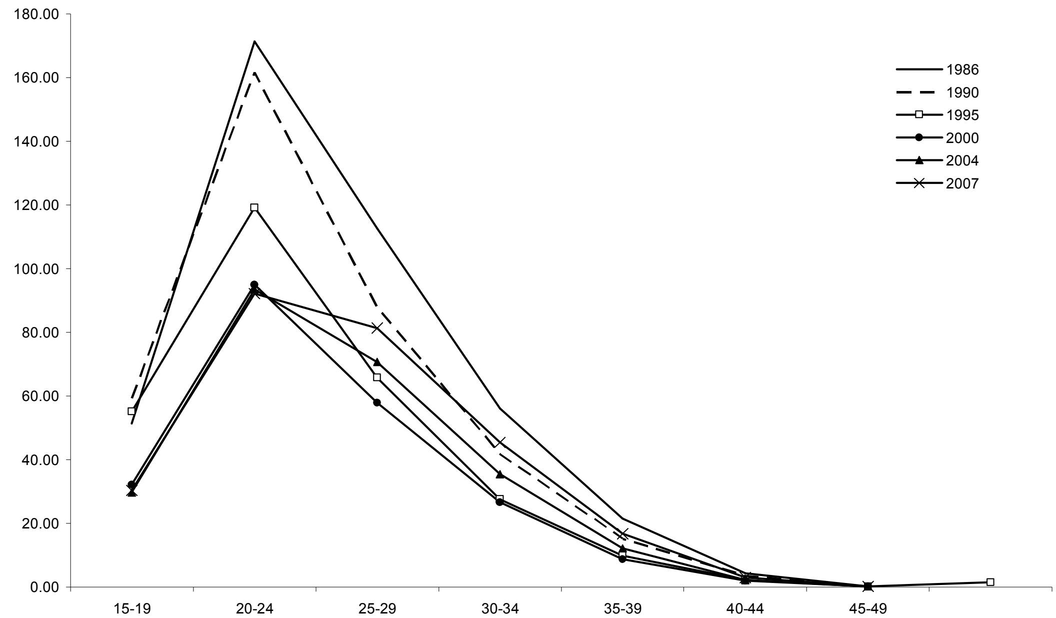
**Figure 2.4. Age-specific fertility rates in selected European countries, 2000-2005**




Source: World Bank Population Division

The evidence presented above proves that Ukraine has a very early and concentrated childbearing pattern by European standards. The data on age-specific fertility rates (ASFRs) for recent years are presented in Figure 2.5. This supports the hypothesis about early first birth and possible postponement of higher order birth.

**Figure 2.5. Age-specific fertility schedules, Ukraine, 1986-2007**



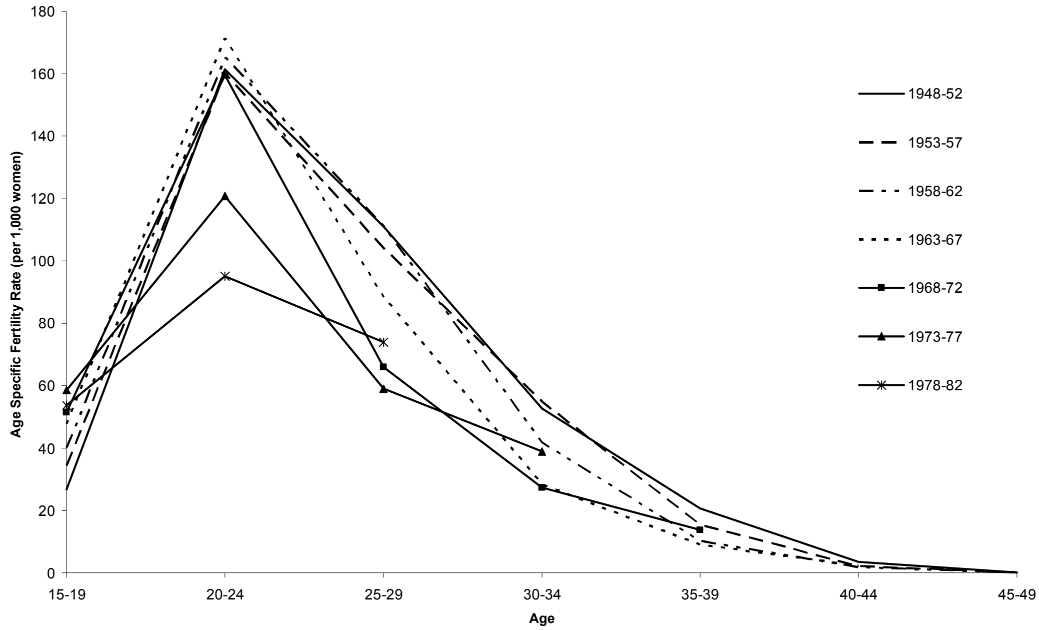

Source: Lutz *et al.,* (1990) for 1986, State Statistics Committee of Ukraine for 1990-2007

The chart shows that Ukraine historically had very concentrated and early fertility. During the period of sharp fertility decline (1986-2000), reduction first hit older age groups. Between 1986 and 1992, most fertility reduction happened in the 25+ age group. In the age group 20-24, fertility significantly decreased between 1993 and 2001. In the youngest fertility group – 15-19 – sharp drop in fertility happened between 1996 and 2001. In recent years, when TFR started to improve, there is noticeable improvement of fertility at later ages. This could be an indication of fertility postponement and/or recuperation of higher parity births.

Based on period ASFRs, cohort ASFRs were calculated. Figure 2.6 presents ASFRs for different birth cohorts. The selected starting and ending years for cohorts are a little unconventional (e.g. 1948-52 instead of 1950-1959). This is done intentionally to utilize the most recent data on fertility (the latest cohort is 1978-1982 instead of 1975-1979).

This graph confirms the young and concentrated pattern of fertility in Ukraine. Except for the two most recent cohorts presented, fertility decline between older and younger cohorts occurred as a result of the reduction at older ages. Starting only from the 1973-1977 cohort, there is a reduction in fertility at age 20-24 and a small improvement in older ages.

**Figure 2.6. Age specific fertility rates, Ukraine, birth cohorts 1948-52 to 1978-82**




Source: own calculations based on ASFRs from Lutz *et al.,* (1990) for 1925-1986, State Statistics Committee of Ukraine for 1990-2007, extrapolation of ASFRs between 1986 and 1989 to add up to TFR from WDI, World Bank (2008)

Thus, recent changes in period and cohort age-specific fertility rates provide indirect evidence of the beginning of fertility postponement. In the absence of fertility data by order of birth, it is impossible to make more accurate conclusions.

What seems likely is that the economically difficult 1990s did not have a significant effect on first births. The high value that society puts on early first childbearing, together with support of the extended family, were important factors that protected first births. However, it is possible that higher order births were postponed until "better times". The fast improvement in the living conditions that come with significant economic growth of the beginning of the century provided possible reasons for the birth of second and higher order children.

Recently, the Ukrainian government has started to pay greater attention to the demographic situation in the country. It implemented several measures aimed at increasing fertility. One of the most important of these is a one-off payment to parents following the birth of a child, which was significantly reformed and increased in 2005. The size of the payment in 2005 amounted to UAH 8,500 (approximately USD 1,500 at 2005 exchange rate). For comparison, average wage at the beginning of 2005 was UAH 640 per month. Later, the amount of assistance was increased for higher order births, which is the right decision, taking into account almost universal childbearing and the very low level of higher order births. Some politicians attribute all of the recent fertility increase to the success of this measure. However, it is early to evaluate its success, and it is reasonable to assume that the overall increase in living standards have played an important role in the fertility increase.

### *2.2.2. Past trends in mortality*

The official mortality statistics for Ukraine during the Soviet years was patchy, and much of it was classified. The data on life expectancy at birth before 1992 discussed below are taken from Meslé and Vallin (2003). They did remarkable work, collecting what was available from various sources, reconstructing missing data and adjusting for under-reported infant and senior mortality. Their estimates are very close to those of other sources (for example, Rudnitsky, 1993; World Bank, 2008), and preference was given to them because they provide the longest time series. For years starting from 1992, the official statistics are reported. For later discussion of age-specific mortality rates by causes of deaths, the data are also taken from Meslé and Vallin (2003).

Figure 2.7 summarizes data on life expectancy at birth for the past 90 years. The history of Ukrainian mortality records until 1950 was dominated by a series of crises suffered by the country. The first dramatic drop accompanied the years of the Great Famine. In 1933, the life expectancy at birth was an unbelievable 7.3 years for males and 10.9 years for females.

**Figure 2.7. Life expectancy at birth, Ukraine, 1927-2007**


Source: F. Meslé and J. Vallin (2003) for 1927-1991, State Statistics Committee of Ukraine for 1992-2007

The next drop occurred during the WWII. During the most difficult years of 1941 and 1942, male life expectancy plummeted to a mere 13.6 years. During another famine, in

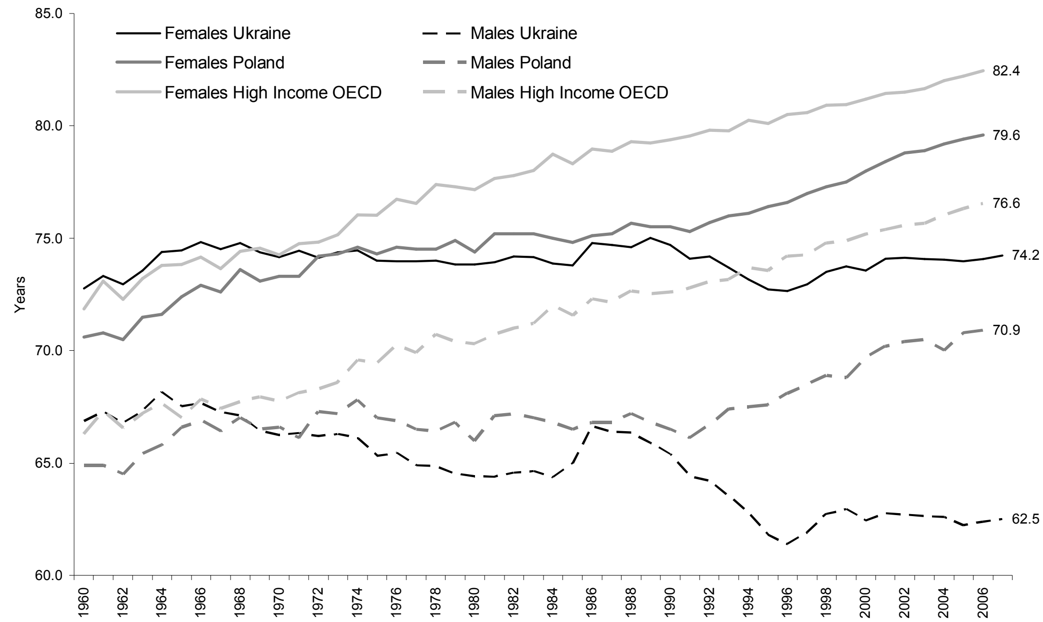
1947, life expectancy declined by 10 years in just one year to 40.3 for males and 50.2 for females. However, leaving aside crisis years, between 1927 and 1964 Ukraine had considerable improvement in life expectancy – 24.8 years for males and 27.5 years for females. The improvement, in fact, was so significant that, by the mid 1960s, Ukraine had reached the level of the most advanced countries. In 1964, life expectancy for males/females in Ukraine was 68.1/74.4, which was higher than in Japan (67.6/72.8) and the US (66.8/73.7) (World Bank, 2008). About two thirds of the life expectancy improvement during 1950-1964 was caused by declining infant and child mortality (Rudnitsky, 1993).

Unfortunately, in 1964 life expectancy for males reached its highest level so far. Two years later, female life expectancy reached its local maximum of 74.8 years, which was exceeded only once – in 1989 (75.0). What happened with mortality after the mid 1960s became known later as the Soviet mortality crisis. To closer examine the post-1960 period and to compare the Ukrainian situation with other countries, Figure 2.8 shows the life expectancy in Ukraine, Poland and the High income OECD countries (World Bank definition). The differences in life expectancy change are striking.

At the beginning of the period, life expectancy in Ukraine exceeded that in Poland and was also higher than the average for the high income OECD countries. But after reaching its peak in the mid 1960s, life expectancy in Ukraine declined for most of the period until 1996, with a brief period of improvement in the mid-1980s during Gorbachev's anti-alcohol campaign. In 1985, the Soviet Government adopted a series of laws aiming to decrease alcohol consumption, production and distribution. These measures were known collectively as the "dry law", and were very unpopular. In 1987, because of growing pressure and the emerging economic crisis, this campaign was abolished.

During the years of the economic crisis of the 1990s, the decline accelerated, especially for males. From its peak in 1964/68 to its bottom in 1996, male life expectancy declined by 6.7 years and female by 2.1 years. Only during the past 11 years has there been a slight improvement in life expectancy – 1.1 for males and 1.6 for females. The gender difference significantly increased since mid-1960s from 5.9 years in 1964 to 11.7 years in 2007.

**Figure 2.8. Life expectancy at birth, Ukraine, Poland and High Income OECD countries, 1960-2007***



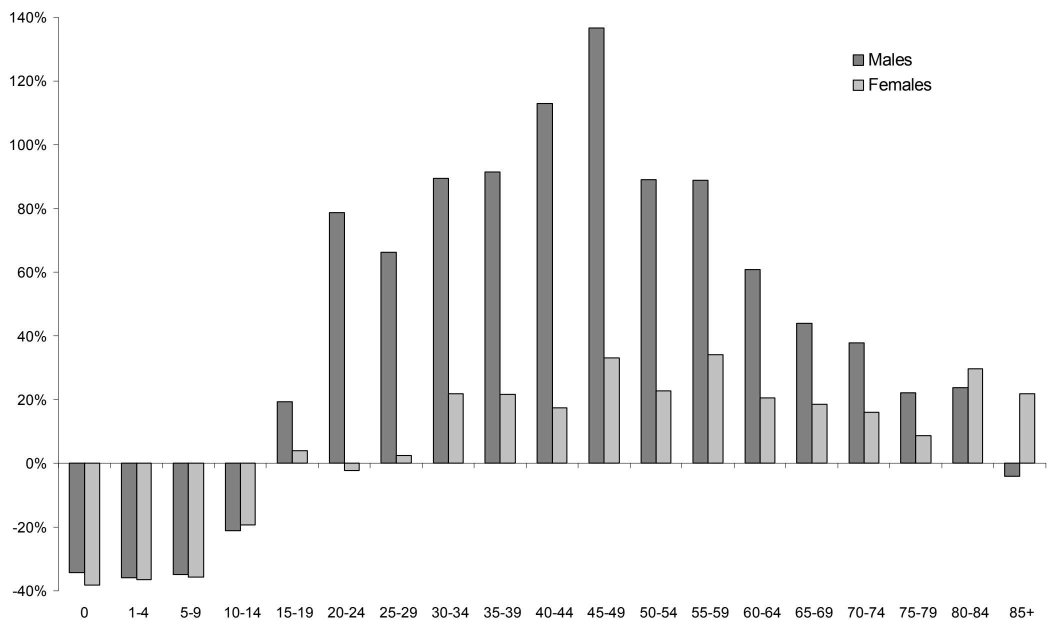

Source: Ukraine -- F. Meslé and J. Vallin (2003) for 1960-1991, State Statistics Committee of Ukraine for 1992-2007
Poland and High Income OECD – WDI, World Bank (2008)
* 2006 for Poland and High Income OECD

On the other hand, the high income OECD countries saw steady and almost linear improvement in life expectancy for both males and females, and after 1991 the gender gap started to narrow down. During the 46 years presented on the graph, the life expectancy of males increased by 10.6 and that of females by 10.3 years.

Poland overtook Ukraine in life expectancy at the beginning of the 1970s. However, the difference between the two countries was not particularly significant until 1992. After that, the mortality rates in Poland started to decline quickly, catching up with those of the high income OECD countries, while Ukraine plunged into economic crisis accompanied by increasing mortality (especially for males). In 2006, the difference between Poland and Ukraine in life expectancy was 8.5 years for males and 5.5 years for females.

However, not all the age groups in Ukraine had deteriorating mortality. Figure 2.9 presents the changes in age specific mortality rates in Ukraine between 1965 and 2000. It demonstrates that infant and child mortality decreased substantially. However, starting from the age group15-19, the 2000 mortality rates were higher than in 1965 (with the exception of females 20-24 and males 85+ groups, which experienced a small improvement). Especially strong deterioration of mortality was observed for working age males. In the age group 45-49, the mortality rate increased by 137%.

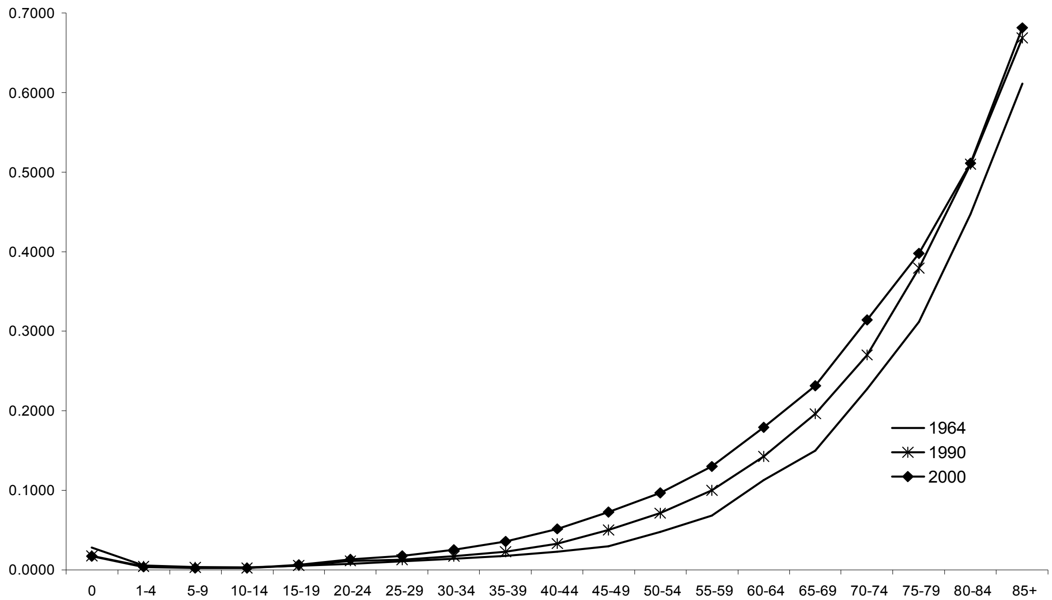
**Figure 2.9. Percentage change in mortality rates between 1965 and 2000, all causes combined**




Source: F. Meslé and J. Vallin (2003), own calculations

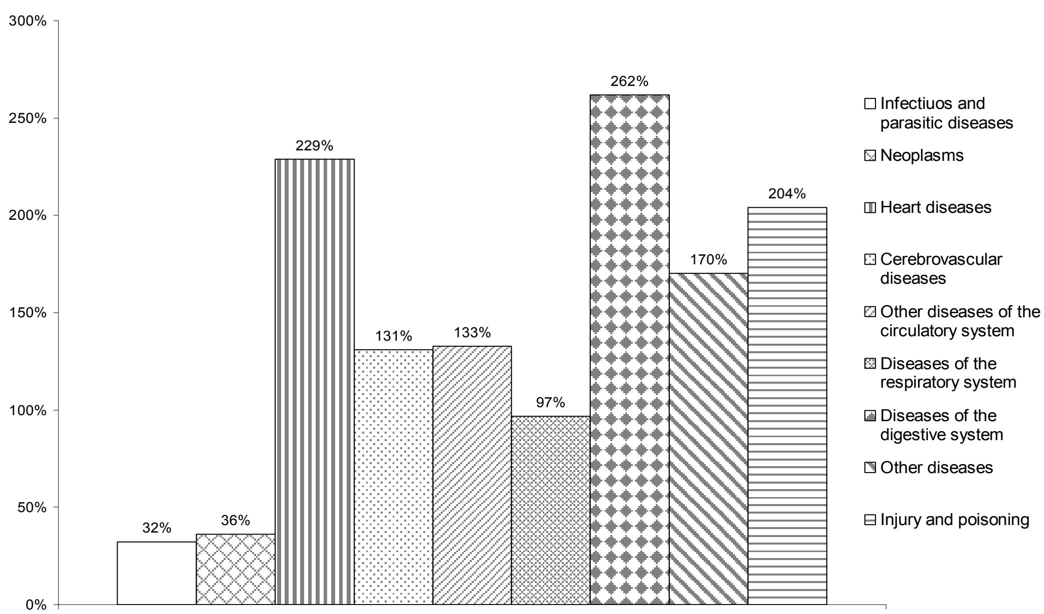
Figure 2.10 shows what was happening to the male mortality schedule over time. Here again, one can see that infant mortality has decreased, while the working age group had the most significant mortality increase. After isolating the age groups that are responsible for increasing mortality, the specific causes of death will be examined. Figure 2.11 presents the changes in mortality rates of males aged 45-49 by cause of death, according to nine large groups of causes of death of the 1981 Soviet Classification, modified in 1988 and in 1994 (Meslé and Vallin, 2003). This age group was selected as the one that saw the largest increase in mortality. What is interesting in this graph is that the mortality of this group has increased across all causes of death, but the largest increase was observed in diseases of the digestive system (262%), heart diseases (229%) and injury and poisoning (204%).

**Figure 2.10. Probability of dying for males, 1964, 1990, 2000**




Source: F. Meslé and J. Vallin (2003)

**Figure 2.11. Percentage change in mortality rate of 45-49 males between 1965 and 2000 by cause**




Source: F. Meslé and J. Vallin (2003)

The highest increase in mortality rates occurred among the so-called preventable or "man-made" diseases. Many researchers connect it with high alcohol consumption

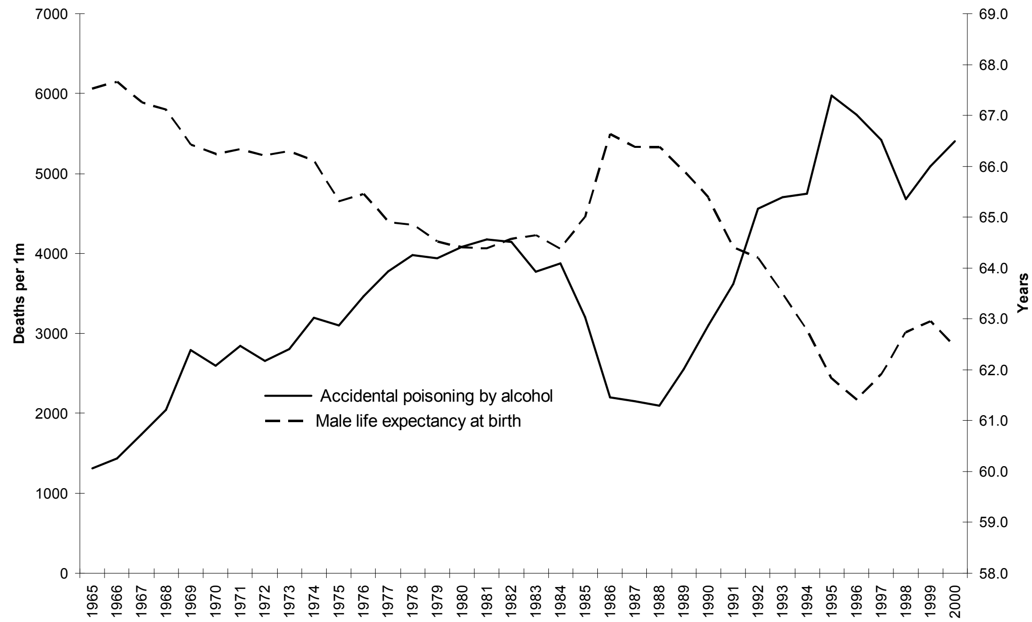
(Meslé and Vallin, 2003; Levchuk, 2005). According to official statistics in 2004, only 2.5% of all deaths were related to alcohol consumption (Levchuk, 2005). However, it is widely accepted that official data do not represent the true situation. For example, in Russia the official number of deaths connected with alcohol is only 3%, but according to estimates of Russian researchers, about 72% of homicides, 42% of suicide, 53% of deaths caused by external factors (injuries and poisonings), 68% of deaths from liver cirrhosis, 60% of deaths from pancreatitis, 23% of deaths from circulatory diseases and 25% of deaths from other causes are related to alcohol consumption (Nemtsov, 2003).

Reliable data on alcohol consumption are also unavailable. For example, according to official statistics, per capita consumption of alcohol in Ukraine is about 6 times lower than in the European Union (Levchuk, 2005). Of death causes directly related to alcohol consumption, in the opinion of the author, one of the most reliable is "accidental poisoning by alcohol". On Figure 2.12 it is plotted against the male life expectancy at birth. The left axis is for the death rate from alcoholic poisoning and the right axis is for life expectancy. Even a simple glance at this chart is enough to deduce that male mortality is highly correlated with alcohol consumption. The coefficient of correlation between these two variables is equal to 0.95. Female life expectancy is less correlated with alcoholic poisoning – the coefficient of correlation is 0.73, which is still very high. An interesting fact, which could be purely accidental, is that female life expectancy is more correlated with the male death rate from alcoholic poisoning – a correlation of 0.76.

This is a highly disturbing picture. Such a strong correlation between deaths from alcohol poisoning and life expectancy is especially surprising, given that this cause of death accounts only for 0.7% of all deaths in 2000. This correlation should not be interpreted as causation. However, given that alcoholic poisoning is strongly correlated with alcohol consumption, the latter is probably correlated with other factors that cause early death – unhealthy lifestyle, smoking, psychological stress, and other risky behaviour.

The fact that the largest increase in mortality occurred for working age males has a direct negative economic impact. Untimely deaths in this group put additional strain on a shrinking (due to population ageing) labour force. The group affected is supposed to be the most productive; thus the effect on productivity and overall quality of labour force can be very pronounced.

**Figure 2.12. Male life expectancy at births vs. standardized mortality rate for accidental poisoning by alcohol, Ukraine, 1965-2000**




Source: Mortality rate from accidental poisoning by alcohol -- Meslé and Vallin (2003)
Male life expectancy – Meslé and Vallin (2003) for 1960-1991, State Statistics Committee of Ukraine for 1992-2000

Declining life expectancy in Europe in the second half of the 20th century during peaceful times should be very embarrassing for a country. During the Soviet era, statistics were not widely discussed precisely for this reason. For an independent country with an ambition to join the EU, this issue should be a top priority. However, there is still a lack of both public discussion and government policy addressing this issue.

### *2.2.3. Past trends in migration*

During the past century, Ukraine experienced four major waves of emigration. The first was at the beginning of the 20$^{th}$ century, before World War I. Western Ukraine, which was a part of the Austro-Hungarian Empire at that time, lost 10% of its population, according to some estimates. People were fleeing poverty and landlessness by moving mainly to the United States, Canada and Latin America. At the same time, at least 1.6 million people living in the territory of Ukraine that belonged to the Russian Empire were relocated by the Tzarist government to Kazakhstan and the Far East to populate these remote territories.

The second wave was between the two World Wars. In Eastern Ukraine, it was caused by the Civil war and an unsuccessful attempt to build independent country after the 1917 Revolution. In Western Ukraine, migration caused by poverty continued.

The third wave of emigration was sparked by WWII. At the beginning of the war, as a result of the Molotov-Ribbentrop Pact, the territory of the Western Ukraine was annexed by the USSR. Participants of the independence movement who were fighting with the Soviet Army on Ukrainian territory were deported during and after the war. The entire population of Crimean Tatars from the Crimean peninsular was deported in 1944 to the Central Asian Republic of Uzbekistan for collaboration with Germans. In addition, a large number of people who had been forcibly moved to labour camps in Germany during the war decided - for various reasons - not to return home after it was over.

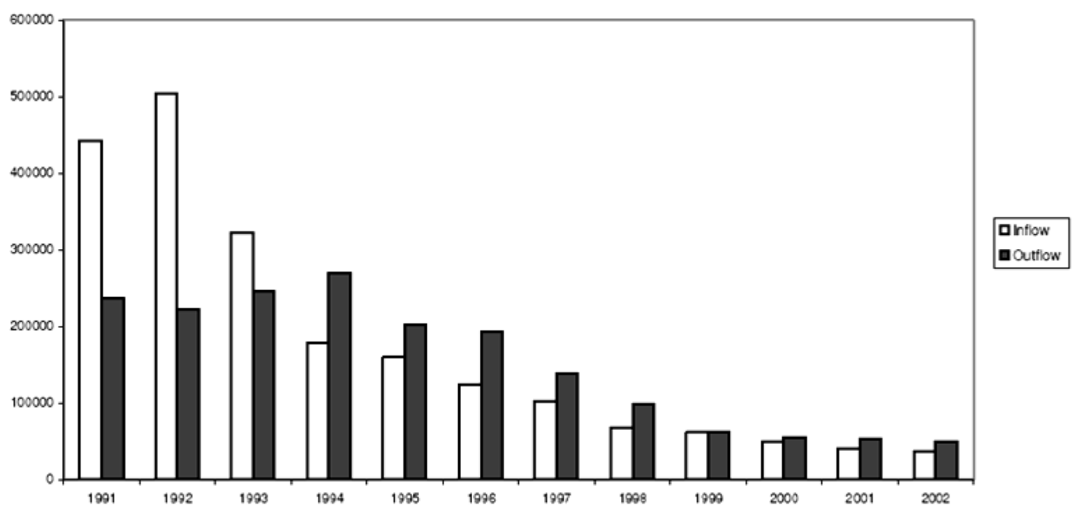
After the war and before independence, international migration was practically non-existent (except for relocation of armed forces to and from foreign-based Soviet bases and garrisons). However, large numbers of people were moving within the Soviet Union. In the attempt to create a new “Soviet people” free of national identity, the government encouraged and promoted inter-republic movement. Some of it was forced movement, like deportations and organized relocations. Other movement was voluntary or semi-voluntary, like relocation to the place of military service, “distribution” of graduates to the first place of work, recruitment of workforce for large national building projects and assignment of professionals to large industrial plants. Ukraine during these years was a net receiver of people. According to the last Soviet census in 1989, only 73% of the Ukrainian population were ethnic Ukrainians, and about 7 million or 15.4%

of Ukrainian nationals were living in other Soviet republics (the majority in Russia – 4.4 million) (Global Commission on International Migration (GCIM), 2004).

The fourth wave of large scale migration started after independence. It consisted of two types of movement – migration within the territory of the former Soviet Union (FSU) and international migration with the rest of the world. Both of these types of migration had their distinctive features.

After the breakup of the Soviet Union, Ukraine experienced a significant inflow of people from the FSU countries. This flow included people who were working or living in other republics and had decided that it was time to come back, and also people who were deported by the Soviet regime and used the opportunity to return. The Soviet Union collapse sparked several wars on its territory, which also created additional incentives to move to the relatively stable and safe Ukraine. People were also migrating from Ukraine to other FSU countries. However, for the first three years after independence, the inflow significantly exceeded the outflow (see Figure 2.13).

**Figure 2.13. Migration between Ukraine and other former Soviet Union countries, 1991-2002**

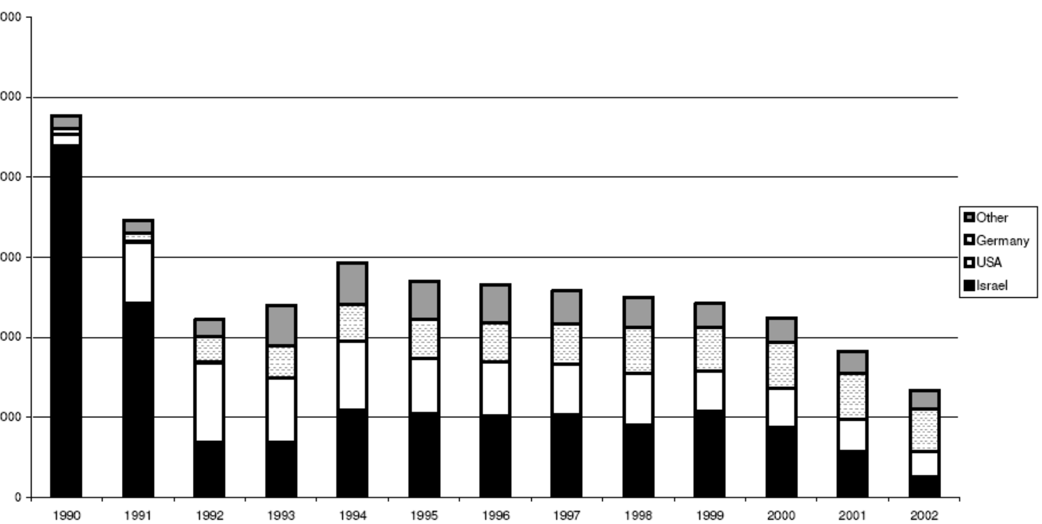



Source: State Statistics Committee of Ukraine cited in GCIM, 2004

Starting from 1994, the net migration between Ukraine and FSU countries became negative. Ukraine plunged into a deep economic crisis caused by the collapse of the old economic system, and it lost its attractiveness for migrants. The harsh economic situation also motivated many Ukrainians to emigrate, seeking better living conditions. The major destination was Russia. During 1994-1998, about 70% of emigrants who went to FSU countries moved there (GCIM, 2004). The total negative net migration between Ukraine and FSU countries during these 5 years accounted for almost 300,000 people. After 1998, migration slowed down significantly and became almost balanced.

Emigration from Ukraine to other countries (the so-called "far abroad") started before the *perestroika* and in 1990, just before independence, reached its peak. Figure 2.14 shows emigration from Ukraine to "far abroad" by destination.

**Figure 2.14. Emigration from Ukraine to "far abroad" by destination, 1990-2002**

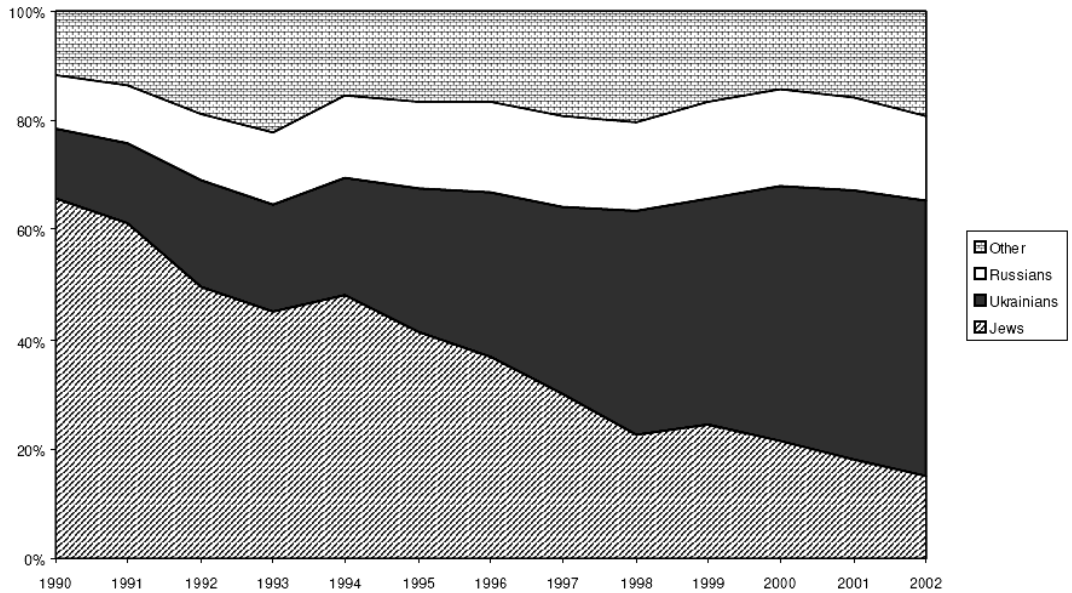



Source: State Statistics Committee of Ukraine cited in GCIM, 2004

Initially this migration had strong ethnic character. In 1990, over 90% of emigrants from Ukraine went to Israel. The share of Israel as a migration destination significantly declined after 1990, as the Jewish population of Ukraine decreased and the Gulf War made Israel less attractive. Other important destinations were the US and Germany.

The ethnic composition of migrants also significantly changed during these twelve years (see Figure 2.15). In 1990, Jews comprised more than 60% of all emigrants. By 2002, their share had decreased to less than 15%. At the same time, the share of Ukrainians increased from about 15% in 1990 to 50 % in 2002.

**Figure 2.15. Ethnic composition of emigrants leaving for "far abroad", 1990-2002**



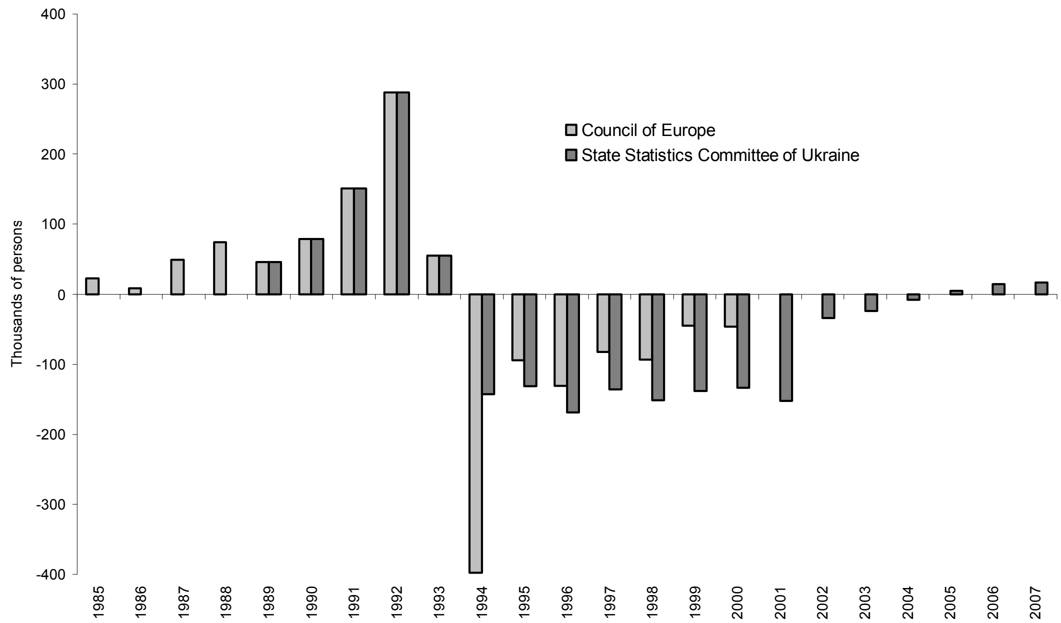

Source: State Statistics Committee of Ukraine cited in GCIM, 2004

Starting from 1994, emigration from Ukraine steadily declined. In 2002, it was only about a quarter of the 1990 level. Immigration from the rest of the world to Ukraine was rarely large. The exception was only the first years after independence when Soviet troops were returning from former socialistic countries.

As the result of these migration flows, the ethnic structure of Ukraine changed after independence. The share of Ukrainians increased from 73% to 78% of the total population between the last Soviet census in 1989 and the first Ukrainian census in 2001. The share of Russians decreased from 22% to 17%. The number of Jews during this period decreased 5 times (the share decreased from 0.9% to 0.2%) and the number of Crimean Tatars increased 5.5 times (the share increased from 0% to 0.5%) (Census, 2001).

Figure 2.16 summarizes the combined net migration in Ukraine over the past 23 years. It presents the data from two overlapping sources – the Council of Europe for 1995-2000 and the State Statistics Committee of Ukraine for 1990-2007. The graph demonstrates the large net inflow of migrants to Ukraine after independence, and a sharp shift of trend to net out-migration in 1994. That year was economically the most difficult after independence. GDP declined by 23%, and living standards plummeted. As Ukraine returned to economic growth, starting from 2000, negative net migration decreased significantly and in recent years it has become positive.

**Figure 2.16. Net migration, Ukraine, 1985-2007**




Source: State Statistics Committee of Ukraine, Council of Europe (2004)

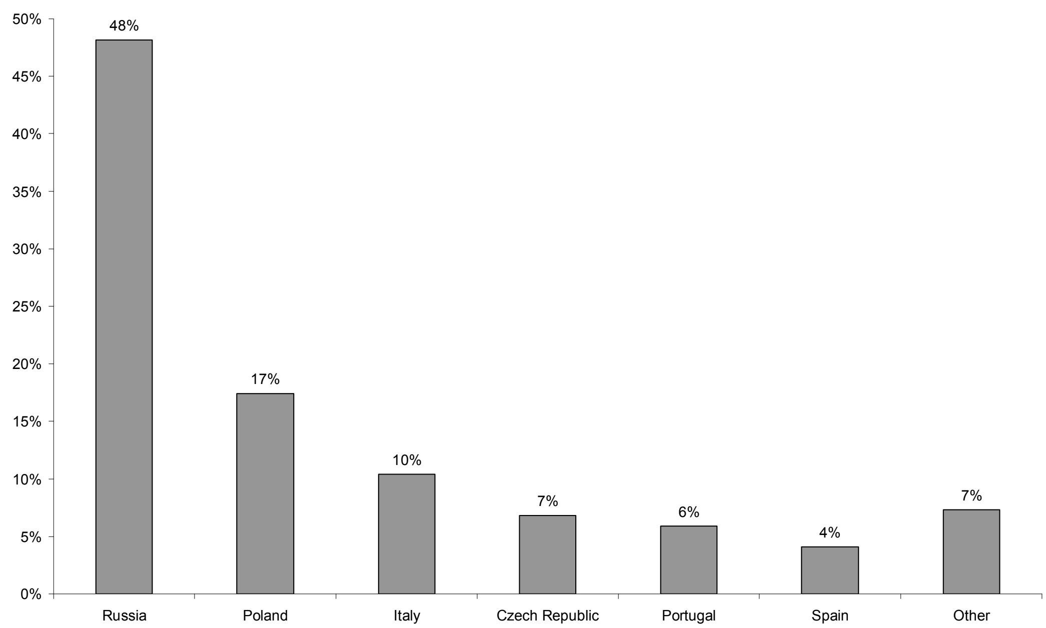
One can also notice that estimates of net migration of the Council of Europe and the Ukrainian statistical authorities vary significantly for 1994-2000. The data on migration, collected by Ukrainian authorities from different sources, is not very effective in reflecting the true situation. According to initial official estimates during 1994-2000, Ukraine lost about 0.6 million people as a result of migration. However, after the 2001 census, the numbers had to be increased 1.7 times to account for missing people. Thus, the difference in existing estimates is not surprising. However, the Council of Europe and the Ukrainian statistical authorities disagree only about the timing but not about the extent of the population loss. According to the State Statistics Committee of Ukraine, during 1994-2000 Ukraine lost 1 million people as a result of migration, and according to the estimates of the Council of Europe, the loss was 0.9 million.

Another new trend which emerged after independence was labour migration. There are no reliable data on how many Ukrainian labour migrants work abroad. However, existing estimates prove that this is an important phenomenon. Different estimates range from 1 million to 7 million people, but the most trustworthy sources provide numbers between 2.5-5 million (ILO, 2005; OECD, 2006; Gajdutsky, 2007) or between 10 and

20% of the economically active population of Ukraine. Such a wide difference between estimates is very easy to explain: most of the labour migrants work abroad illegally, and, for that reason, are not registered by corresponding authorities. Hence, all of the estimates are based on some sort of indirect information. The duration of the trips ranges from several weeks to several years. Therefore, not all of the labour migrants are recorded as emigrants by the authorities.

Although there is wide dispute about the number of labour migrants, most researchers and politicians agree about their distribution by destination. Almost an equal number of labour migrants travelled to the East – to Russia, and to the West – to the EU (see Figure 2.17). Among the EU destinations, Poland is the most popular. The main sectors of employment of Ukrainian migrants are construction (men), agriculture, manufacturing and domestic help (women). Residents of the Western regions of Ukraine are the most active participants in labour migration.

**Figure 2.17. Approximate distribution of labour migrants by destination**




Source: Average share from Malynovska (2006), Gajdutsky (2007) and Katusenko (2007)

The remittances of labour migrants are an important source of income for their families. Again the estimates of remittances vary greatly. According to the National Bank of Ukraine (NBU), in 2006 about $2 billion were transferred through the bank system. Another $1 billion was transferred via money transfer systems (like Western Union, MoneyGram, etc.). Everybody agrees that real flow is much more significant. Most estimates range from $5 to $7 billion, which corresponds to 6-9% of GDP (International Fund of Agricultural Development (IFAD), 2007; Malynovska, 2006).

Labour migration is a highly debated and political issue. In the current difficult demographic situation, a significant outflow of the most active population can put additional strain on the labour market. During the difficult crisis years, the remittances of labour migrants were essential for survival of many families. However, the major question is: What are these labour migrants going to do now when Ukraine is starting to recover from the crises and experience high economic growth? What becomes clear from different pools targeting labour migrants is that the majority of them would prefer to return home if the economic situation improves and they are able to earn an appropriate level of income in Ukraine.

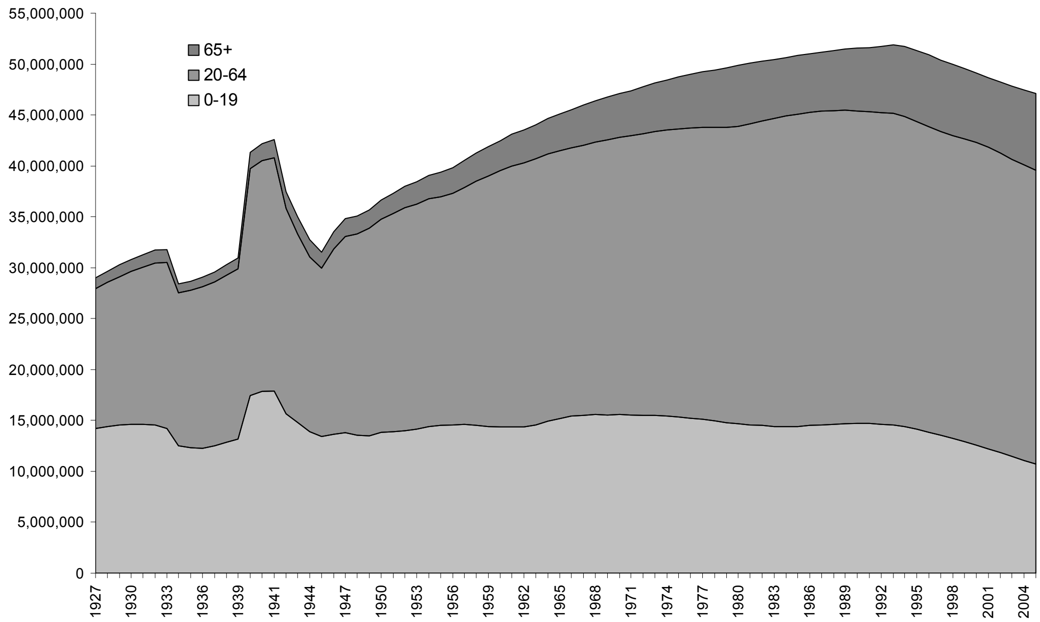
Many countries that surround Ukraine look at it as potential source of migrants to solve their internal demographic problems. In 2008, Poland announced the introduction of the so-called “Card of the Pole”. It is aimed at citizens of neighbouring countries who can prove their Polish roots. The holder of this card is entitled to free multi-entry visa to Poland, can take legal employment without a work permit and is also granted some other rights (like free education, access to medical services, etc.). In recent years, Russia has also significantly simplified the procedure of naturalization for citizens of the FSU countries.

Ukraine is situated at the crossroads of two major European migration flows. One is “EU-centric”, attracting workers from EU border countries and new accession states to more developed European countries. The other is “Russia-centric”, attracting workers from FSU countries to Russia. It remains to be seen whether Ukraine will be able to win in this migration game, not only for foreign workers but even for its own.

*2.2.4. Resulting population structure*

In the previous section, the past trends in fertility, mortality and net migration were discussed. The discussion suggests that, during 1960-1985, Ukraine experienced relatively stable fertility and mortality and positive net migration. The late 1980s and 1990s were very turbulent years in FSU countries, and during these times Ukraine experienced a sharp decline in fertility and life expectancy and a large positive to negative swing in net migration.

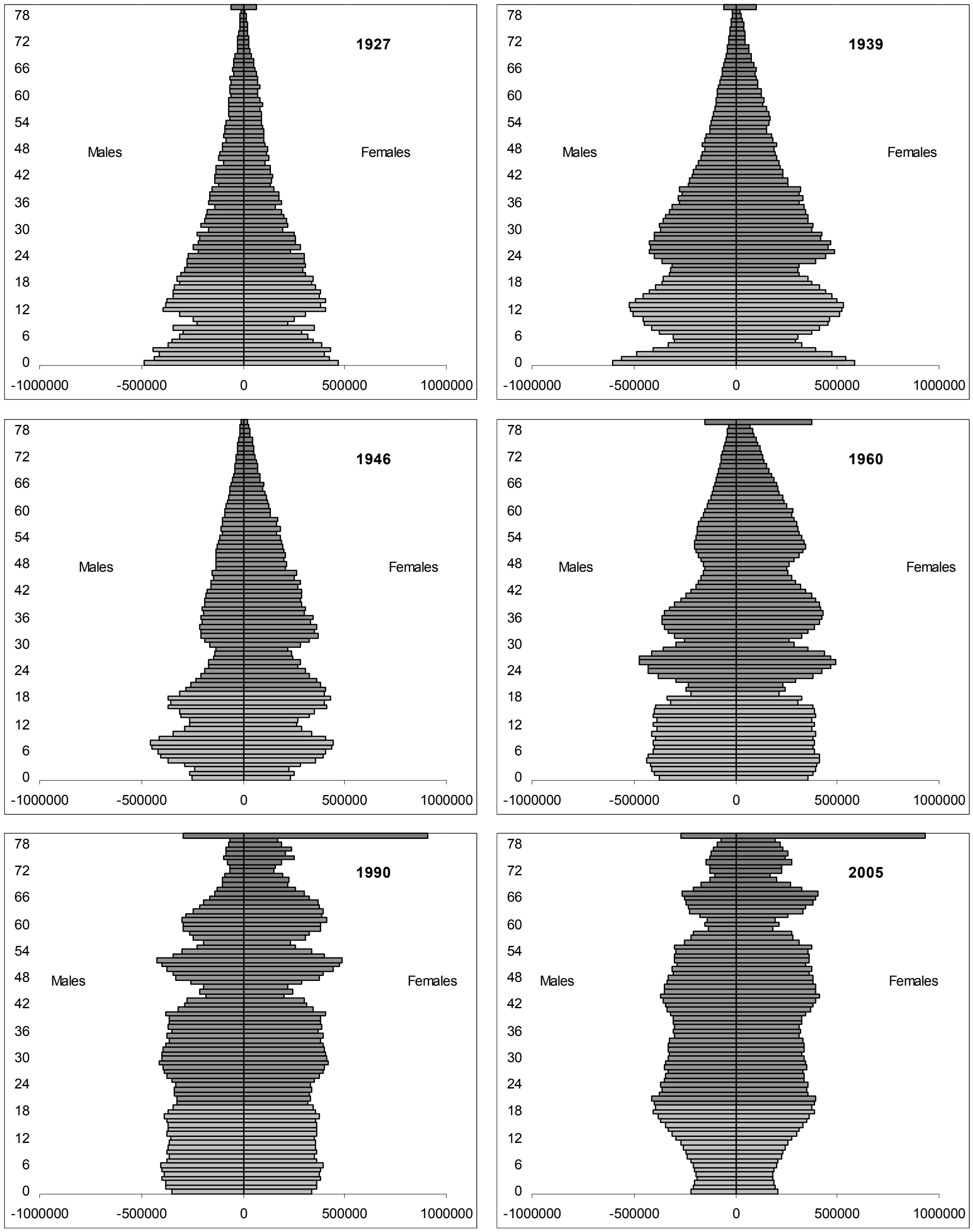
**Figure 2.18. Ukrainian population structure, 1927-2005**




Source: F. Meslé and J. Vallin (2003) for 1927-1988, State Statistics Committee of Ukraine for 1989-2007

All these trends had an impact on the Ukrainian population size and structure. Figure 2.18 shows Ukrainian population age structure for the past 80 years. The series of socio-political shocks that Ukraine went though in the first part of the 20th century are visible in this graph. The first sharp decline in population is the Great Famine of 1933. Shortly after that, the population increased by about 10 million as the result of the annexation of Western Ukraine in 1939. The next drop in population was caused by WWII. The post-war period was relatively stable, without large shifts in population size. Between 1945 and 1993, the population increased steadily. In 1993, at its peak, the population of Ukraine reached almost 52 million. Since then, it started to decline rapidly and by January 1, 2008, had shrunk by 11% to 46 million. One can also notice that the age structure of the population was changing, with the share of younger age groups declining and that of working age and old age groups increasing.

**Figure 2.19. Ukrainian population pyramids for selected years**



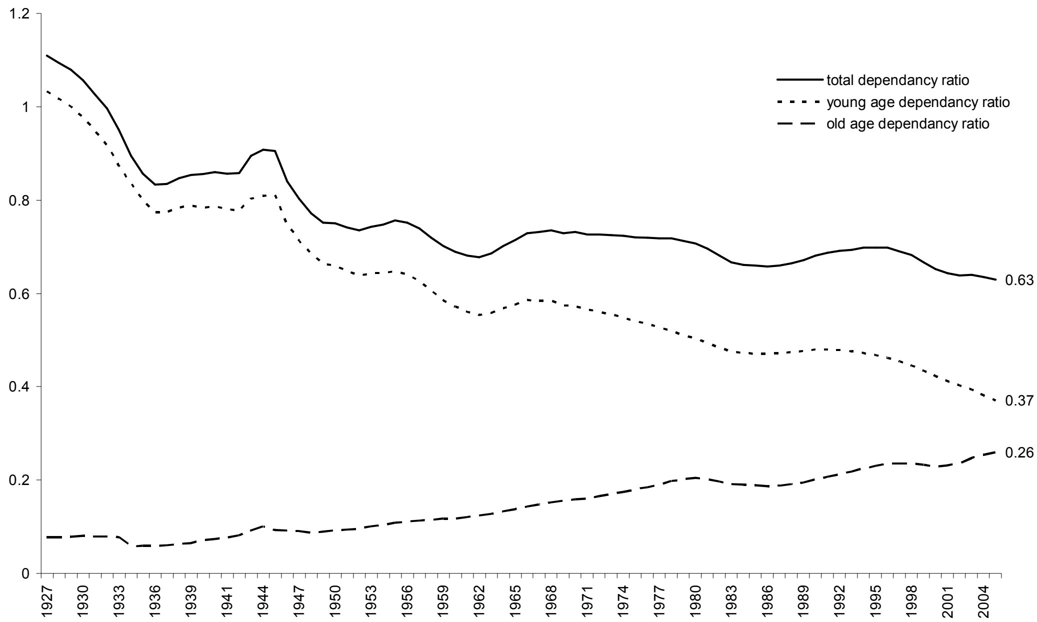

Source: F. Meslé and J. Vallin (2003) for 1927, 1939, 1945 and 1960. State Statistics Committee of Ukraine for 1990 and 2005

Figure 2.19 presents six snapshots of the detailed Ukrainian population age/sex structure. Population pyramids better reveal scars left on the population age structure by different events. In the pyramid for 1927, one can see small generations born during the First World War and during the Civil War that followed the Revolution. The smallest cohorts were born in 1917-1918. The second pyramid for 1939 shows a noticeably larger population after the annexation of the Western Ukraine. The thin cohorts born in 1916-1923 become older, and the second mark appears on the population structure from the years of the Great Famine. The third population pyramid is for post-war 1946. The very thin base shows a deficit of births during the war. The population structure becomes skewed as many more men than women died during the war. The pyramids for 1960 and 1990 demonstrate that cohorts born after the war are almost the same in size, which is not surprising given that Ukraine had almost constant fertility during these years. Finally, the last population pyramid for 2005 reveals the sharp decline in fertility in the 1990s, resulting in a very narrow base.

If one considers the overall shape of these pyramids, one can see how the population age structure was changing over time under the influence of the demographic trends. The 1927 population pyramid has a triangular shape typical for societies with high fertility and high mortality. By 1960, the triangular shape is observed only for cohorts aged 25 and above. Younger cohorts are smaller then cohorts born just before the WWII and are very similar in size. This is explained by decline in fertility after the war and significant improvements in infant and child mortality. In 1990, the population had very uniform age distribution up until the age of 60 (ignoring the two thin cohorts discussed above). Finally in 2005, the population pyramid had the so-called “bee hive” shape, reflecting very low fertility and a strong tendency to population ageing.

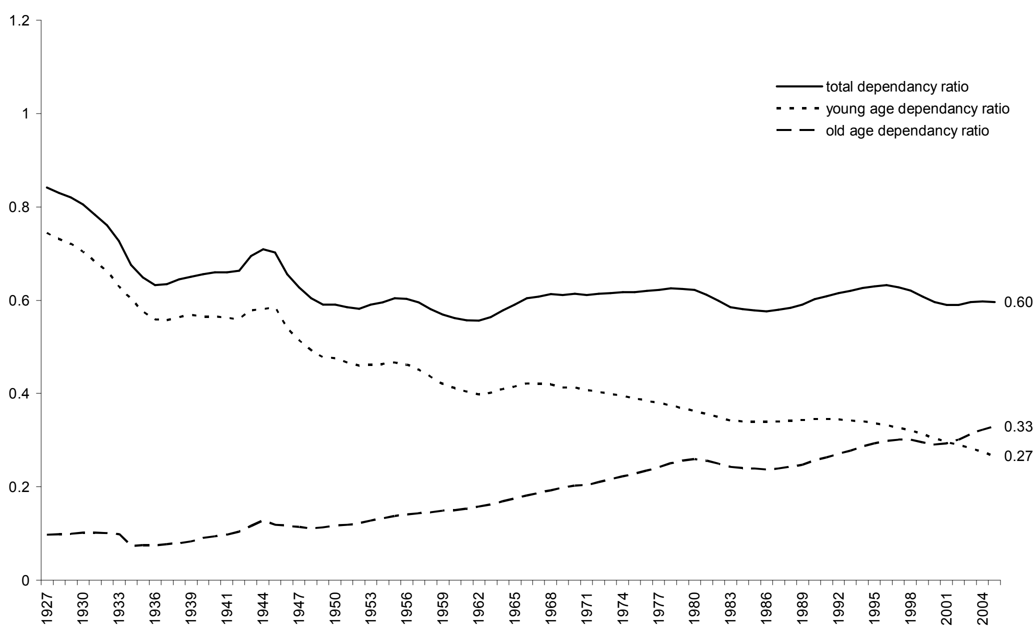
The dynamics of the dependency ratios for Ukrainian population are presented in Figure 2.20. The dependency ratio shows the number of dependants per working age individual. In this case, young age dependants are younger then 20 years old, old age dependants are older then 64 years old and the working age population is 20-64 years old. As expected, young age dependency ratio has been steadily declining over the past 80 years. After 1960, the decline slowed down a little, but after 1993 it intensified again. The old age dependency ratio has been gradually increasing over time. It should be noted that the total dependency ratio was declining until the 1960s, and after that it remained virtually constant as young age dependency was declining at approximately the same rate as the increase in old age dependency.

**Figure 2.20. Young age, old age and total dependency ratios in Ukraine, 1927-2005**




Source: F. Meslé and J. Vallin (2003) for 1927-1988, State Statistics Committee of Ukraine for 1989-2007, own calculations

**Figure 2.21. Consumption-adjusted young age, old age and total dependency ratios in Ukraine, 1927-2005**




Source: F. Meslé and J. Vallin (2003) for 1927-1988, State Statistics Committee of Ukraine for 1989-2007, own calculations

This type of dependency ratios calculation, however, implicitly assumes that young and old dependants "depend" in the same way. This is clearly not the case, and children present a lower burden than the elderly, in terms of government expenditures per head, for example. Therefore, some researchers suggest using adjusted dependency ratios that deflate the dependency of children and inflate the dependency of old age persons. For example, Cutler *et al.* (1990) used US data to estimate needs-weighted consumption measure weighing consumption of people under 20 at 0.72 and consumption of people aged 65+ at 1.27 of the consumption of people aged 20-64 (the consumption of an older person is larger than that of a working age person, mainly owing to higher health care expenditures). Figure 2.21 presents the dependency ratios using these adjustment coefficients. In this case, old age dependency in 2005 increases to 0.33 from 0.26, young age dependency decreases from 0.37 to 0.27, and total dependency ratio declines from 0.63 to 0.60. This means that every adult has to support him/herself, and also 60% of the consumption needs of another adult person.

One more thing that should be noted about Ukrainian population ageing is that it is driven mainly by declining fertility and not increasing longevity. As was discussed in the previous sections, life expectancy in Ukraine has been decreasing since the mid-1960s. Thus, the increasing share of older generations is driven only by the decreasing share of younger ones. However, the decline in fertility was so significant that the share of population aged 65+ in Ukraine is comparable with that in other European countries. Italy has the highest level in Europe – 19.9% of Italian population are aged 65 and above. Ukraine takes the $14^{th}$ position with 16.2%, between France (16.3%) and the UK (16.1). The lowest level is in Ireland (11.1%) and Albania (8.7%) (World Bank, 2008).

Low life expectancy has slowed down the process of population ageing in Ukraine until now. However, the long period of very low fertility created an age structure that is programmed for fast population ageing. The next section will discuss how future trends in fertility, mortality and migration will affect this process.

### 2.3. Demographic Future

There are two organizations that produce population projections for Ukraine. The one mostly used in international comparisons is produced by the United Nations Population Division. The other one is mostly used inside the country and produced by the Institute for Demography and Social Studies at the National Academy of Science of Ukraine. This section is devoted to discussion of the population projections produced by these two organizations, or based on their assumptions. More specifically, the 2006 revision of the UN projections (United Nations Population Division, 2006) and 2006-based Institute for Demography projections are discussed (Institute for Demography, 2006).

The UN produces eleven population projections for each country. Table 2.4 summarizes all scenarios and assumptions. The current analysis focuses on the first three – high, medium and low scenarios. Each of them shares the same mortality and migration assumptions, and only fertility assumptions vary. The base year for the 2006 revision is 2005.

**Table 2.4. Fertility, mortality and migration assumptions in different UN projection scenarios**

| | **Assumptions** | | |
|---|---|---|---|
| **Variant** | **Fertility** | **Mortality** | **Migration** |
| *Low* | *Low* | *Normal* | *Normal* |
| *Medium* | *Medium* | *Normal* | *Normal* |
| *High* | *High* | *Normal* | *Normal* |
| Constant-fertility | 2000-2005 | Normal | Normal |
| Instant-replacement-fertility | Replacement | Normal | Normal |
| Constant-mortality | Medium | 2000-2005 | Normal |
| No-change | 2000-2005 | 2000-2005 | Normal |
| Zero-migration | Medium | Normal | Zero |
| No-AIDS | Medium | No-AIDS since 1980 | Normal |
| High-AIDS | Medium | High-AIDS as of 2005 | Normal |
| AIDS-Vaccine | Medium | AIDS-Vaccine as of 2010 | Normal |

Source: UN Population Division (2006)
The main assumptions are selected in italic

The Institute for Demography produces six different assumptions for each of the components of demographic change (fertility, mortality and migration). The list of the assumptions is presented in Table 2.5. The authors of the projections say that high (high1 in case of fertility), medium and low are the main assumptions, and the rest are of “analytical character”. With a different combination of these assumptions, the

Institute for Demography produces 20 different scenarios. Here, three scenarios are going to be discussed in more detail – low-low-low, medium-medium-medium and high1-high-high.

**Table 2.5. Variants of fertility, mortality and migration assumptions in Institute for Demography projections**

| Assumptions | | |
|---|---|---|
| **Fertility** | **Mortality** | **Migration** |
| *Low* | Lowest low | Lowest low |
| *Medium* | *Low* | *Low* |
| *High 1* | *Medium* | *Medium* |
| High 2 | *High* | *High* |
| Normative | Normative | Normative (zero net migration) |
| Constant | Constant | Constant |

Source: Institute for Demography (2006)
The main assumptions are selected in italic

### *2.3.1. Fertility assumptions*

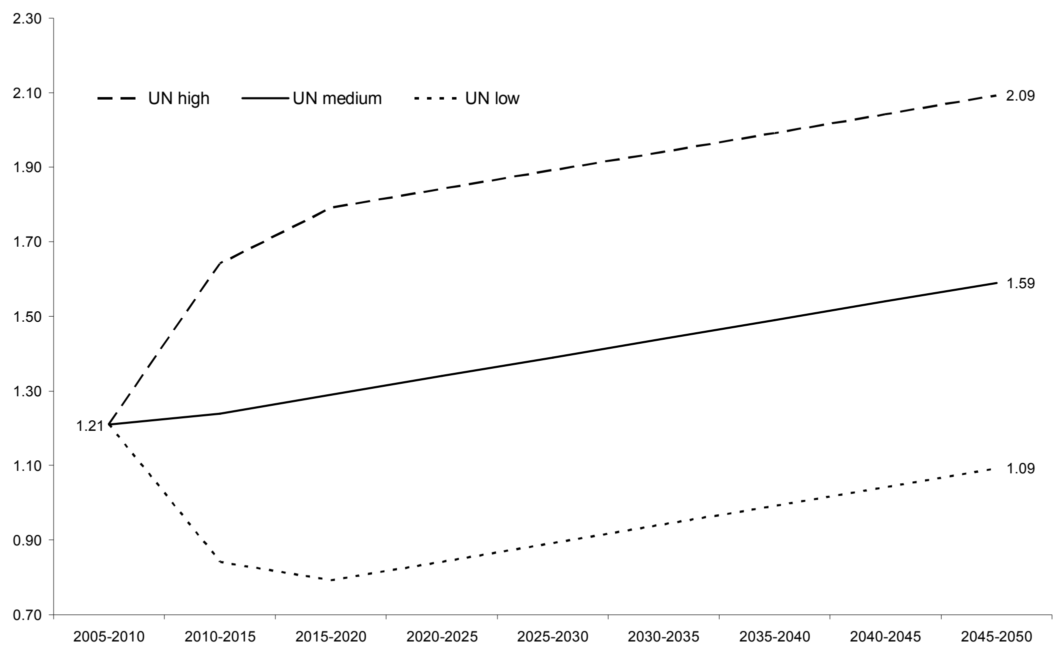
The medium fertility assumption of the United Nations Population Division in its 2006 population projections revision is that eventually fertility level in all countries will converge to 1.85 births per woman. However, this need not happen during the projection period, i.e. until 2050. The countries are divided into three categories, based on their most recent fertility level:

- High-fertility countries: no fertility reduction or only an emerging decline until 2005;
- Medium-fertility countries: fertility has been declining but TFR was still above 2.1 births per woman in 2000-2005;
- Low-fertility countries: TFR at or below 2.1 children per woman in 2000-2005.

Countries that belong to different fertility groups follow different fertility convergence processes. Ukraine is one of the low-fertility countries. For this group, it is assumed that over the first 5 or 10 years of the projection period, fertility will follow the recent trends. After the transition period, fertility is assumed to increase linearly at a rate of 0.05 births per woman per five-year period. Thus, because Ukraine is a country with very low fertility, it will not reach a level of 1.85 children per woman by 2050.

The high fertility assumption is that fertility will be 0.5 children above the fertility in the medium variant, and the low fertility assumption is that it will be 0.5 children below the fertility in the medium variant after the initial adjustment process. All three UN fertility assumptions are presented in Figure 2.22. In all three scenarios, it is assumed that the average age at childbirth will increase, and by the middle of the projection period, the fertility schedule will be reaching its maximum in the age group 25-29 (compared with 20-24 at the moment).

**Figure 2.22. The UN Population Division fertility assumptions**

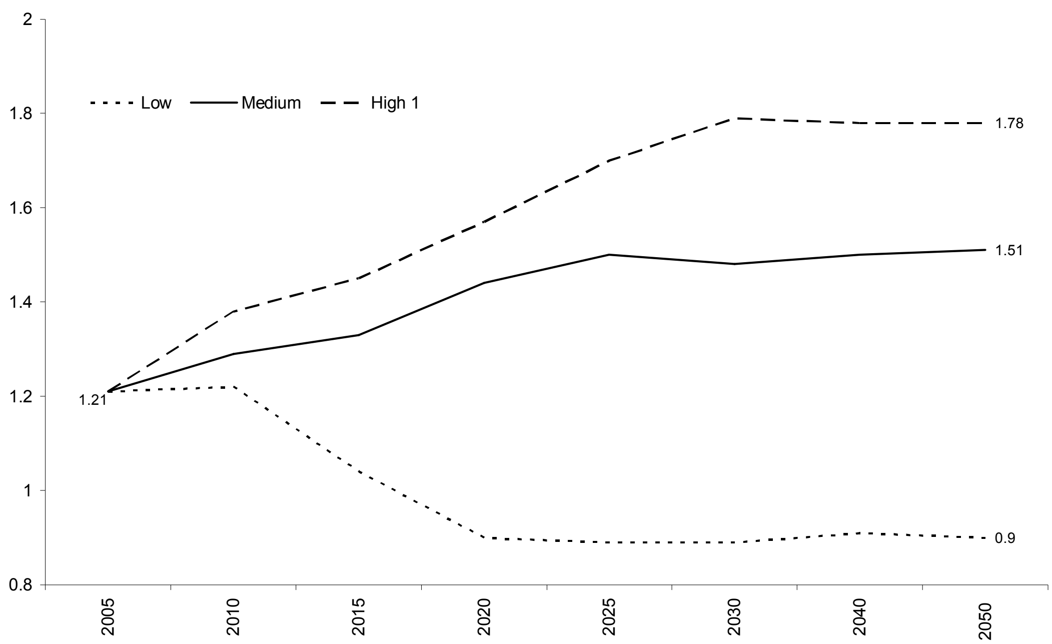



Source: UN Population Division (2006)

The Institute for Demography approach to assumptions formulation is less mechanistic. It takes into account the recent demographic trends, socio-economic conditions and demographic processes in neighbouring countries. As mentioned before, it produces six fertility scenarios, but only the main three of them are discussed here: low, medium and high1. They are presented in Figure 2.23.

The difference amongst the three scenarios in the initial periods comes from what we believe about how far Ukraine is into the process of fertility postponement. In the case of the low fertility scenario, the assumption is that postponement of fertility will accelerate in the nearest future and this will lead to a further reduction in fertility. In the case of the medium fertility scenario, the assumption is that the postponement is well on the way and that the realisation of previously-postponed births will lead to the increased fertility. This process will be accompanied by a continued gradual shift in the fertility schedule to older ages. Another factor that will lead to increasing fertility at the beginning of the projection period in the medium scenario is government measures aimed at economic support of fertility. As mentioned in the previous section, starting from 2005 for every new born baby a family receives a substantial one-off payment from the government.

**Figure 2.23. The Institute for Demography fertility assumptions**




Source: Institute for Demography (2006)

The high fertility scenario is based on the assumption that the government will be able to use an experience of North European countries (characterized by high fertility by European standards) to increase the fertility level in Ukraine. The measures mentioned in the description of this scenario are raised economic standards of living, family-friendly labour market policies, changes in the gender roles in families and society, financial support for families with children and the development of quality public services that make children less “costly” (like free health and education provision). This scenario seems the most ambitious, as it assumes the largest role of government policy in increasing fertility. Also, it does not address the issue of fertility postponement as if it was completely over in Ukraine.

It is assumed that by 2020-2030, fertility will have stabilized but at different levels in different scenarios. It is also mentioned that different long-run fertility levels are influenced by social norms and society expectations. For example, in the case of a low fertility scenario, the majority of women that will reach the most fertility age after 2020 will have grown up in the families with one child, and society as a whole will be formed mostly of one-child families. Thus, this type of family will become a norm and later generations of women will also tend to have just one child. The same reasoning applies to other scenarios as well. In the case of the medium fertility scenario, the majority of families will have one or two children, and in the case of the high fertility scenario, the majority of families will have two children.

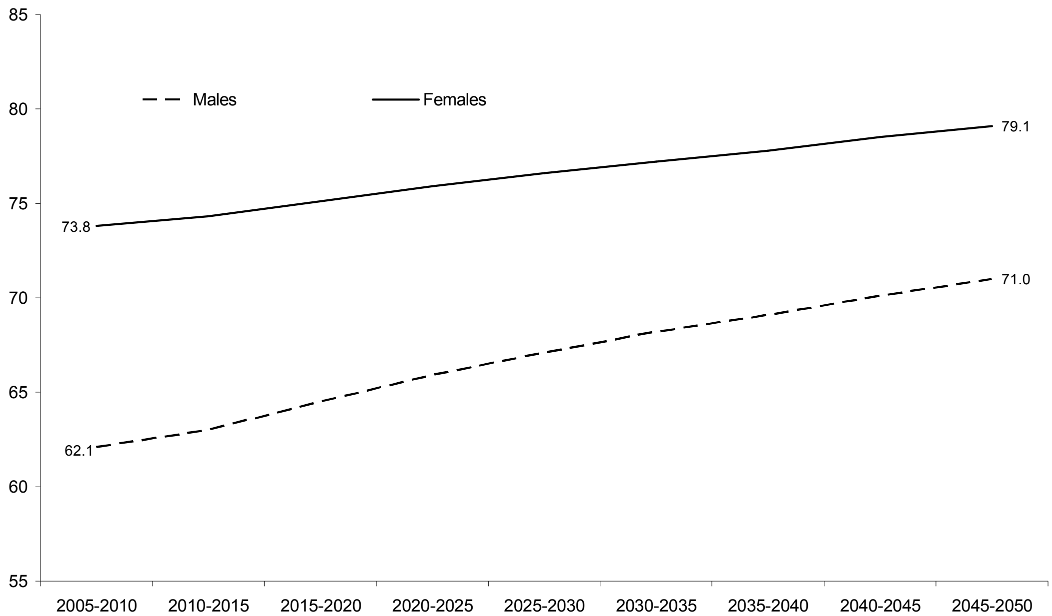
### *2.3.2. Mortality assumptions*

The United Nation Population Division produces several mortality scenarios. Here in more detail we will discuss just the normal mortality scenario. Others include constant mortality and several scenarios based on assumptions about the prevalence of AIDS.

Normal mortality is projected on the basis of models of change of life expectancy produced by the United Nations Population Division. These models produce smaller gains, the higher the life expectancy already is. The selection of a model for each country is based on recent trends in life expectancy by sex.

As discussed in the previous section, Ukraine has relatively low life expectancy by European standards. Thus, it is assumed to have significant advancement over the projection period. Also, during the projection period, male life expectancy will increase faster than female life expectancy, which will lead to eventual convergence. According to the assumptions of the UN Population Division, by the end of the projection period, female life expectancy will have increased by 5.7 years and will have reached 79.1 years, while male life expectancy will have increased by 9.5 years and will have reached 71 years. Thus, by 2045-2050, Ukraine will have reached the same level of life expectancy that was in Poland in 2006 (see Figure 2.8). The UN mortality assumptions are presented in Figure 2.24.

**Figure 2.24. The UN Population Division life expectancy assumptions, 2006-revision**

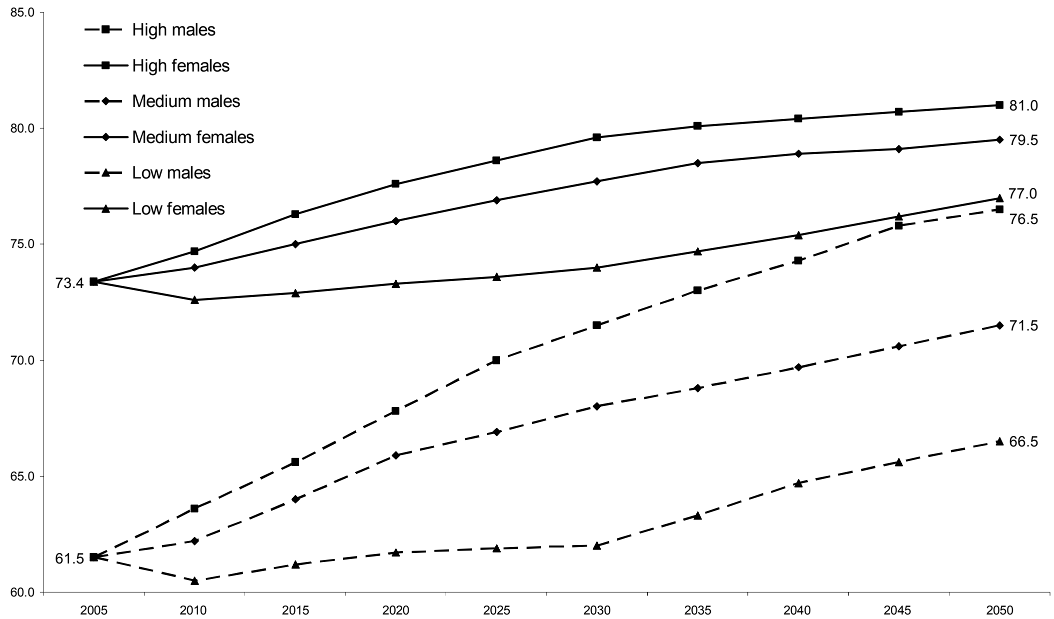



Source: UN Population Division (2006)

The Institute for Demography produces six mortality scenarios, but only the main three of them will be discussed here: low, medium and high, which refer to levels of life expectancy. Mortality scenarios produced by the Institute for Demography are more detailed and based on more rigorous demographic analysis. Life expectancy for each mortality scenario is calculated on the basis of assumptions about survival probabilities for wide age groups: younger than 1 year old, 1-19, 20-39, 40-59, 60-99 and more than 100 years old. This allows greater flexibility of projection, as different age groups can experience different speeds of mortality improvement/deterioration and even different directions of change. The resulting life expectancy at birth for three mortality scenarios by sex is presented in Figure 2.25.

The low life expectancy scenario is based on the assumption that the negative factors that were driving mortality up in recent years are going to continue, at least in the short term. The overall level of life expectancy will decline initially but will start to improve after 2008. However, in the wide age group 20-59, negative mortality dynamics will be observed until 2011.

**Figure 2.25. The Institute for Demography life expectancy assumptions**




Source: Institute for Demography (2006)

In the case of the medium life expectancy scenario, the underlying assumption is that mortality rates in most age groups have already reached their maximums or will reach them during the first five years of the projection. Starting from 2010-2012, mortality rates in all age groups will improve. Negative growth will persist the longest in the 40-50 age group.

The most optimistic high life expectancy scenario assumes that mortality rates will improve in all age groups, starting from the beginning of the projection period. The largest improvements are expected in the age groups 20-39 and 40-60. In the latter group, positive trends will include not only a decline in mortality coefficients but also an increase in the average age of the dead. All three scenarios assume that the gender gap in life expectancy is going to narrow down with time. The high life expectancy scenario assumes the most rapid convergence.

It should also be noted that the Institute for Demography medium mortality scenario is very close to the UN normal mortality scenario. At the end of projection period, the difference is only 0.9 years for females and 0.4 years for males, with the Institute for Demography being more optimistic.

### *2.3.3. Migration assumptions*

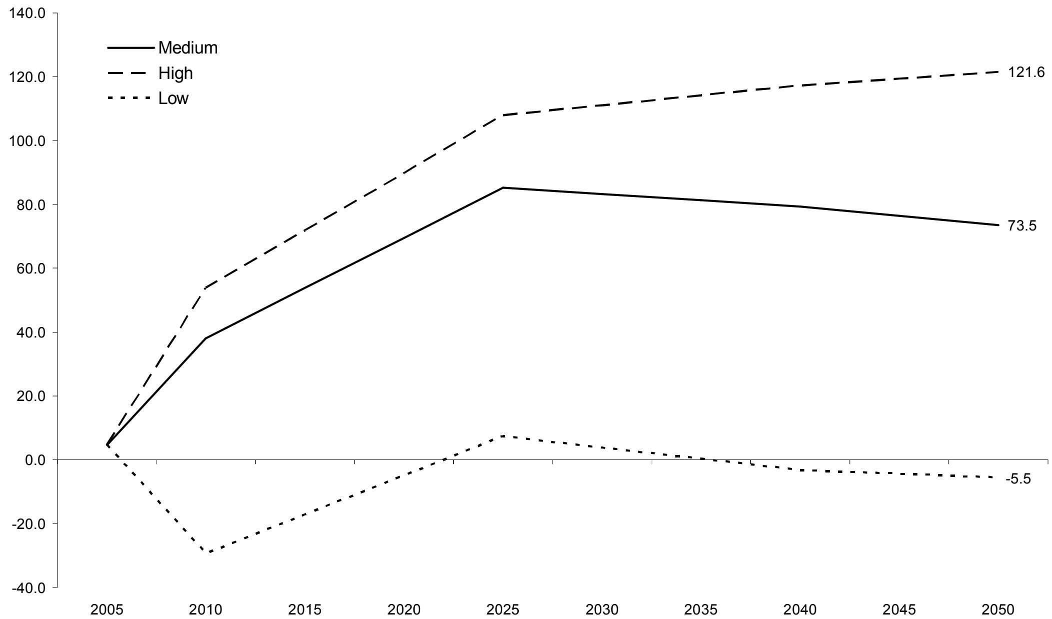
Of the three components of demographic change, migration assumptions are the most difficult to make, and usually they turn out to be the least accurate. There are several reasons for that. First, migration flows are influenced by many social, economic and demographic factors, not only inside the country but also outside of it. Second, migration is a composite process – it consists of in and out flows, each of which can be sub-divided according to the age groups of migrants, and/or according to the destination or origin country. Each of these flows is driven by specific factors and follows its own logic. Thus, the projected level of net migration is the result of a very difficult process. Third, the variation in migration level during the relatively short period of time can be very large, much larger than the variation in mortality and fertility. Thus, it is more difficult to rely on recent trends, even with short-term assumptions. That is why, when producing migration assumptions, scholars use expert estimates more often than with other components of demographic change.

The United Nation Population Division produces two types of migration scenarios: "normal migration" and "zero migration". Under the normal migration assumption, the future level of migration is determined on the basis of past international migration estimates and assumptions about the country specific future migration policy. In case of Ukraine, the normal net migration assumption is -20,000 per year.

The Institute for Demography produces separate in and out migration assumptions by five geographic regions: (1) Russia, (2) other European post-soviet republics (Belarus, Moldova and Baltic states), (3) southern post-soviet republics (Caucasian and Central Asian republics), (4) "the territory of European settlement" (the rest of the Europe, North and South Americas, Australia, New Zealand and Israel), (5) "Eastern countries" (the rest of Asia, Africa and Oceania). The aggregate net migration assumption is calculated by adding together regional assumptions.

The Institute for Demography produces six migration scenarios. The main three of these will be discussed here: high, medium and low migration. The aggregate net migration assumptions from these three scenarios are presented in Figure 2.26.

**Figure 2.26. The Institute for Demography net migration assumptions**




Source: Institute for Demography (2006)

The medium migration scenario is based on the assumption that positive economic processes observed in the recent years are going to continue. This will lead to the following factors that will determine the level of migration:

- the recent trend of declining intensity of contacts with the post-soviet countries is going to stop;
- the positive migration balance with these countries following the recent trends will continue;
- a second smaller scale repatriation wave of previously deported people will emerge;
- the declining intensity of emigration to the countries belonging to "the territory of European settlement" as a result of the depletion of ethnic component of this flow and decline in other factors that stimulate emigration to this group of countries;
- the increase in immigration from Europe and the US, caused by higher integration of Ukraine in international economy and the growing number of

foreign and joint companies;

- the emergence and increase in the number of emigrants from developing countries.

All these factors will lead to a gradual increase in the level of net migration, which will reach its maximum of 90 thousand persons at the end of 2020s, and by the end of the projection period will have amounted to 73.5 thousand persons per year.

The high migration scenario is grounded on the assumption that the Ukrainian economy is going to develop faster than that of neighbouring CIS and Eastern European countries. In this case, the flow of migrants from Russia, Belarus and Moldova as well as from Asian and African countries is going to increase. This will result in a steady increase in the level of net migration, and by the end of the projection period it will have reached 122 thousand persons per year.

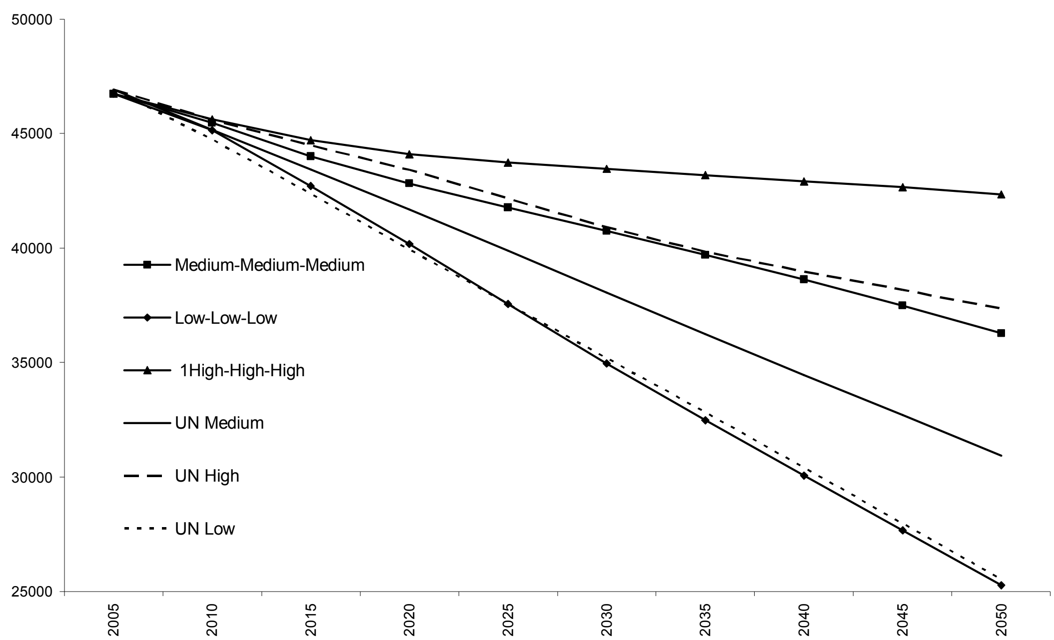
The low migration scenario describes a situation when the rates of economic growth will slow down and living conditions will deteriorate. In this case, during the first half of the projection period, there will be a significant increase in emigration to the countries belonging to “the territory of European settlement” group. This will happen as a result of two factors: an increase in the outflow of highly skilled workers, and labour migrants who switch from being temporary to long-term residents.

In the second half of the projection period, a widening of the negative migration balance with Russia will be observed. The second wave of repatriation will not materialize, and migration flows from post-soviet Caucasian and Asian republics will gradually disappear. The flow of immigrants from Asian and African countries will be positive but less significant, and their level of settlement will be relatively low: about 25% will return to their home region or will move further to Western countries. The resulting level of net migration will be negative for most of the projection period.

### *2.3.4. Population projections*

This section describes the population projections produced by the UN Population Division and by the Institute for Demography. Figure 2.27 presents six different scenarios, three for each institution. These projections are based on the assumptions described above.

**Figure 2.27. Projected total population of Ukraine**



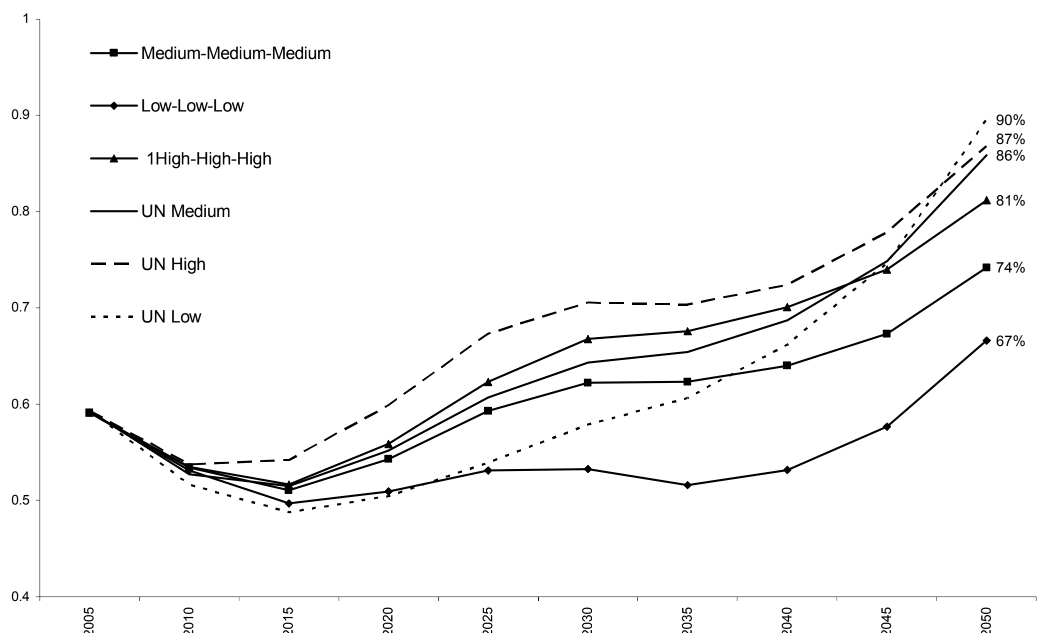

Source: Institute for Demography (2006), United Nation Population Division (2006)

All population scenarios forecast that the population of Ukraine will contract during the next 45 years. However, the rate of population decrease will be very different depending on demographic assumptions. The most optimistic scenario is produced by the Institute for Demography and combines high fertility, high life expectancy and high migration assumptions. In this case, the total population will decrease from 46.9 million in 2005 to 42.4 million in 2050, or by 9%. The low projection of the UN Population Division is almost the same as the low-low-low population by the Institute of Demography. According to these two projections, the population of Ukraine is projected to decline to 25.3/25.5 million by 2050, or by 46%.

The difference in projected population decline is very large if the most extreme scenarios are compared. Nevertheless, according to the most plausible medium scenarios of these two organizations, the Ukrainian population is expected to decline between 22% (the Institute for Demography projection) and 34% (the UN projection) by 2050.

The decline in total population, however, does not describe all the demographic transformations of a country. Apart from the size of the population, its structure plays a crucial role. For economic processes, especially important is the number of workers relative to non-workers. Figure 2.28 presents consumption-adjusted[1] total dependency ratios for the six population projections discussed above.

**Figure 2.28. Projected consumption-adjusted total dependency ratio in Ukraine**




Source: Institute for Demography (2006), United Nation Population Division (2006), own calculations

In the short term, until 2015, all scenarios forecast a decline in the total dependency ratio. This is explained by a simultaneous decline in the young age dependency ratios, as a result of low fertility and a decline in the old age dependency ratios, because at this time small WWII cohorts leave the labour force. However, after 2015, dependency

[1] Described in section 2.2.4.

ratios will increase significantly according to all scenarios, and by the end of projection period, will range from 0.67 to 0.90.

The consumption-adjusted dependency ratios for the low UN population projection and the low projection of the Institute for Demography are very different, although the total projected population is almost the same. Until 2025, dependency ratios in these two scenarios are very close. However, after 2025 they diverge drastically. The main reason for that are different mortality assumptions. It should be recalled that the UN produces only one mortality scenario which corresponds roughly to the medium mortality scenario of the Institute for Demography. Thus, the higher life expectancy in the low UN projection results in much higher dependency ratio.

Some authors use the share of the population aged 65+ as an indicator describing population ageing. In 2005, it was about 16%. By 2050, according to different population scenarios, it will have reached between 23% and 33% of the total population. It is important to note that all population scenarios result in substantial population ageing. The difference is mainly in the speed of the process and not in the direction of change.

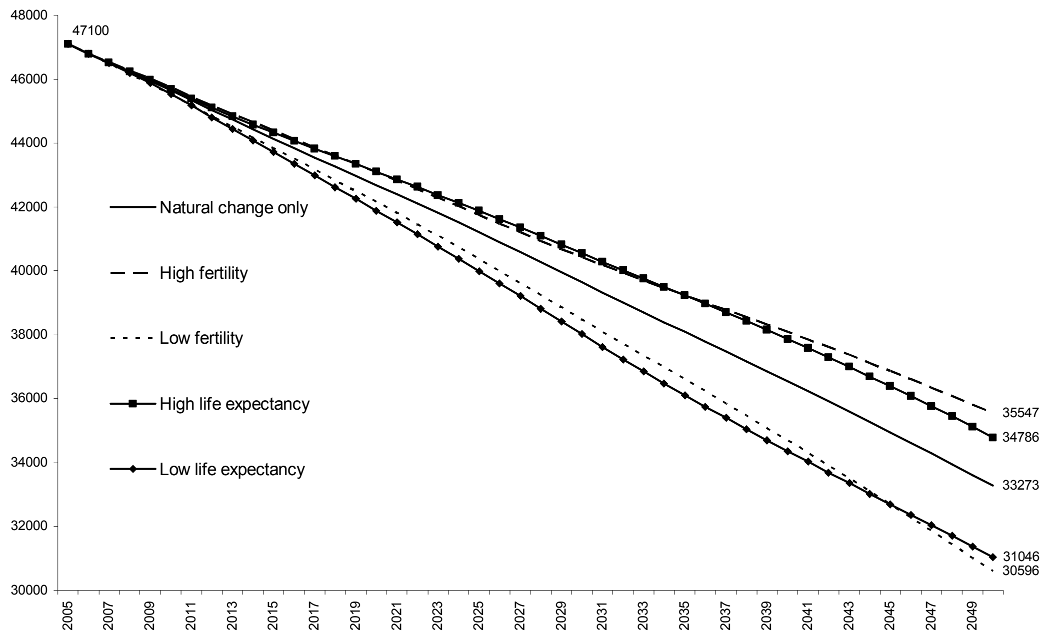
#### *2.3.4.1. Sensitivity analysis*

To investigate the individual effect of fertility, mortality and migration assumptions on population projections, a sensitivity analysis based on the assumptions of the Institute of Demography is performed. The preference is given to the Institute for Demography projections for two reasons. First, this organization bases its assumptions on a more rigorous analysis of the socio-demographic situation in the country. Second, it produces complete set of mortality assumptions (the UN has just one normal mortality and migration scenario). The specialized population projections software POPGROUP developed by the Cathie Marsh Centre for Census and Survey Research at the University of Manchester is used to perform the projections.

As a baseline, a modified scenario is created, based on medium fertility and mortality assumptions and zero net migration assumption. This scenario is called “natural change only”, as it reflects demographic changes only as a result of the difference between births and deaths, disregarding migration.

Two sets of sensitivity scenarios are presented. The first set uses the high and low fertility and mortality assumptions of the Institute of Demography discussed above. In this set, there are four scenarios: high fertility, low fertility, high mortality and low mortality. The projected total population according to these four scenarios, together with the baseline scenario, are presented in Figure 2.29.

**Figure 2.29. Projected total population of Ukraine, fertility/mortality sensitivity**

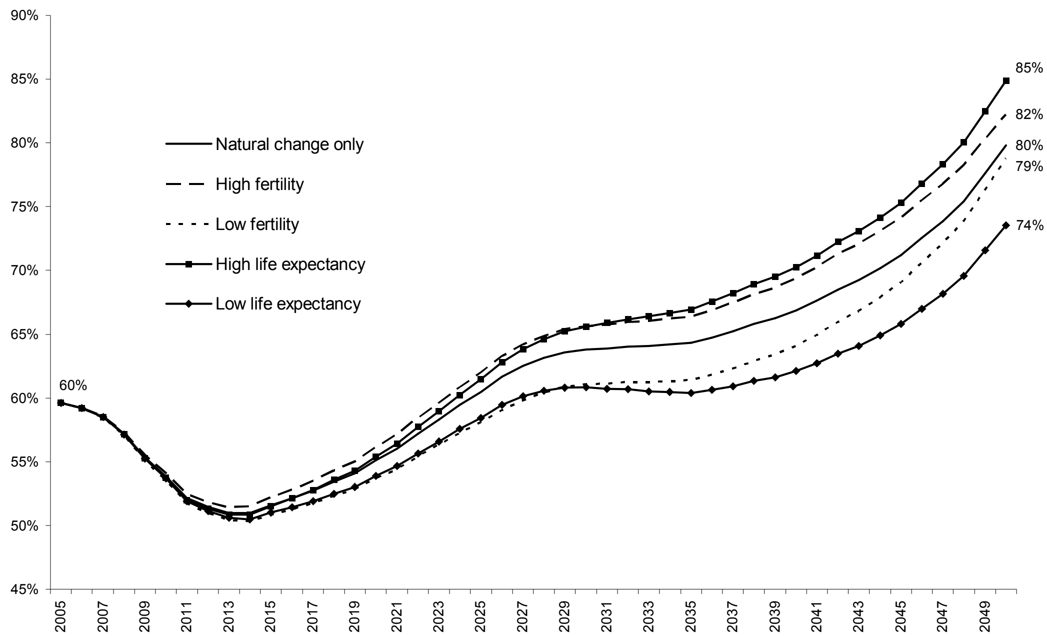



Source: own projections

The graph reveals that the effect of high/low fertility and life expectancy on the total population is comparable. Higher life expectancy adds to the resulting total population in 2050 about 1.5 million, while the increase in fertility adds about 2.4 million, compared with the baseline scenario. On the other hand, lower life expectancy decreases the total population in 2050 byabout 2.2 million, and lower fertility by about 2.8 million. According to all scenarios, the population is expected to decrease significantly.

Figure 2.30 presents consumption-adjusted total dependency ratios for these five scenarios. As one can see here, the difference between the effect of fertility and mortality changes is more significant. Changes in mortality assumption have a more significant effect on dependency ratios, because it has a quicker effect on the number of people aged 65 and above, and they have higher weight. In all scenarios, dependency is projected to increase significantly.

**Figure 2.30. Projected consumption-adjusted total dependency ratio in Ukraine, fertility/mortality sensitivity**

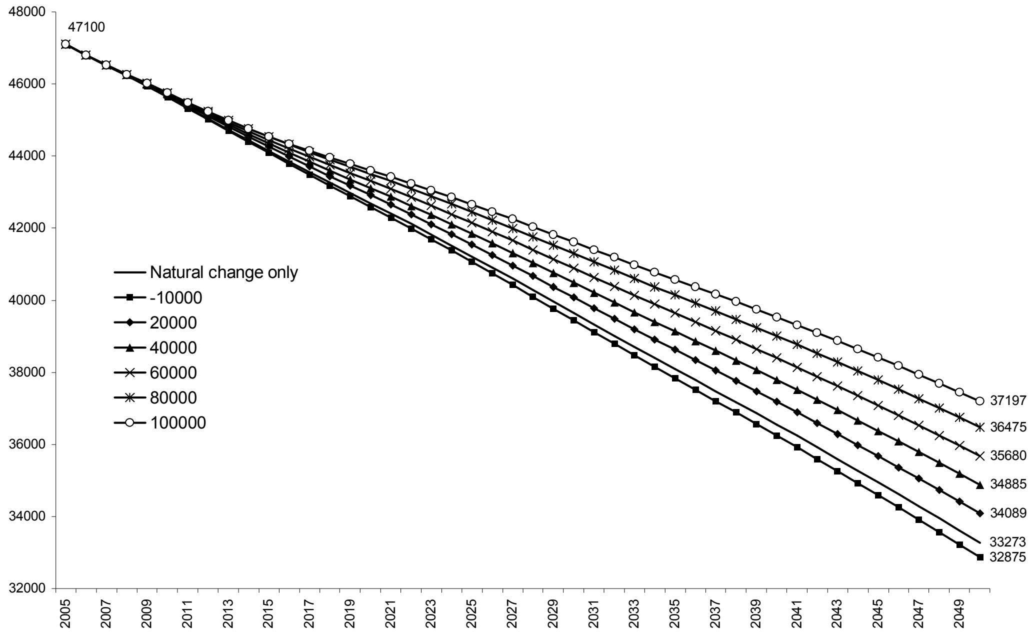



Source: own projections

The second set of sensitivity scenarios varies net migration assumption. In the baseline scenario, it is assumed that there is no migration. In sensitivity scenarios, net migration assumption is varied from -10,000 to +100,000 per year. The lowest boundary corresponds to the UN migration assumption. The highest boundary is almost equal to the highest level of migration achieved in the high migration assumption of the Institute for Demography (90,000).

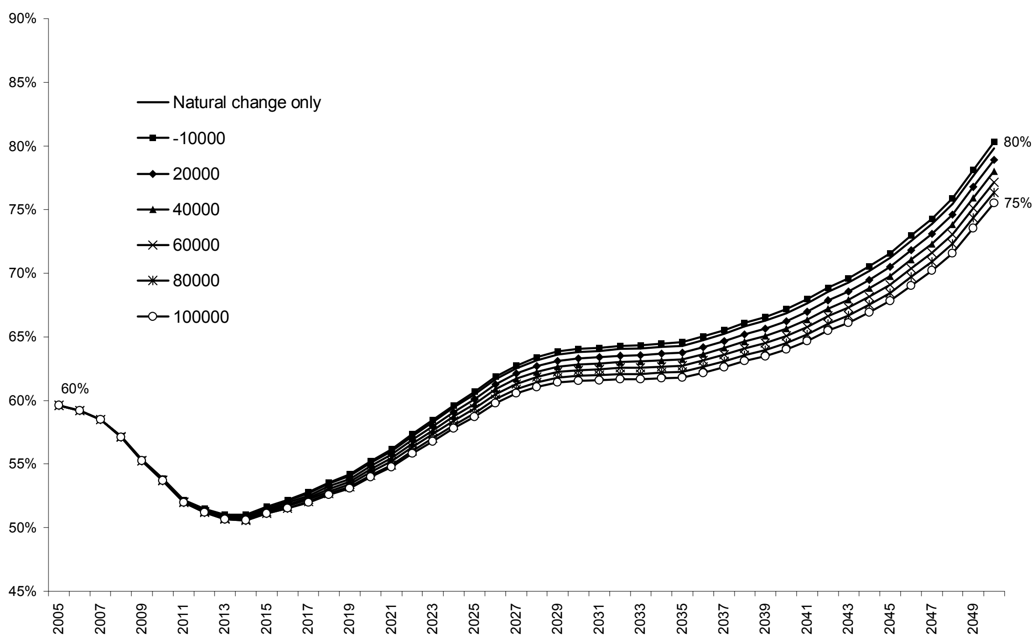
The age-sex structure of migrants is the same in all sensitivity scenarios. It is assumed that there is an equal number of male and female migrants, and their age structure is as follows: 10% younger than age 20; 45% aged 20-34; 45% aged 35-59. This age structure corresponds approximately to the structure of migrants observed in 2005. Figure 2.31 presents the total projected population based on these migrations scenarios. An increase in net migration by 20,000 per year results in a corresponding increase in the 2050 population of c. 0.8 million.

**Figure 2.31. Projected total population of Ukraine, net migration sensitivity**




Source: own projections

**Figure 2.32. Projected consumption-adjusted total dependency ratio in Ukraine, net migration sensitivity**




Source: own projections

Consumption-adjusted total dependency ratios for different migration scenarios are presented in Figure 2.32. Higher migration reduces dependency owing to the age-structure of migrants. However, even a significant increase in migration does not lead to a considerable decrease in dependency.

### *2.3.4.2. Population projections for macroeconomic simulations*

In addition to the scenarios described in the previous sections, two more scenarios were created based on the fertility and mortality assumptions of the Institute for Demography. These projections are used in later chapters as an input. In Chapter 3, they are used to calculate future age-earnings profile, and in Chapter 4 they provide demographic scenarios for CGE simulations of the impact of population ageing on the Ukrainian economy.

The first scenario combines fertility and mortality assumptions, which leads to the highest dependency – low fertility and high life expectancy. The second scenario combines high fertility and low life expectancy, which leads to the lowest dependency. Both scenarios assume zero net migration. It has been discussed above that migration assumptions are the least reliable. It is especially difficult to project migrations flows in transition countries like Ukraine, which is still in the process of looking for its place on the European map of migration flows. Another factor supporting zero migration assumption is the most recent migration history, when the number of emigrants and immigrants was approximately equal. These two scenarios provide a useful range of variation in potential dependency level for Ukraine.

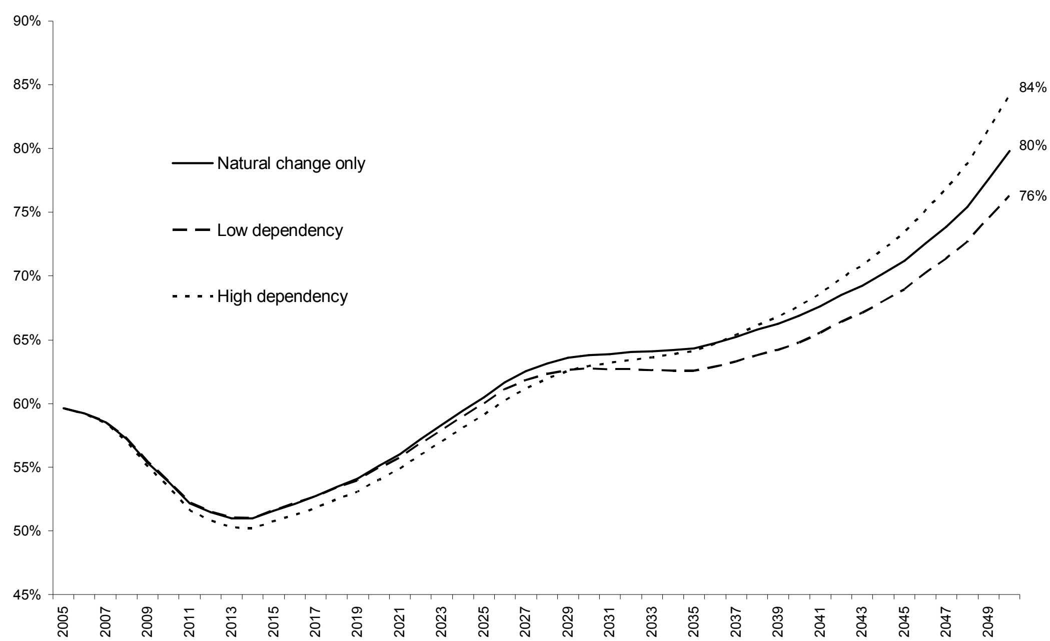
As expected, both scenarios result in noticeable population decline and population ageing. The projected demographic changes are presented in Table 2.6. The most noticeable difference between these three scenarios is in the projected size of the population aged 65 and above. In two out of three scenarios, it increases, and in one scenario it decreases. All other population groups decline during the projection period, according to all three scenarios.

The consumption-adjusted dependency ratios presented in Figure 2.33 are increasing in these three scenarios. What should be noted is that the high dependency scenario during the first 24 years of projections results in lower total dependency. This happens because of the lower fertility assumption. In the longer term, however, this scenario leads to the highest dependency. By 2050, the high dependency scenario has a total dependency ratio 4 percentage points higher and low dependency 4 percentage points lower than the baseline scenario (80%).

**Table 2.6. Changes in selected population groups, different dependency scenarios**

| Scenario | | Natural change only | Low dependency | High dependency |
|---|---|---|---|---|
| Population 0-19 | 2005 | 10689 | 10689 | 10689 |
| | 2050 | 5936 | 7353 | 4423 |
| | % Δ | -44% | -31% | -59% |
| | | | | |
| Population 20-64 | 2005 | 28904 | 28904 | 28904 |
| | 2050 | 18853 | 18811 | 18150 |
| | % Δ | -35% | -35% | -37% |
| | | | | |
| Population 65+ | 2005 | 7507 | 7507 | 7507 |
| | 2050 | 8483 | 7129 | 9525 |
| | % Δ | 13% | -5% | 27% |
| | | | | |
| Total population | 2005 | 47100 | 47100 | 47100 |
| | 2050 | 33273 | 33293 | 32098 |
| | % Δ | -29% | -29% | -32% |

**Figure 2.33. Projected consumption-adjusted total dependency ratio in Ukraine, different dependency scenarios**




Source: own projections

The difference in the resulting total population and total dependency between these scenarios is not very large. However, they result in a very different age structure and have different consequences for the longer term. Figure 2.34 presents the age-sex structure of the Ukrainian population in 2050, according to high and low dependency scenarios. The low dependency scenario results in almost uniform age structure, while the high dependency scenario leads to an age structure that is skewed to older ages.

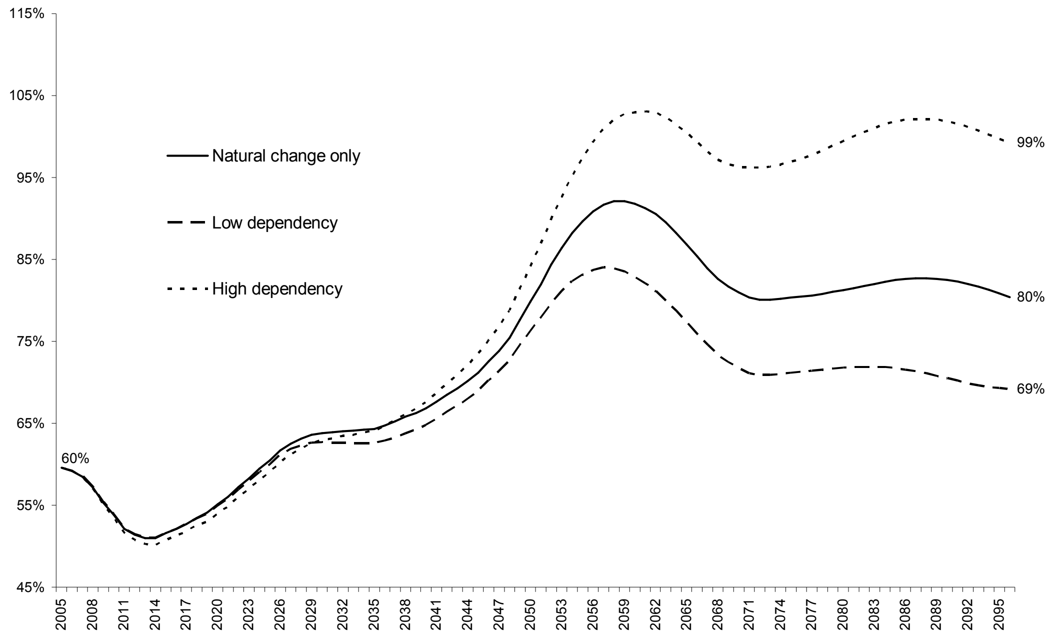
**Figure 2.34. Age-sex structure of the Ukrainian population in 2050, different dependency scenarios**


Source: own projections

To identify a very long-term effect of these processes, these three population projections were extended for another 45 years under the assumption that fertility and mortality will remain constant after 2050. If fertility and mortality do not change for a sufficiently long period of time (life time of one generation) and migration is equal to zero, a population reaches the so-called stable population, when shares of all age groups stabilize and their respective growth rates become equal to the growth rate of the total population. In our extended projections, Ukraine almost reaches stable population. The results of these projections, summarised by consumption-adjusted total dependency ratios, are presented in Figure 2.35.

Dependency ratios almost stabilize by the end of projection period; however, depending on the scenario, they stabilize at different levels. In the high dependency scenario, the long-term total dependency ratio is about 100%, in the low dependency scenario about 70% and in baseline scenario about 80%. Also, this graph shows that, according to all scenarios, the most difficult period will be between 2045 and 2070, when dependency will increase the most, reaching its maximum around 2055-2060.

**Figure 2.35. Projected consumption-adjusted total dependency ratio in Ukraine, different dependency scenarios**




Source: own projections

### *2.3.4.3. Discussion*

All the population projection scenarios presented above forecast significant demographic changes for Ukraine during the first half of the 21st century. Many reasons behind this process are already in the past and thus out of our control. The major reason for the projected sharp population decline is the low fertility that Ukraine experienced in the second half of the 20th century, and the especially low fertility of the past 20 years. The level of fertility has a very long-term effect on the demographic processes, because it determines not only the growth of the population in this generation, but also the number of potential mothers in future generations.

Of two organizations whose projections were discussed above, the Institute for Demography bases its assumptions on a more rigorous analysis, while the UN Population Division uses a more mechanistic approach suitable for larger scale projections and comparative work. However, notwithstanding the differences in the approach to formulating assumptions, the medium scenarios of these two organizations are very similar. The major difference is in the migration assumptions. Here the Institute for Demography is much more optimistic and UN migration assumption better correspond to the Institute for Demography low migration assumption. Such a large discrepancy again demonstrates that migration is the most difficult to forecast.

The consumption-adjusted total dependency ratio is projected to increase in all population scenarios. In 2005, this parameter was equal to 60%. By 2050, it is projected to increase from 67% to 90%, depending on scenario. The lowest dependency increase is in scenarios that assume low fertility and low life expectancy. However, these scenarios lead to the fastest decline in population, and low life expectancy testifies about continued degradations of the Ukrainian population and no improvements in the quality of life. At the same time, low fertility has only a short-term beneficial effect on dependency, because when small new cohorts enter the working age, the dependency ratios will rapidly change. This process is noticeable at the end of the projection period, when dependency ratios in scenarios with low fertility start to increase faster than in other scenarios.

Many other European countries are experiencing demographic changes leading to population ageing and potential population decline. One possible strategic response to such a situation is to attract migrants. Many developed countries rely on migration as a major factor preventing population decline and rapid population ageing. With respect to the Ukrainian situation, this solution is problematic for two reasons. First, Ukraine is less attractive as a destination country for migrants compared with developed economies, especially taking into account its geographical position between the EU and Russia. Besides economic conditions, the language barrier presents significant difficulty for long-distance migrants. Second, as the sensitivity analysis of different migration levels showed, even a very large increase in migration has a relatively small impact on demographic trends. For negative tendencies to be reversed, the flow of migrants to Ukraine has to be exceptionally high. At least at the moment there are no reasons to expect that Ukraine will be able to change its migration outlook significantly.

High dependency and low dependency scenarios will not result in drastically different population size and total dependency by 2050. However, the population age structure in 2050 is very different, according to these two scenarios. If population projections are extended until the end of the century, when the population structure will have almost stabilized, these two scenarios result in very different long-term dependency ratios. Also, long-term projections suggest that the ageing of the population is not a permanent but a transitory process, and it will reach its peak around 2060.

Overall, the analysis of population projections reveals a very difficult situation. Urgent measures addressing the declining labour force and population are required, and policy makers should put this issue at the top of their agendas.

### 2.4. Summary

Analysis of Ukrainian demographic trends has shown that this country is unique in many respects. It experienced a long period of turmoil connected with the two world wars and Soviet repressions in the first half of the 20th century. These events left marks on its population and still influence its demographic processes.

Over the past 20 years, Ukraine has experienced very low fertility. This is the most important factor behind the process of population ageing. Unlike in developed countries, where increasing longevity plays important role in population ageing, Ukraine has not shown any improvement in life expectancy since the mid-1960s. However, the decline in fertility was so significant that it alone is enough to produce significant change in age structure of the Ukrainian population. The future trends in fertility, among other things, will depend on the process of fertility postponement. Based on the limited data available on this issue, it seems likely that the process of postponement has just started. If it continues as in other European countries, then before the fertility schedule transformation is completed, there is no reason to expect a significant increase in the fertility level.

Low life expectancy and a large gender gap in Ukraine are largely explained by the exceptionally high mortality rates of working age males. This has a significant negative economic impact, as the most productive age group suffers the most. A simple analysis of mortality by cause of death suggests that a potential explanation for this trend could be excessive alcohol consumption. The coefficient of the correlation between the mortality rate from accidental poisoning by alcohol and male life expectancy is 95%. However, alcohol consumption is just one side of the multidimensional process that includes unhealthy life style, high levels of violence, risky behaviour and other factors, all of which contribute to the high mortality rates in this group.

All population projection scenarios of the UN Population Division and the Institute for Demography at the Academy of Science of Ukraine assume that life expectancy will increase during the next 45 years. This, together with sub-replacement fertility, will result in rapid population ageing. Many developed countries rely on the flow of migrants to combat these negative processes. However, at the moment Ukraine does not have a migration policy that would address this issue. A major inflow of migrants was experienced after the collapse of the USSR when people with Ukrainian background living in other parts of the Soviet Union returned to Ukraine. However, this was a one-time event. In the future, if Ukraine decides to attract more migrants, it will have to look further afield (outside of the former Soviet Union). This can be problematic for a number of reasons, such as language barriers, lower economic attractiveness compared with neighbouring countries and resentment of population unprepared for large scale immigration. At the same time, a sensitivity analysis of population projections with respect to migration scenarios showed that even a large – by Ukrainian standards – increase in net migration will not reverse but may slow it down the population decline and population ageing.

All the population projections discussed in this chapter forecast population decline and population ageing. To summarize the level of economic dependency, consumption-adjusted total dependency ratios were calculated for all scenarios. The difference of this measure is that it gives higher weight to the number of old-age dependents, compared with the number of young-age ones on the basis of their higher consumption needs. On this measure, by 2050 dependency will have increased from the current level of 60% to 67%-90%, depending on the projection scenario. A sensitivity analysis of fertility and mortality assumptions showed that life expectancy assumptions influence this parameter more during this time period.

Two combination scenarios that result in high dependency (high life expectancy and low fertility) and low dependency (low life expectancy and high fertility) were extended until the end of the century under the assumption that fertility and mortality rates will not change after 2050. During this period, the population of Ukraine will almost reach stable state. It has been shown that, depending on the scenario, the stabilized level of dependency will be very different: 100% in the case of the high dependency scenario and 70% in the case of the low dependency scenario.

# Chapter 3. Impact of Population Ageing on Earnings Structure in Ukraine

## 3.1. Introduction

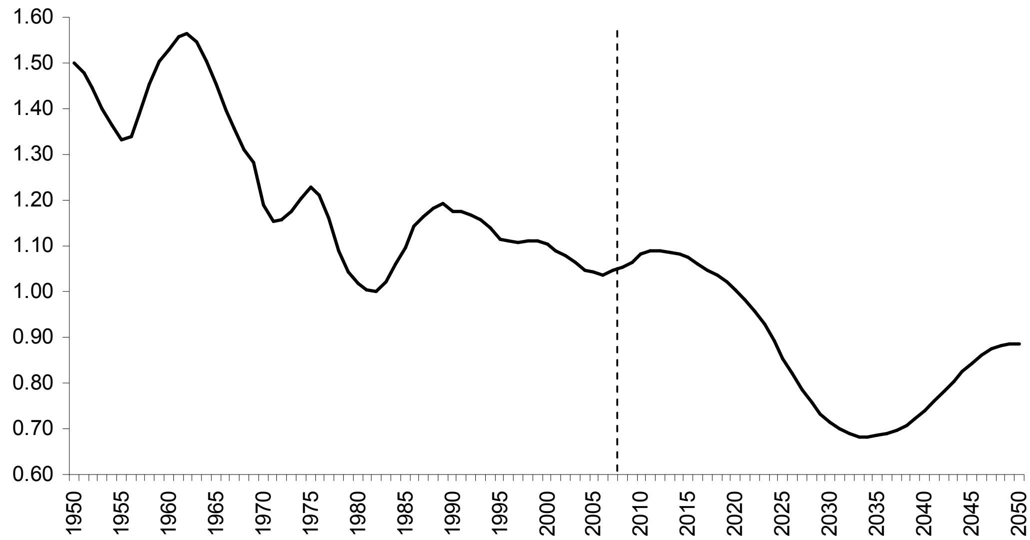
Like most of the European countries, Ukraine is experiencing population ageing, i.e. an increasing proportion of elderly generations in the age distribution of the population. The share of population aged 60+ in Ukraine has increased 2.2 times over the past 50 years and, according to the baseline projections presented in Chapter 2, is going to increase by 67% over the next 45 years, reaching the level of 35% of total population. At the same time, during the next 50 years, the size of the working age population (aged 20-59) will shrink by 41%.

This age structure shift will have a major impact on the supply and demand of labour. Not only will the total size of labour force change but also its age composition. These changes could have different effects on different age groups, leaving some of them at a disadvantage.

Population ageing not only affects general structure of the total population but also brings changes to the structure of the working age population – increasing the share of older workers and decreasing the share of younger workers. One of the statistics that summarize changes in age structure of the working age population is the relative cohort size index (here calculated as the ratio of population aged 20-39 to population aged 40-59). It is presented in Figure 3.1. As the figure shows, according to the baseline population projections, Ukraine is to experience a significant increase in the share of the older age workers in the total working age population.

If older (more experienced) and younger (less experienced) workers are not perfect substitutes and perform different tasks, then population ageing leads to a big change in relative supply, which will have an impact on relative earnings. The lower the substitutability, the greater the change in relative earnings which will result from a given change in relative supply.

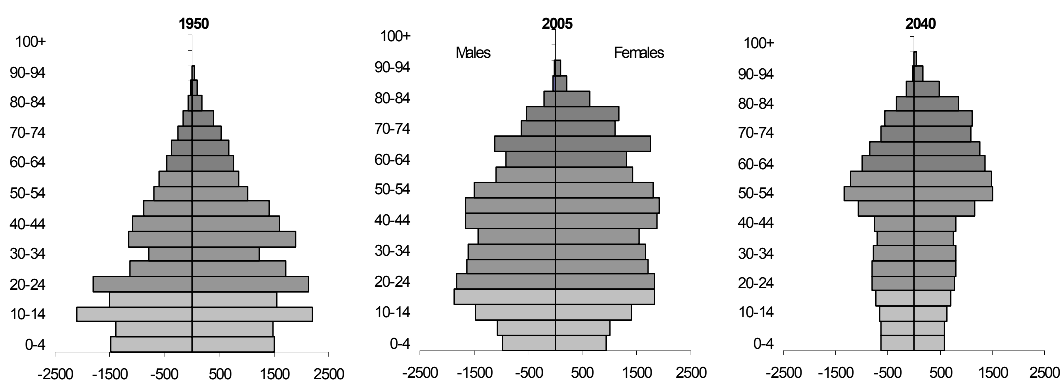
**Figure 3.1. Relative cohort size (N 20-39/N 40-59), 1950-2050**




Source: State Statistics Committee of Ukraine, own projections and calculations

Figure 3.2 shows the changes that have occurred in the age distribution of the Ukrainian population over the past 55 years, and that will happen in the future. As one can see, Ukraine is forecasted to move from the "normal" age structure with a relatively large number of inexperienced workers and a smaller number of experienced ones to the reverse situation with a large number of experienced workers and an insufficient number of inexperienced ones to assist them. It should also be noted that the total size of the labour force population is falling.

**Figure 3.2. Evolution of the age structure Ukrainian population, thousands**




Source: UN population division

Using an estimated age-earnings equation, this chapter tests the hypothesis that cohort size affects the earnings of Ukrainian workers. More specifically, owing to the process of population ageing which causes changes to the age structure of the working age population, we will observe a flattening of the age-earnings profile in the future (decrease of the relative earnings of the older workers).

There is extensive literature studying the impact of cohort size on earnings in the developed countries. Original interest in this topic was sparked by unusually large cohorts of baby boomers. Two pioneering papers on US baby boomers by Freeman (1976) and Welch (1979) showed that members of unusually large cohorts suffer from depressed earnings in the early stages of their career. Later, the same approach was used to study the effect of cohort size on earnings in other developed countries (Dooley, 1986 examines Canada; Dahlberg, *et al.,* 2003 examine Sweden; Riboud, 1988 examines France; Ermisch, 1988 and Wright, 1991 examine the case of UK).

Although the effect of cohort size on earnings has been studied extensively in developed countries (especially North America), none of the research has been done for transition countries. Transition economies could be of special interest as they are still reforming their highly regulated labour markets. Some researchers have suggested that cohort size has a noticeable effect on wages in economies with relatively flexible labour markets. If the labour market is rigid and over-regulated, then wages cannot be adjusted sufficiently to compensate for different cohort size. In this case, cohort size has a stronger impact on age-specific unemployment rates (for evidence on the effect of cohort size on employment (unemployment) rates see OECD (1980), Bloom *et al.* (1988)). The unavailability of age specific employment data for Ukraine prevents one from studying the impact of cohort size on employment prospects. However, the significant impact of cohort size on earnings found by this research suggests that the Ukrainian labour market is sufficiently liberalized and flexible to allow for wage adjustment.

The effect of cohort size on earnings estimated in this chapter is much larger than in previous studies for developed countries. It is possible that the reason for this lies in different model specification. Traditionally, two cohort size variables are included in the model: cohort size index and its interaction with age. The first one shows the direct effect of cohort size and the second one shows how this effect changes over time. In addition to these two variables, the current research includes the interaction of the cohort size index with age squared. This quadratic interaction shows whether the speed of the adjustment of the cohort size effect accelerates or decelerates with age. It is possible that in previous research the effect of cohort size on earning is underestimated, owing to the omission of this quadratic interaction with age.

This research also takes into account the so-called “vintage” effect, which is typical for transition countries. In this case, “vintage” effect refers to the situation when earnings of every consecutive cohort are larger then those of previous cohorts. This leads to age-earnings profiles that peak at a very early age if the vintage effect is not taken into account. This effect is explained by the mismatch between the human capital accumulated by workers during the planned economy and human capital required in a reformed market economy. For discussion of this effect and estimation for the case of Russia, see Borisov (2007).

Unlike most European countries, Ukraine did not experience a baby boom after WWII. On the contrary, cohorts that were born between 1960 and 1985 are of similar size. But owing to the significant decline in fertility after 1986, in the very near future Ukraine will see very small cohorts entering its labour market. Small cohorts of Ukrainian “baby busters” might have a significant effect on the structure of Ukrainian wages. In particular, they might lead to depressed wages of older workers and general flattening of the age-earnings profile.

This work makes several contributions to the cohort crowding literature. First, it expands the applicability of the major finding that cohort size has a negative effect on earnings. This research expands validity geographically – providing evidence for a transition country in Eastern Europe and one of the post-Soviet republics – and demographically – providing evidence not linked to the labour market outcomes of baby boomers. Second, it modifies model to include quadratic interaction of cohort size with age potentially important for results. Third, it uses technical advances in the estimation technique, some of which were not available before, like sampling weights, robust standard errors and cluster-robust technique of simultaneous models estimation. Finally, it combines the obtained results with population projections to estimate potential future age-earnings profiles.

What happens to the earnings of older workers and age-earnings profiles in general as the population ages has potential implications for public policy. First, the shape of the age-earnings profile could have a major effect on decisions about human capital accumulation (if return on experience is expected to fall). Second, many researchers suggest that increasing the labour force participation of older people (as well as increasing the pension age) could provide a solution to the dilemma of a shrinking labour force and growing demands of a rapidly ageing society. Continued work may be less desirable if the relative wages of older workers fall.

The rest of the paper is organized as follows. Section 3.2 presents a review of relevant literature. Section 3.3 provides an overview of the methodology and data. Section 3.4 describes the results. Section 3.5 concludes the discussion.

### 3.2. Previous Research

There is extensive literature dedicated to the issue of the relationship between cohort size and earnings in developed countries. Most of the research was conducted for the United States; however, there are several studies concentrating on other developed countries (Dooley (1986) examines Canada, Dahlberg and Nahum (2003) examine Sweden, Riboud (1988) examines France, Ermisch (1988) and Wright (1991) examine the case of the UK).

The research devoted to this issue provides abundant evidence supporting the idea that the members of larger than average cohorts have lower earnings at the beginnings of their careers (Alsalam, 1985; Dooley, 1986; Easterlin, 1980; Ermisch, 1988; Freeman, 1976; Welch, 1979; Wright 1991). However, there is no consensus regarding the persistence of the effect. Most researchers argue that effect vanishes over time, while others find confirmation that it persists throughout the career, and earnings of large cohorts never reach a "normal" level (Berger, 1985).

Two pioneering studies in the late 1970s by Freeman (1976) and Welch (1979) were the first to explore the effect of cohort size on earnings in the US. Both of them were interested in the effect of the unusually large cohort of US baby boomers on wage structure. They used different approaches to estimate this effect.

Freeman (1976) used the relative wage of older to younger workers as a dependent variable, and the ratio of the number of older and younger workers as an independent demographic variable. He showed that the relative wage of males is negatively related to the relative cohort size. The effect is stronger for college graduates. He also found that negative effect becomes stronger with age. The same analysis performed for females provides little evidence of relationship between relative wage and relative cohort size. Freeman (1976) explained this by the higher substitutability between older and younger female workers owing to a frequently interrupted career path.

Welch (1979) used the logarithm of weekly earnings as a dependent variable, and cohort size measure and its interaction with early career spline as independent demographic variables. He showed empirically that individuals from large cohorts experience lower earnings at labour market entry compared with those from small cohorts. At the same time, the growth rate of earnings in the former group is higher than in the latter, meaning that after a few years the negative effect of cohort size disappears. In this study, he also proposed a "two career phases" framework. Welch pointed out that it is useful to divide the career into two phases: the "learning phase" and the "experienced phase". When an inexperienced individual enters the labour force, s/he assists more experienced workers, gaining experience in the process. The two types of workers could be seen as complements (rather than substitutes). Thus, changes in their relative supply should have an impact on their relative earnings.

Wright (1991) adopting Welch (1979) approach examined the effect of cohort size on earnings of males from different education level groups in Great Britain. He built his analysis on data covering the period from 1973 to 1982 which includes the period when baby boomers entered the labour force. As a result of an estimation of an earnings equation, he found that, indeed, younger workers born in large cohorts face lower earnings, and the effect is larger, the higher the level of qualification of the group (in fact, the effect of cohort size is not significant for the group with no qualification). However, Wright also showed that individuals from large cohorts tend to have a higher growth rate of earnings compared with those born into small cohorts.

In contrast to Welch and other scholars who claim that the negative effect diminishes as cohort ages, Berger (1985) empirically showed that cohort size not only affects earnings at entry but also reduces earnings growth. Using almost the same data as Welch (1979) but a somewhat less restrictive model with separate earnings equations for younger and older workers, the author showed that the negative effect appears to worsen with experience, and earnings of individuals from large cohorts never reach the level of earnings of those born into average cohorts.

There is at least one study which, while reporting a significant cohort effect on earnings, found a positive relationship between these two variables. Dahlberg and Nahum (2003) studied the Swedish baby boom generation using longitudinal panel data for the period of thirty years. They found that large cohorts have a higher overall earnings level than small cohorts, and that cohorts born in an upswing of a demographic cycle have a higher earnings compared with cohorts born in a downswing. They propose several explanations of this finding, one of which is an aggregate demand (and correspondingly labour demand) effect of cohort size. However, they admit that it is very difficult to distinguish between the demand and supply effects of cohort size, and do not provide evidence supporting this explanation.

There is another line of literature that examines the effect of cohort size on employment (unemployment rates). The argument is that if market is not sufficiently flexible, wages do not adjust sufficiently to compensate for cohort size. In this case, cohort size has a significant effect on employment prospects. For evidence on the effect of cohort size on employment prospects, see Ahlburg (1982), Russell (1982), OECD (1980) and Bloom *et al.* (1988).

## 3.3. Methodology

### *3.3.1. Theoretical background*

In a standard earnings model cohort size will not influence earnings only if all workers, regardless of experience, are perfect substitutes. In this case, the relative size of different groups does not matter, and the shape of age-earnings profile is the result of physical ageing. However, if the age-earnings profile is the result of learning and depreciation, then workers do different things at different stages of their careers. This means that the number of people doing specific thing should determine its value, and cohort size matters.

Following Welch (1979), it is assumed here that an individual's working life is divided into two phases – a "learning phase" and an "experience phase". When a person enters the labour market, s/he spends a large portion of her/his time in learning activities, thus gaining necessary experience. During this time period, a younger worker serves as a complement to a more experienced older worker – the former assists the latter. The productivity of both workers is interrelated; if there are more young workers to assist older ones, the productivity of the older workers increases and the productivity of the younger workers decreases. Similarly, if there are fewer inexperienced workers relative to experienced ones, the productivity of the former group increases. Assuming that earnings are a positive function of productivity, one can expect that changes in the relative supply of different types of workers should have an effect on their relative earnings.

### *3.3.2. Empirical model*

A standard quadratic age-aggregated earnings equation with added demographic controls is employed. The exact specification is as follows:

$$\begin{aligned} LnE_{it}^{s} &= \alpha_0^s + \beta_1^s age_{it} + \beta_2^s age_{it}^2 + \gamma_1^s CS_{it} + \gamma_2^s CS_{it} age_{it} + \gamma_3^s CS_{it} age_{it}^2 \\ &+ \alpha_1^s D_t + \alpha_2^s u_t + \alpha_3^s yearborn_i + \varepsilon_{it}^s \end{aligned} \qquad (3.1)$$

where

$E_{it}$ – mean of average yearly earnings of age group $i$ in year $t$;

$age_i$ – normalized working age (0-41 corresponding to real age 18-59);

$CS_{it}$ – cohort size index of age group $i$ in year $t$;

$D_t$ – year dummies;

$u_t$ – level of unemployment in year $t$;

$yearborn_i$ – normalized year of birth of age group $i$ (0-45 corresponding to 1940-1985).

$s$=1,3 – subscript showing level of qualification, 1 being the highest

The data for estimation comes from the Ukrainian Household Budget Survey (UHBS). One of the limitations of the UHBS is that it does not have data on hours worked. Thus, it is impossible to calculate the average hourly wage or even distinguish between full-time and part-time workers.

Age is used as a proxy for experience, because although the survey includes the question for number of years of working experience, it contains many missing observations. Thus, here it is assumed that age is linearly correlated with working experience. Age is included in a quadratic form to reflect the fact that earnings tend to increase with age but at a diminishing rate.

Cohort size index is calculated as a logarithm of a 5-year weighted moving average of age group $i$'s relative share of the potential size of labour force (males aged 18-59) in year $t$.

$$CS_{it} = \ln \frac{\sum_i (1/9N_{i\pm 2t} + 2/9N_{i\pm 1t} + 3/9N_{it})}{\sum_{i=18}^{59} N_{it}} \qquad (3.2)$$

where $N_{it}$ – is number of males aged $i$ in year $t$

V-shaped weights are used to show that more distant cohorts have smaller effects on one's labour market success. It is the same cohort size measure as the one used by Wright (1991). Other authors (i.e., Welch (1979), Berger (1985)) use a different approach. Their cohort size index is calculated separately for each level of qualification and shows the share of males aged $i$ with a specific qualification level in the total number of working age males with this qualification level. In other words, the numerator and denominator of the cohort size index are qualification-level specific. This cohort size measure could be endogenous and lead to inconsistent OLS estimates if level of qualification depends on cohort size. This seems likely if further education institutions have limited capacity and the highest qualification is the most desired one.

This equation is estimated separately for three educational groups (described in the next section). It is expected that workers with lower qualifications should have higher substitutability between groups with different experience levels than workers with higher qualification, because the learning curve in the occupations requiring higher qualification is steeper and it takes longer to reach the "experience phase" of a career. Accordingly, cohort size should have a higher impact on earnings of workers with higher qualifications.

If cohort size does not affect earnings, estimates of $\gamma_1$, $\gamma_2$ and $\gamma_3$ should be equal to zero. If cohort size does affect earnings, then $\gamma_1$ demonstrates the direct effect of cohort size (positive or negative), $\gamma_2$ shows how this effect changes over the working career (gets stronger or weaker) and $\gamma_3$ shows whether this change accelerates or slows down with age. Year dummies and level of unemployment are included to control for year-specific conditions.

Year of birth is included to take into account the so-called "vintage" effect. It has been established by previous research that in transition countries older workers who received an education and work experience during the planned economy period, have lower wages. This effect is explained by the mismatch between the accumulated "planned economy human capital" and the required "market economy" one. For discussion of this effect in Russia, see Borisov (2007).

### *3.3.3. Data description*

The Ukrainian Household Budget Survey is a primary source of data. The data for the seven years from 1999 to 2005 are used. The survey is conducted quarterly, but here annual data collected in the fourth quarter are used. The sample consists of more than 10,000 households, covering more than 25,000 individuals. The survey is constructed to be representative of the Ukrainian population. Participants of the survey change from year to year, so it is not panel data. A pooled cross-section of seven waves is used.

In 2002, the coding of education variable was changed and in 2003 the coding of socio-economic status. The old coding was mapped to match the new one in the waves preceding change. This could have an impact on the quality of the data. After the re-coding the sample structure in adjacent years was checked for consistency.

The analysis is restricted to males to avoid problems with discontinuity in female labour force participation which is standard in this literature (Welch, 1979; Berger, 1985; Wright, 1991). Only individuals aged 18-59 are included in the analysis, as most of the economically active population is concentrated in this group, and also in order to avoid problems with factors determining retirement decisions (60 is the official male retirement age in Ukraine). Data were further restricted to include only individuals whose socio-economic status in a given year is reported as "employee" and who provided data on their earnings.

The remaining observations are divided into three educational levels:

1. "high qualification" – individuals with higher education (institute, university)
2. "medium qualification" – individuals who have completed secondary education (college);
3. "low qualification" – individuals that have basic school education or those who acquired training in a vocational school;

The education structure of the resulting sample is presented in Table 3.1.

**Table 3.1. Sample education structure**

| | **Qualification level** | | | |
|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **Total** |
| **1999** | 781 | 1,120 | 1,971 | 3,872 |
| **2000** | 837 | 989 | 1,988 | 3,814 |
| **2001** | 730 | 929 | 2,064 | 3,723 |
| **2002** | 726 | 913 | 2,063 | 3,702 |
| **2003** | 834 | 779 | 2,192 | 3,805 |
| **2004** | 924 | 819 | 2,347 | 4,090 |
| **2005** | 936 | 847 | 2,555 | 4,338 |
| | | | **Total** | 27,344 |

Individual-level earnings are aggregated into means on the base of age, year of observation and qualification level. For early ages (18-22) in medium and high qualification groups in some years, there are no or very few observations. This is easy to explain: the age at which one's working career starts depends on the level of qualification s/he has chosen to acquire. For that reason, the grouped observations that were obtained from fewer than three individual observations were also excluded. Thus, there is a different number of age groups for different qualification levels. For high qualification, there are up to 39 age groups (21-59), for medium qualification up to 41 age groups (19-59), and for low qualification 42 age groups (18-59). The resulting number of observations is 269 for the high qualification group, 282 for the medium qualification group and 294 for the low qualification group. Table 3.2 provides summary statistics of key variables in the aggregated sample.

**Table 3.2. Summary statistics of selected variables**

| | Qualification level | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Log of earnings[1] | 8.07 (0.41) | 7.78 (0.46) | 7.59 (0.43) |
| Age | 40.28 (11.12) | 39.35 (11.65) | 38.50 (12.14) |
| CS | -3.77 (0.19) | -3.76 (0.19) | -3.75 (0.19) |
| No. of observations | 269 | 282 | 294 |

Note: standard errors are reported in brackets
[1] logarithm of deflated yearly earnings from, primary employment

### *3.3.4. Estimation technique*

The UHBS data set contains survey design weights. They are aimed at making the sample representative of the Ukrainian population in a given year. These weights are used in sample aggregation. The mean yearly wage by qualification level, year of observation and age group is calculated as weighted average.

To correct for heteroskedasticity accompanying grouped data, OLS with robust standard errors is used. These standard errors are asymptotically valid in the presence of any kind of heteroskedasticity and suitable for a standard inference procedure. The aggregated data are pooled into the pseudo panel. To account for this, and for the fact that observations representing the same cohort in different periods are not independent of each other, a clustered estimation procedure is used. The grouped observations are clustered by the same year of birth.

In order to test cross-equation restrictions, the Stata command *suest* is used. This command uses the "cluster-robust" approach to construct a variance-covariance matrix for a system of equations. The *suest* command can be applied to *n* equations with *M* observations, each corresponding to *M* clusters. In our case *n*=3 (level of qualification) and *M*=294 (number of observations in individual equation). The intuition behind *suest* is that it clusters by observational unit across equations; in our case, the observational unit is average earnings of males aged *i* in year *t*. As a result, *suest* generates a variance-covariance matrix that is robust to arbitrary cross-equation correlation.

### 3.4. Results

At the beginning equation 3.1 is estimated in different variants for all qualification levels but without cohort size variables. The results are presented in Table 3.3. In the first panel, only year dummies are included as period controls. In the second panel, the level of unemployment is also included and one year dummy is dropped to avoid dependency. In the third panel, year of birth is added (and another dummy variable is dropped).

**Table 3.3. Parameter estimates of the earnings equation without cohort size effects**

| | 1 | | | 2 | | | 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | High | Medium | Low | High | Medium | Low | High | Medium | Low |
| Age | 0.055*** (0.007) | 0.044*** (0.006) | 0.049*** (0.004) | 0.055*** (0.007) | 0.044*** (0.006) | 0.049*** (0.004) | 0.135*** (0.040) | 0.131** (0.049) | 0.126*** (0.031) |
| Age2 | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) |
| 2000 | 0.075* (0.041) | 0.178*** (0.057) | 0.069** (0.029) | -0.008 (0.038) | 0.082 (0.054) | -0.021 (0.027) | -0.048 (0.040) | -0.039 (0.057) | -0.059** (0.026) |
| 2001 | 0.346*** (0.055) | 0.424*** (0.055) | 0.312*** (0.035) | 0.113** (0.051) | 0.160*** (0.050) | 0.061* (0.032) | 0.063 (0.052) | 0.106** (0.049) | 0.013 (0.029) |
| 2002 | 0.515*** (0.047) | 0.629*** (0.054) | 0.569*** (0.035) | 0.007 (0.038) | 0.054 (0.044) | 0.021 (0.027) | 0.007 (0.038) | 0.054 (0.044) | 0.021 (0.027) |
| 2003 | 0.674*** (0.048) | 0.820*** (0.054) | 0.686*** (0.040) | 0.060 (0.039) | 0.126*** 0.046) | 0.024 (0.032) | 0.030 (0.032) | 0.093** (0.036) | -0.004 (0.029) |
| 2004 | 0.780*** (0.037) | 0.879*** (0.048) | 0.833*** (0.035) | 0.059* (0.030) | 0.064* (0.037) | 0.057** (0.023) | | | |
| 2005 | 1.017*** (0.048) | 1.150*** (0.049) | 1.095*** (0.033) | | | | | | |
| u | | | | -0.211*** (0.010) | -0.239*** (0.010) | -0.228*** (0.006) | -0.112** (0.054) | -0.131** (0.063) | -0.132*** (0.038) |
| yearborn | | | | | | | 0.079* (0.040) | 0.086* (0.049) | 0.076** (0.031) |
| const | 7.097*** (.083) | 6.855*** (0.070) | 6.693*** (0.044) | 9.639*** (0.112) | 9.730*** (0.115) | 9.432*** (0.072) | 5.167** (2.303) | 4.879* (2.802) | 5.152*** (1.739) |
| $R^2$ | 0.779 | 0.768 | 0.882 | 0.776 | 0.768 | 0.882 | 0.779 | 0.768 | 0.882 |
| N | 269 | 282 | 294 | 269 | 282 | 294 | 269 | 282 | 294 |

Note: standard errors are reported in brackets
***- significant at 1% level; **- significant at 5% level; *- significant at 10% level

As expected, the estimates show that earnings increase with age at a decreasing rate (positive age and negative age2 coefficients). In the first two panels, when we do not account for the vintage effect, for all levels of qualification maximum earnings are reached in the middle of the working career at age 40 to 46 (depending on qualification level). This means that at the end of working career earnings start to decrease with age. In developed countries, the age of maximum earnings tends to be much later. However, if year of birth is added, the age effect changes significantly and in this case maximum age effect is reached outside of the normal working career duration; i.e. during the working career, the effect of age is always positive. Thus, this analysis shows the significance of the vintage effect in Ukraine.

**Table 3.4. Parameter estimates of the earnings equation with cohort size effects**

| | 1 | | | 2 | | | 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | High | Medium | Low | High | Medium | Low | High | Medium | Low |
| Age | 0.738*** (0.238) | 0.949*** (0.252) | 0.842*** (0.145) | 0.738*** (0.238) | 0.949*** (0.252) | 0.842*** (0.145) | 0.809*** (0.229) | 1.029*** (0.246) | 0.919*** (0.150) |
| Age2 | -0.011*** (0. 003) | -0.016*** (0.004) | -0.014*** (0.002) | -0.011*** (0.003) | -0.016*** (0.004) | -0.014*** (0.002) | -0.011*** (0.003) | -0.016*** (0.004) | -0.014*** (0.002) |
| CS | -2.863*** (0.919) | -2.965*** (0.919) | -2.601*** (0.511) | -2.863*** (0.919) | -2.965*** (0.919) | -2.601*** (0.511) | -2.863*** (0.919) | -2.965*** (0.919) | -2.601*** (0.511) |
| CS*age | 0.189*** (0.065) | 0.251*** (0.070) | 0.221*** (0.040) | 0.189*** (0.065) | 0.251*** (0.070) | 0.221*** (0.040) | 0.189*** (0.065) | 0.251*** (0.070) | 0.221*** (0.040) |
| CS*age$^2$ | -0.002*** (0.001) | -0.004*** (0.001) | -0.003*** (0.001) | -0.002*** (0.001) | -0.004*** (0.001) | -0.003*** (0.001) | -0.002*** (0.001) | -0.004*** (0.001) | -0.003*** (0.001) |
| 2000 | 0.061 (0.043) | 0.164*** (0.055) | 0.063** (0.030) | -0.022 (0.040) | 0.068 (0.052) | -0.028 (0.028) | -0.057 (0.041) | -0.028 (0.056) | -0.066** (0.027) |
| 2001 | 0.331*** (0.056) | 0.414*** (0.053) | 0.309*** (0.034) | 0.101* (0.052) | 0.150*** (0.048) | 0.056* (0.029) | 0.056 (0.053) | 0.100** (0.047) | 0.008 (0.028) |
| 2002 | 0.496*** (0.048) | 0.617*** (0.055) | 0.569*** (0.036) | 0.006 (0.039) | 0.040 (0.046) | 0.017 (0.026) | 0.006 (0.039) | 0.040 (0.046) | 0.017 (0.026) |
| 2003 | 0.658*** (0.048) | 0.812*** (0.048) | 0.689*** (0.037) | 0.050 (0.039) | 0.116*** 0.043) | 0.022 (0.029) | 0.023 (0.033) | 0.085** (0.033) | -0.006 (0.027) |
| 2004 | 0.765 *** (0.038) | 0.876*** (0.045) | 0.839*** (0.037) | 0.053* (0.029) | 0.060 (0.037) | 0.058** (0.023) | | | |
| 2005 | 1.005*** (0.049) | 1.152*** (0.053) | 1.103*** (0.036) | | | | | | |
| U | | | | -0.209*** (0.010) | -0.240*** (0.011) | -0.229*** (0.007) | -0.120** (0.054) | -0.140** (0.066) | -0.133*** (0.039) |
| Yearborn | | | | | | | 0.071* (0.039) | 0.080 (0.049) | 0.077** (0.031) |
| const | -3.269 (3.329) | -3.842 (3.313) | -2.649 (1.838) | -0.755 (3.345) | -0.960 (3.334) | 0.108 (1.834) | -4.747 (3.501) | -5.447 (3.929) | -4.225* (2.490) |
| $R^2$ | 0.789 | 0.782 | 0.901 | 0.789 | 0.783 | 0.901 | 0.789 | 0.783 | 0.901 |
| N | 269 | 282 | 294 | 269 | 282 | 294 | 269 | 282 | 294 |

Note: heteroskedasticity robust standard errors are reported in brackets
***- significant at 1% level; **- significant at 5% level; *- significant at 10% level

The results with cohort size variables are reported in Table 3.4, separately for each level of qualification and for three different specifications. The same model specifications were estimated using the weighted GLS technique with weights equal to the reciprocal of the number of observations in each cell. This method was used in previous research (Wright (1991), Welch (1979), Berger (1985)). This does not change the results qualitatively. Also, if the variable aimed at controlling for a sample selection bias used by Welch (1979) is included (share of missing observations in each cell), this does not change the results.

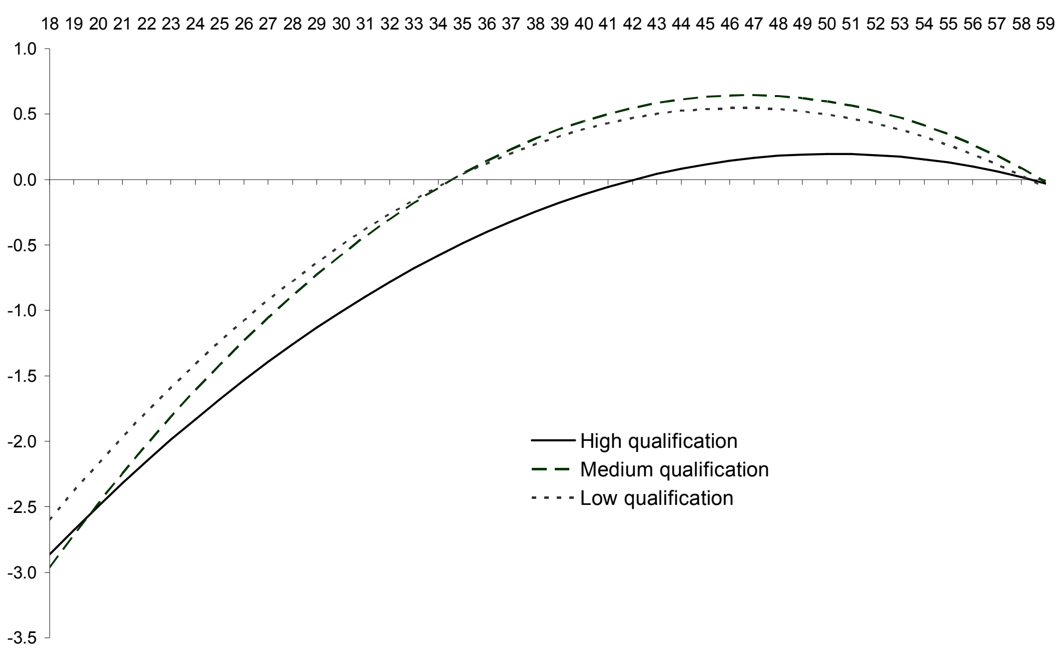
As expected, cohort size has a negative impact on earnings (negative CS coefficient) but it decreases with age (positive coefficient of CS and age interaction) at a slowing rate (negative coefficient of CS and age2 interaction). To illustrate this, Figure 3.3 shows calculated elasticity of earnings with respect to cohort size.

The earnings elasticity with respect to cohort size is

$$\partial \ln E / \partial CS = \gamma_1^s + \gamma_2^s age_{it}^s + \gamma_3^s {age_{it}^s}^2 \qquad (3.3)$$

It should be recalled that cohort size index is calculated as a natural logarithm of the moving average of relative share of the specific cohort in the total labour force.

**Figure 3.3. Cohort size effect on earnings (OLS)**



Most of the previous research also found that cohort size has the strongest negative impact on earnings at the beginning of career. However, previous research did not include an interaction of the cohort size index with age in quadratic form. This specification shows that at older ages the cohort size effect might turn negative again. However, the effect is much smaller than at early ages. The quadratic interaction might also explain why the magnitude of the cohort size effect found for Ukraine is much larger than found for other countries. For example, Wright (1991) found for Great Britain the cohort size coefficient for the high qualification group of -0.35. If the quadratic interaction term is taken out from the estimation described here, then the cohort size effect is significant only at 10% and is equal to -0.79. Thus, it is possible that omitting a quadratic interaction of age with cohort size means that the cohort size effect was previously underestimated.

As mentioned above, it was expected that the lower the level of qualification, the lower the negative effect of cohort size on earnings, because in occupations requiring higher qualifications there is a lower degree of substitutability between workers from different cohorts (e.g. younger and older workers). Figure 3.3 shows that this is roughly the case. For the higher qualification group, the negative effect of cohort size persists the longest and for lower qualification the initial negative effect is the smallest.

The difference in effects for different qualification levels is, however, rather small compared with the results from previous research. One possible explanation, which would require additional investigation, is that in post-Soviet transition countries, a higher level of qualification does not guarantee a higher qualification job. From anecdotal evidence, it is known that the cases of people with higher education working in low qualification jobs are numerous. This could potentially decrease the quality of data on the level of qualification, and make division of the sample into qualification groups less than meaningful.

To check if the difference between estimated cohort size effects for different qualification groups is statistically significant, three models for different levels of qualification were estimated jointly using Stata command *suest.* This procedure allows the testing of a cross-model hypothesis. The results of joint estimation are reported in Table 3.5. Previously, the statistical significance of difference in coefficients in different models was not tested, possibly because it was technically more difficult to implement.

**Table 3.5. Parameter estimates of the simultaneously estimated earnings equations**

| | 1 | | |
|---|---|---|---|
| | High | Medium | Low |
| Age | 0.809*** (0.224) | 1.029*** (0.241) | 0.919*** (0.147) |
| Age2 | -0.011*** (0.003) | -0.016*** (0.004) | -0.014*** (0.002) |
| CS | -2.863*** (0.899) | -2.965*** (0.900) | -2.601*** (0.502) |
| CS*age | 0.189*** (0.064) | 0.251*** (0.068) | 0.221*** (0.039) |
| CS*age$^2$ | -0.002*** (0.001) | -0.004*** (0.001) | -0.003*** (0.001) |
| 2000 | -0.057 (0.040) | 0.028 (0.055) | -0.066** (0.026) |
| 2001 | 0.056 (0.051) | 0.100** (0.046) | 0.008 (0.028) |
| 2002 | -0.006 (0.038) | 0.040*** (0.045) | 0.017 (0.025) |
| 2003 | 0.023 (0.032) | 0.085*** (0.032) | -0.006 (0.027) |
| u | -0.120** (0.052) | -0.140** (0.064) | -0.133 (0.038) |
| yearborn | 0.071* (0.039) | 0.080 (0.048) | 0.077** (0.031) |
| const | -4.747 (3.426) | -5.447 (3.850) | -4.225* (2.443) |
| N | 845 | | |

Note: heteroskedasticity robust standard errors are reported in brackets
***- significant at 1% level; **- significant at 5% level; *- significant at 10% level

**Table 3.6. Parameter estimates of the earnings equation, pooled sample**

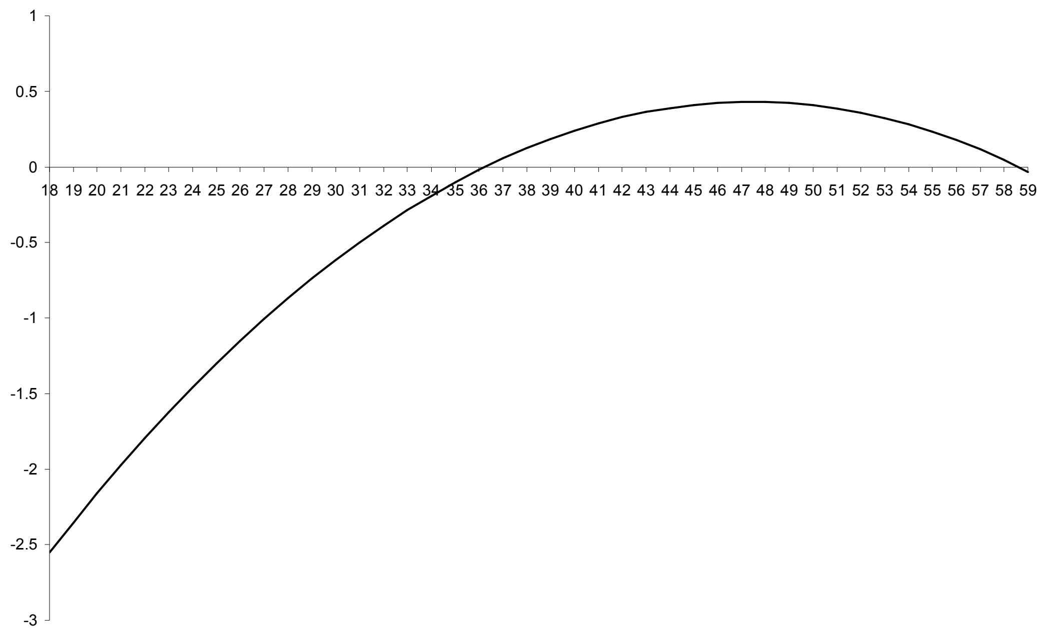
| | 1 | 2 | 3 |
|---|---|---|---|
| Age | 0. 777*** (0.118) | 0.777*** (0.118) | 0.853*** (0.113) |
| Age2 | -0. 013*** (0.002) | -0.013*** (0.002) | -0.013*** (0.002) |
| CS | -2.552*** (0. 381) | -2.552*** (0.381) | -2.552*** (0.381) |
| CS*age | 0. 202*** (0.033) | 0.202*** (0.033) | 0.202*** (0.033) |
| CS*age$^2$ | -0. 003*** (0.001) | -0.003*** (0.001) | -0.003*** (0.001) |
| 2000 | 0.097*** (0.024) | 0.007 (0.023) | -0.031 (0.022) |
| 2001 | 0.352*** (0.028) | 0.102*** (0.025) | 0.054** (0.024) |
| 2002 | -0.563*** (0. 028) | 0.019 (0.020) | 0.019 (0.020) |
| 2003 | 0.720*** (0. 023) | 0.063*** (0.020) | -0.034** (0.017) |
| 2004 | 0. 828*** (0. 022) | 0.057*** (0.017) | |
| 2005 | 1.088*** (0. 028) | | |
| Educ2 | -0.264*** (0.019) | -0.264*** (0.019) | -0.264*** (0.019) |
| Educ3 | -0.435*** (0.017) | -0.435*** (0.017) | -0.435*** (0.017) |
| u | | -0.226*** (0.006) | -0.130*** (0.031) |
| yearborn | | | 0.076*** (0.023) |
| const | -2.072 (1.370) | 0.648 (1.364) | -3.647** (1.620) |
| $R^2$ | 0.849 | 0.849 | 0.849 |
| N | 845 | 845 | 845 |

Note: heteroskedasticity robust standard errors are reported in brackets
***- significant at 1% level; **- significant at 5% level; *- significant at 10% level

The Wald test on the first five variables (the age and the cohort size effects) does not allow us to reject the hypothesis that the coefficients in all three models are the same.

For that reason, the model with the cohort size variables was re-estimated for the pooled sample. Table 3.6 reports results of this estimation for different specifications. To control for qualification, education dummies were included (reference level is high qualification). The cohort size effect on earnings from the pooled estimation is presented in Figure 3.4 (results from the panel three).

**Figure 3.4. Cohort size effect on earnings, pooled sample**

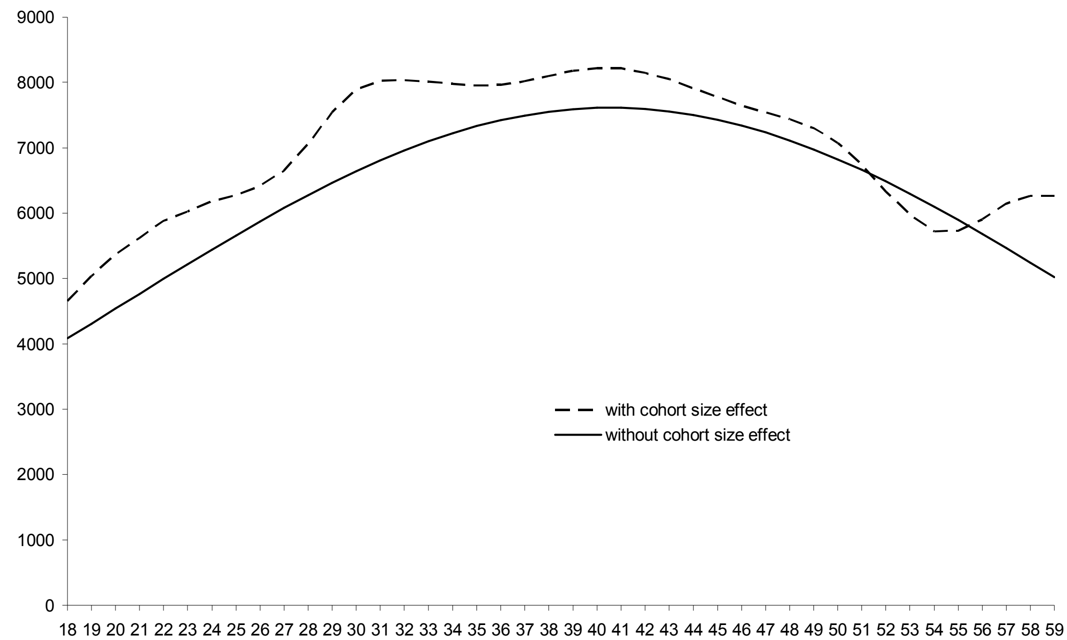



It should be noted that the cohort size index of a specific cohort can change during the lifetime. The cohort size index as calculated here reflects changes in a relative and not an absolute size of cohort. Thus over time it can change if the size of the cohorts leaving the labour force is not equal to the size of the cohorts entering the labour force, or if there is a significant difference in age-specific mortality rates.

The main question for this chapter is what implications the results obtained have for an ageing labour force. Previous research was concentrated on the earnings of baby boomers when they entered the labour force. It has been consistently shown using data for different countries that if an unusually large cohort enters the labour force, its members will suffer from lower earnings, at least at the beginning of their careers. However, cohorts that are about to enter the labour force in Ukraine are, on the contrary, unusually small and thus their earnings are going to be higher than that of the average size cohort, especially at the beginning of their career. To see how large the impact can be, the predicted age-earnings profiles for several years were calculated.

Figure 3.5 shows the predicted age-earnings profiles for 1999. The solid line shows the age-earnings profile without taking into account cohort size, and the broken line shows the predicted age-earnings profile taking into account the cohort size effect. The two lines resemble each other quite closely.

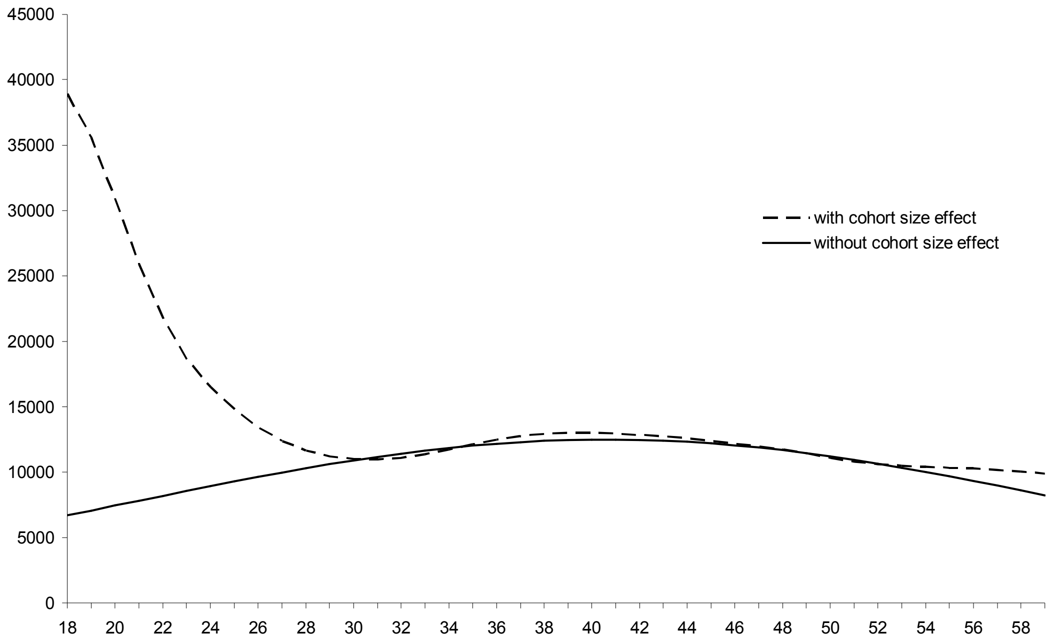
**Figure 3.5. Predicted age-earnings profiles with and without cohort size effect, 1999**




To create predicted age-earnings profiles for future years, it is necessary to know how the age structure of Ukrainian labour force is going to evolve. For that purpose, the baseline projections presented in Chapter 2 were used. On the basis of these projections, cohort size indexes were calculated for all cohorts for selected future years. Figure 3.6 shows predicted age-earnings profiles for year 2020. For other future years, the similar age-earnings profiles were calculated.

Of course, this is not an attempt to predict future earnings, and the graphs are presented for illustration purposes only. Between now and 2020, much can change in the labour market processes. The purpose is rather to see possible effects on the relative earnings of older and younger workers. It is clear that significant changes in the relative supply of workers of different ages (and different levels of experience) can have very sizable effects on relative earnings.

**Figure 3.6. Predicted age-earnings profiles with and without cohort size effect, 2020**




This finding has important implications for social policy. Inevitable changes in age structure of Ukrainian labour force can put older workers at a disadvantage relative to younger workers. To reduce this impact, the labour market should become more flexible. It can be argued that older workers can more easily substitute younger less experienced workers than vice versa, at least in some occupations.

### 3.5. Summary

This chapter examines the effect of cohort size on age-earnings profile. It has been shown that cohort size has a significant negative effect on earnings that diminishes with age. This means that the larger the cohort the lower earnings it will receive. The negative cohort size effect is the strongest at the beginning of career, owing to imperfect substitutability of workers with different levels of experience. If we reverse the statement, it can be argued that if new cohorts entering the labour market are unusually small, then they are going to experience higher earnings and put older larger cohorts at relative disadvantage.

According to population projections, the Ukrainian population is expected to age rapidly in the future. Consequently the Ukrainian labour force is going to age as well. The main driver of the labour force ageing in the very near future will be the entrance of the small cohorts born after 1986 into the labour market.

It has been shown in this chapter that if estimated coefficients are applied to the future age structure of the Ukrainian labour force to calculate the future age-earnings profiles, then we get a profile of unusual shape – with wages of younger workers exceeding those of older workers. It is of course impossible to predict future age-earnings profiles based on these estimations, as they use data from a rather short period and do not take into account other factors that will influence the labour market when the situation is going to change. However, it provides a valuable first estimate of potential change, and shows that the effect could potentially be very strong.

The main argument against this sort of projections is that workers with more experience can perform the tasks of workers with low experience (at least in some professions), and this would not allow the earnings of younger workers to increase so much. However, this would still lead to a flattening of the age-earnings profile. One potential consequence of this could be decreasing investment in human capital if the return on it decreases.

It would be interesting to test the hypothesis outlined in this study in ten years' time, when small cohorts would have already penetrated the labour market. Such a study could reveal whether the cohort size effect is significant at the beginning of the career, not only for large cohorts (as has been demonstrated in many of the developed countries that experienced a baby boom), but also for small cohorts. Ukraine provides ideal conditions for such research, as it experienced a very sharp decline in fertility after 1986 and does not attract a lot of immigrants (which could also affect the age structure of the labour force).

Another possibility for future research is to study how vintage effect interact with cohort size effect. Transition economies present good opportunities to explore vintage effect, because for those generations that grew up during the Soviet era there is a sharp difference between a required human capital and an accumulated one.

The two most important contributions of this research are the modified specification of the model and the identification of cohort size effects without relying solely on variation derived from the baby boom generation. The estimated model, in addition to usual cohort size variables, includes quadratic interaction of cohort size with age. This changes the shape of the cohort size effect over time from a linear to an inverted-U shape. Because of this, the initial cohort size effect is much larger, and at the end of the working career it almost disappears (and potentially can become negative). By applying cohort crowding theory to a country that did not experience a baby boom, this work shows that this effect is general and not specific to the baby boom generation.

# Chapter 4. Macroeconomic Effects of Population Ageing in Ukraine: A Dynamic CGE Approach

## 4.1. Introduction

Ukraine has a population which is not only ageing but also declining. The total population has decreased by 11% since 1993, when it reached its peak of almost 52 million. According to the baseline population projections presented in Chapter 2, 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 certainly change the demand composition, as consumption preferences vary by age. It will also affect national savings, as at different stages in their life cycles people have different savings propensities. As was discussed in the last chapter, there will be significant impacts on the size, composition and productivity of the labour force. Population ageing may even potentially affect the speed of technological progress, as new technology comes with new investments, and if the labour force is shrinking this will decrease the required investment level.

This chapter concentrates on the effect of interaction of the declining labour force and the growing number of pensioners on the macroeconomy. Simulations are performed in the dynamic CGE model of Ukraine. It is a standard forward-looking model with intertemporal optimisation and perfect foresight with an explicitly modelled Pay-As-You-Go component of the pension system. The model is calibrated on the base of the 2002 Ukrainian Social Accounting Matrix (SAM).

The effect of an ageing population structure is modelled by interaction of three processes: a declining labour force (affects labour supply and through it output), an increasing proportion of pension age population (affects the size of the outstanding pension benefits) and a declining total population (affects the size of the government consumption). The period covered by simulations is 100 years. The model set-up requires that in the last period the economy reaches new equilibrium. A prerequisite for economic equilibrium is demographic equilibrium, i.e. a stable age structure when all age groups change at the same rate. Based on population projections, it will take approximately 100 years for Ukraine to reach this state.

The baseline scenario is based on the baseline projection presented in Chapter 2 and no change in pension system arrangement. Under this scenario, the peak of population ageing will be reached by 2060. For that reason, and also because the accuracy of projections diminishes significantly with time, closer attention is paid to the first 58 years of simulations (from 2002 until 2060).

Under the baseline scenario, by 2060 consumption per capita will have declined by 19% and GDP per capita by 17% relative to the benchmark, with no change in population age structure. The share of government spending will have increased from 24% of GDP in the first period to 29% by 2060, and the effective rate of workers' pension contributions from 17% of the labour income at the beginning to 28% in 2060. A sensitivity analysis shows that results are influenced significantly by demographic assumptions. However, even the most favourable demographic scenario does not change the picture qualitatively – population ageing will have a deteriorating impact on the Ukrainian economy and pension system.

Analysis of the potential changes to the pension system is limited to two alternatives: increase of the pension eligibility age, keeping the workers' contribution rate or replacement rate constant. If the replacement rate is kept constant and pension eligibility age is increased to 65 years for both sexes, then the effective rate of workers' pension contributions would have to increase from 17% to 20% at the highest point. If, on the other hand, the workers' contribution rate is held constant and pension age is increased in the same way, then the replacement rate drops from 33% to 22% by 2060.

The rest of the chapter is organized as follows. Section 4.2 presents an overview of the Ukrainian pension system. Section 4.3 provides a review of CGE literature. Section 4.4 gives brief descriptions of the model, calibration and data. Section 4.5 describes simulations, scenarios and presents results. Section 4.6 presents the implications for pension system reform in Ukraine. Section 4.7 concludes with a discussion of potential model developments and the policy implications of the results.

### 4.2. Overview of the Ukrainian Pension System

#### *4.2.1. 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 Fund 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 more advanced transition economies (Kazakhstan, Hungary – 1998, Poland – 1999, Latvia – 2001, Croatia, Estonia, Russia – 2002).

The first tier is the mandatory PAYG component (repackaged existing system), 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 – as of October 2006 only 138.4 thousand persons participated in private pension funds. Introduction of the second tier is conditional on reforming the PAYG component and has been postponed several times. According to the most recent information, it now has to be introduced in 2009. However, the law regulating it has not yet been accepted by the Parliament, and it is unlikely that it will be passed this year. The law "On Mandatory State Pension Insurance" does not stipulate when the second tier has to come into operation, only the conditions that are required for that. 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. The level of minimal pension was increased to the level of subsistence minimum set by the Cabinet of Ministers. As a result, between January and September 2004, the minimum pension increased from UAH102.8 to UAH284.6 – an increase of 177% – and by the end of 2004 around 83% of pensioners were receiving the minimum pension (Institute for Economic Research and Policy Consulting (IER), 2006). After this increase in 2005, the balance of the

Pension Fund turned negative (for the first time), with a deficit reaching 25%. In 2005 and 2006, the deficit was covered from the privatization receipts.

During the parliamentary election campaign of 2007, the party that later formed the ruling coalition and appointed the Prime Minister promised further substantial increases in pensions. This was implemented at the beginning of 2008. The next presidential elections are due in 2010, and most analysts expect further increases in pension benefits. Thus, pension benefits have become an important instrument in the political battle. This makes pension reform unlikely to succeed until the political situation stabilizes.

### *4.2.2. Revenue side*

The Pension Fund of Ukraine has two major sources of income: workers' contributions and state budget contributions. In 2007, workers' contributions accounted for 69% of total revenues, State budget contributions accounted for 26% 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. Such contributions also cover "additional pension benefits set by different state pension programs". Although in 2007 (for the first time since 2005) the balance of the Pension Fund as approved by the Government was not in deficit, the share of the state budget contributions had increased from 10.2% in 2005 to 26.1% in 2007. Therefore, it seems that some of the deficit was re-labelled "additional pension benefits".

In 2008, workers who pay contributions under the standard scheme contribute 35.2% of the gross wage. An employer pays the largest part of these contributions: 33.2%. 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. Thus, pension contributions are 35.2%/133.2% = 26.43% of the total labour payments.

There are two major exceptions from the standard scheme. The first of them applies to companies working in agriculture and paying the so-called fixed agricultural tax (FAT). In 2005 and 2006, their contribution rate constituted 20% of the standard rate, and for each year thereafter it has to increase by 20 percentage points until it reaches the standard rate in 2010.

The second exception applies to small enterprises and self-employed individuals working under the simplified taxation scheme (STS). They have to contribute to the Pension Fund 42% of the simplified tax – the only tax they pay. The maximum level of tax under this scheme was set in 1999 at the level of UAH200. Therefore the maximum pension contribution under the STS is UAH84, i.e. 44% of the contribution from the minimum wage (as of  October 1, 2008 the minimum wage was UAH545 per month.).

**Table 4.1. Worker's contributions to the Pension Fund of Ukraine by type, 2005**

| | Category of workers | Number of individuals (m) | Share in total number of contributors (%) | Contributions (UAH b) | Contributions (%) | Average monthly contribution per person (UAH) |
|---|---|---|---|---|---|---|
| FAT | Agricultural workers | 4.1 | 22.04% | 0.8 | 1.96% | 16.26 |
| STS | Self-employed | 2.0 | 10.75% | 0.4 | 0.98% | 16.67 |
| Standard scheme | All remaining workers | 12.5 | 67.20% | 39.6 | 97.06% | 264.00 |
| Total | | 18.6 | 100.00% | 40.8 | 100.00% | 182.80 |

Source: IER 2006

The structure of the workers pension contributions by type in 2005 is summarised in Table 4.1. About 97% of contributions are made by 67% of contributors. Such a contribution structure could potentially be a result of a strong income disparity between different groups of contributors. However, if one looks at average contribution by type of contributor, it becomes clear that such a big difference cannot be explained by difference in incomes – agricultural workers and self-employed do not earn 16 times less than other categories of workers in Ukraine. It is obvious that the burden of pension contributions is distributed very unequally. Taking into account that currently there is limited differentiation in pension benefits, such organization of a pension system is clearly unfair.

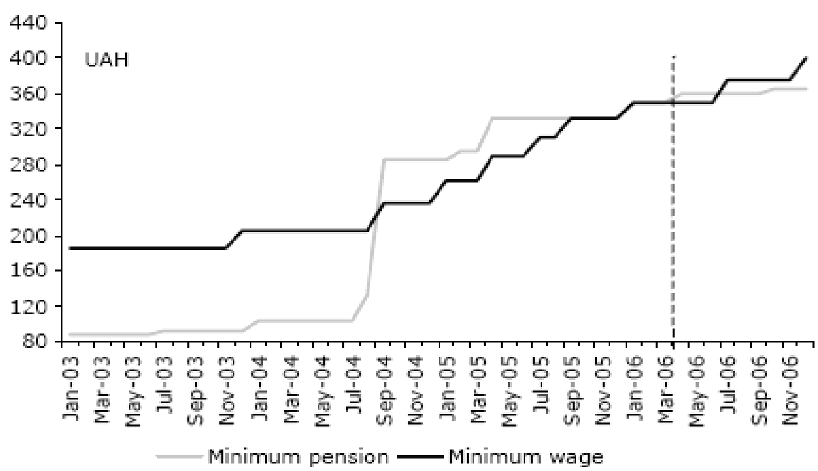
### *4.2.3. Expenditure side*

The old-age pension eligibility age in Ukraine is 55 years for females and 60 for males. To be eligible for the minimum old-age pension, males have to have 25 years of working records and females have to have 20 years of records. For every additional year of work exceeding this minimal requirement, the pension increases by 1%. If a person has only a fraction of the minimal required working records, the pension is calculated proportional to the minimal old-age pension level. The minimal old-age pension is set equal to the subsistence minimum for a disabled person.

Two mechanisms of pension indexation are in place. Pensions are indexed to inflation, but only in a part that does not exceed the subsistence minimum for a disabled person. Pensions are also indexed to increase in an average wage, and this indexation should be no less than 20% of the wage increase in the previous year, provided that pensions were growing more slowly than wages.

After the sharp pension increase in 2004, for some period the minimum pension has exceeded the minimum wage (see Figure 4.1). As of October 1, 2008, the minimal pension is set at UAH495 and the minimum wage at UAH 545 per month. Thus, the difference remains small.

**Figure 4.1. Monthly minimum pension and minimum wage**




Source: Cabinet of Ministers of Ukraine cited in IER, 2006

The replacement rate of average pension to average wage is presented in Figure 4.2. For most of the period, it fluctuated at around 33%; however in 2005 and 2006 it reached almost 40%, which coincided with peaks of political cycle.

**Figure 4.2. Replacement rate**


Source: State Statistical Committee of Ukraine

To place it into perspective, Table 4.2 provides the international comparison of replacement rates in a selection of OECD (highlighted in italics) and CEE countries compiled by the World Bank (Palacios and Pallarès-Miralles, 2000). The Ukrainian pension system is at the bottom of distribution. However, one has to treat international comparison of replacement rates with caution because of different measurement issues. For discussion see Whiteford (1995).

As mentioned before, a substantial share of pensioners receive the minimal pension: at the end of 2004 83% of pensioners, at the end of 2005 44% of pensioners (IER, 2006). 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).

**Table 4.2. Replacement rates in selected OECD and CEE countries**

| Country | Year | Replacement rate |
|---|---|---|
| Armenia | 1996 | 24% |
| *Japan* | *1989* | *25%* |
| Estonia | 1995 | 25% |
| Azerbaijan | 1996 | 29% |
| Bulgaria | 1995 | 31% |
| Kazakstan | 1996 | 31% |
| *Australia* | *1989* | *32%* |
| **Ukraine** | **2002** | **33%** |
| *Iceland* | *1993* | *33%* |
| *Luxembourg* | *1993* | *33%* |
| *Greece* | *1990* | *34%* |
| *United States* | *1989* | *35%* |
| *Ireland* | *1993* | *36%* |
| Georgia | 1996 | 36% |
| *Denmark* | *1994* | *36%* |
| *Austria* | *1993* | *37%* |
| *United Kingdom* | *1998* | *38%* |
| *Norway* | *1994* | *40%* |
| *Netherlands* | *1989* | *41%* |
| *Spain* | *1995* | *42%* |
| Slovakia | 1994 | 43% |
| Belarus | 1995 | 43% |
| Romania | 1994 | 43% |
| *Switzerland* | *1993* | *44%* |
| *Portugal* | *1989* | *44%* |
| *Canada* | *1994* | *44%* |
| *Germany* | *1995* | *45%* |
| Croatia | 1997 | 49% |
| Czech Republic | 1996 | 49% |
| *Finland* | *1994* | *49%* |
| Poland | 1995 | 55% |
| Hungary | 1996 | 58% |
| Latvia | 1994 | 63% |
| Macedonia | 1996 | 64% |
| Slovenia | 1996 | 69% |

Source: Palacios and Pallarès-Miralles (2000)
OECD countries highlighted in italics

### *4.2.4. Problems*

The arrangement of the Ukrainian PAYG component of the pension system that was summarized in previous sections has many problems which make the system unstable and vulnerable to demographic and political risks. The first serious drawback is that the current arrangement creates incentives for participants to pay the minimal possible contributions for a minimal possible period. This is possible even though the rates are set by law. The differentiation of benefits is very limited and the situation is worsened by indexation rules (only the minimum pension is indexed to inflation). Also, possibilities for avoiding paying large contributions are abandoned. The simple legal way is to use a simplified taxation system. Some employers abuse this system, and, instead of hiring a worker, contract him/her as a sole proprietor, since in this case s/he can pay simplified tax and avoid high pension contributions (and other taxes). An illegal but widespread method is to pay a fraction of the wage "in an envelope", i.e. unregistered and without paying social security 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 2002 the effective workers' contribution rate was 20%, while the standard rate was 34% of gross wage. This is calculated based on the size of workers' pension contributions, taken from the Balance of the Pension Fund, and employees' compensation, taken from the Social Accounting Matrix (SAM).

The second problem is the very low pension eligibility age which creates an additional burden for the system. Currently, Ukraine shares with Russia and Belarus the lowest pension eligibility age in Europe – 55 years for females and 60 years for males. This 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 eligibility age in most OECD countries is 65 years. Iceland, Norway and the United States have a normal pension age of 67 years. Czech Republic, France, Hungary, Korea, the Slovak Republic and Turkey have pension eligibility ages between 60 and 65 years (OECD 2005).

The common argument against an increase in pension eligibility 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 the 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 eligibility age for males is somewhat controversial, then the pension eligibility age for females is clearly much too low. In 2005, life expectancy for females at age 55 was 23.4, i.e. higher than the minimal required number of contribution years. This means that, after contributing for only 20 years, a woman on average can expect to receive benefits for 23.4 years.

One of the important reasons for the pension eligibility age not being increased when pension reform started in 2003 is probably political instability. Pensioners and people approaching pension age constitute a substantial and growing share of voters. They also are the most politically active part of the population and least interested in sustainable long-term policy. The combination of an ageing population with the weak political power makes it very difficult to increase pension eligibility age now. However, for any pension reform to succeed, it is important to separate the pension system from the politics.

## 4.3. CGE Overview

### *4.3.1. Brief overview of CGE literature*

The Computable General Equilibrium (CGE) model attempts to provide a comprehensive description of an economy using a system of simultaneous equations. The general equilibrium framework requires that all the markets, sectors and industries are modelled together with corresponding inter-linkages, as opposed to partial equilibrium which takes into account only a part of the system and neglects potential feed-backs between system components (general equilibrium effects). A mathematical representation of the model, coupled with some solver algorithm, ensures a "computable" nature of the problem; i.e. by using the CGE model for simulations, one obtains numerical results for endogenous variables based on assumptions about exogenous variables, functional forms and parameters.

CGE has been used as a tool for about 50 years to study a variety of economic questions, ranging from welfare effects of trade and taxation policies to macroeconomic stabilisation and sectoral development policies and, in recent years, demographic processes, energy efficiency and climate policy.

The approach is based on the Walrasian general equilibrium structure formalised by Arrow and Debreu (1954). The models rest on neo-classical assumptions. Consumers are assumed to maximize their utility subject to budget constraint (demand-side), and producers are assumed to maximise their profit, given the price vector (supply-side). For each good and factor of production, equilibrium price is calculated such that demand equals supply.

The first CGE model was built by Johansen (1960). He had to apply severely restrictive assumptions about the shape of production and utility function in order to be able to solve the model at that time. Seven years later, Scarf (1967) developed powerful fixed point method of equilibrium computation, which removed the need for these restrictions.

The models that will be discussed here belong to the group of applied CGE models. This means that, unlike theoretical models (which also can have GE structure), they study a particular applied issue in the context of a specific country or region.

In early years, CGE models were widely used to study the efficiency of the fiscal policies and international trade issues. The survey of this research is presented in Shoven and Whalley (1984). At the beginning of the 1990s, the Global Trade Analysis Project (GTAP) was created with an ambition to produce a consistent database and global CGE model that would provide the possibility for it to be used for individual countries or regions. GTAP provides training on the use of their model, backed up by open source modelling. At the moment, the GTAP 7 database contains 106 regions and 57 sectors.

There are different types of CGE models, based on a number of criteria. By number of regions modelled, there could be single region, multi-region or global models. There are models with different levels of disaggregation of industry and household sector. By treatment of time, one can differentiate static and dynamic models.

The earlier CGE models were static. They provided an equilibrium solution for a single period for a one-time shock. This solution was often viewed as a long-term equilibrium. While these models are suitable for some types of questions (e.g. effect of introduction/removal of trade restrictions), they are completely unusable for others (e.g. dynamic shocks or shocks affecting capital accumulation decisions). One big criticism is that these models do not have capital accumulation, and consequently neglect any supply-side effects of investments. To model these issues, dynamic models were developed. A survey of eleven CGE models, which include some type of dynamics in their structure, is presented in Pereira and Shoven (1988).

There are two types of dynamic models. The first one is the family of recursive dynamic models. This is a straightforward extension of the static models. The model is solved sequentially for several periods, tracing the changes occurring after single or multiple shocks. Saving/investment decisions are modelled in different ways (binding savings or investments), but in any case they require exogenous assumptions. The process of reconciliation of aggregate savings and investments is known as closure rule. There is a number of different closure rules that can be applied to government balance (government savings), foreign balance (foreign savings) and household consumption/savings decisions. One common criticism of this approach is its analytical inconsistency. The same consumers and producers, that are rational utility and profit maximisers within each period, stop optimisation when it comes to between period decisions. For an example of the recursive dynamic CGE model, see the description of the GTAP-Dyn – a conversion of the standard static GTAP model (Ianchovichina and McDougall, 2000). Because it is a global model, it has an extensive treatment of international capital mobility.

The second type is the family of intertemporal dynamic CGE models. In these models, economic agents optimise between periods over an infinite time horizon as well as within periods. Intertemporal optimization removes the issues with capital accumulation inherent to recursive dynamic models. Since the model cannot be solved for the infinite number of periods, it includes terminal conditions. This ensures that by the end of the simulation period, the modelled economy reaches a steady state growth path and remains on it forever. In a standard intertemporal dynamic CGE model, the household sector is usually described by representative household. It can be aggregated or disaggregated (e.g. by income), but in both cases it is assumed to live indefinitely.

An alternative approach is to model the household structure in the overlapping-generations (OLG) framework. This type of models was pioneered by Auerbach and Kotlikoff (1987). They also are based on an infinite time horizon and intertemporal optimisation, but the household sector consists of several generations living alongside each other at any time. Each period one oldest generation "dies", one youngest generation is "born"[2] and all the generations in-between become one year older. The advantage of these models is that they can incorporate life cycle behavioural assumptions. Individual work/leisure and consumption/savings decisions are age dependant and the OLG approach allows them to be modelled explicitly. Some OLG models include considerations of bequest (Auerbach *et al.,* 1989).

The sequence of model types development described above is very relative. Different types of models exist simultaneously. The use of static models is still very prevalent because they are less costly to create and implement. However, as time progresses, model specifications become more and more complex. Data availability and ever

[2] In some models, generations younger than working age are not explicitly included because they do not take independent decisions.

growing computational power allows for complexity unthinkable 50 years ago. The non-linear structure of CGE models requires the use of specialised software. Most (but not all) modern CGE models are implemented in GAMS (General Algebraic Modelling System) or GEMPACK (General Equilibrium Modelling Package) software.

### *4.3.2. CGE as a tool to study the effects of demographic change*

In recent years, the issue of demographic change and population ageing has attracted a lot of attention. Dynamic CGE models proved to be very useful tools for studying the impact of demographic processes on the economy. Demographic transformation is a slow and long-term process, and being able to track the changes occurring in age structure over time is very useful.

The majority of research devoted to the study of demographic processes in CGE framework uses OLG models. The pioneers of this direction are Auerbach and Kotlikoff. In 1987, they presented their initial model in a book describing the new approach and providing simulations of the US fiscal policy (Auerbach and Kotlikoff, 1987). Two years later, in a paper with other co-authors (Auerbach *et al.,* 1989), they extended the model by including bequest behaviour, technological change, international trade and age-dependant government consumption. In this research, the simulations covered four OECD countries: Germany, Japan, Sweden and the United States. They found that an increase in dependency ratios in these countries will have a significant impact on national savings, real wages and current accounts. A special focus was devoted to different options of social security system reform, i.e. increase in pension eligibility age and decrease in average replacement rate. Both of these policies were found to decrease the social security contributions required to keep the system solvent. However, both of these policies increase the welfare of younger (smaller) generations at the expense of that of older (larger) generations. The OLG structure of the model allowed the tracking of the different effects of these policies on different cohorts.

Later, the original Auerbach and Kotlikoff model was extended to include uncertain life-time (for example, see Chauveau and Loufir, 1997). Hviding and Merette (1998) extended the work of Auerbach *et al.,* (1989) by applying their model to study population ageing and pension reform in seven OECD countries: Canada, Japan, France, Italy, Sweden, the United Kingdom and the United States. They studied three pension scenarios: "gradual removal of public pensions", "20% cut in the replacement rate", "fiscal consolidation" (the government aims to offset the decline in private savings by increasing public savings). They found that the increase in the wage-income tax rate and the decline in the national savings are inevitable, even with simulated policy reforms. In the long run, the gradual removal policy is the most effective, but the increase in retirement age is the most effective policy in the short run.

Although the reform of public pension schemes attracted much attention of scholars studying population ageing, dynamic CGE models were also applied to the study of other demographic processes. Two other important directions of research are human capital accumulation and migration policy. Fougère *et al.,* (2009) explored the long-term impact of population ageing on labour supply and human capital investment in Canada. They found that population ageing provides an incentive for young people to invest more in human capital and supply more skilled labour later in their career. Thus, a reduction of labour supply by young cohorts initially exacerbates the economic cost of population ageing, but, in the long run, the higher supply of skilled labour increases productivity and significantly lowers the negative effect of population ageing.

In a recent study, Lisenkova *et al.* (2008, 2009) have studied the impact of increased migration on the Scottish economy. In particular, they examined whether higher net migration can neutralise the negative labour market effect of population ageing. Based on their calculations, to prevent the labour force from shrinking by 2040, Scotland has to achieve net migration of 20,000 per year, which is significantly higher than the official long-term migration assumption of 8,500 per year produced by the Government Actuary Department (GAD). Unlike other papers discussed in this section, this group of researchers used the recursive dynamic model to study the impact of demographic shock.

### *4.3.3. Existing research on Ukraine*

Most of the CGE research in the post-Soviet countries is concentrated on international trade issues, more specifically, on the impact of the WTO accession. Jensen, Rutherford and Tarr (2004) studied the impact of Russia's accession to the WTO. Jensen and Tarr

(2007) built a trade-centred model for Kazakhstan. Pavel and Tochitskaya (2004) analyzed the impact of the WTO accession of Belarus.

Pavel *et al.* (2004) constructed a static CGE model of Ukraine. It has 20 sectors. The model was based on the 2001 input-output table. Households were disaggregated into unskilled, skilled and highly skilled groups; there were seven trading regions: EU15, 10 new members (by 2004), Russia, other CIS, Asia, North America and the Rest of the World. They found that total gains from Ukraine's accession to the WTO are a 3% increase of consumption, 1.9% increase of GDP and 14% increase in exports and imports.

To study the impact of demographic change in Ukraine on the pension system, the economic-demographic growth model was developed by the Social Security Reform Project of the International Institute for Applied Systems Analysis (IIASA). This model was used by a number of researchers. MacKellar and Ermolaeva (1999) presented a general description and algebraic structure of this model. Dobronogov (1998) used an earlier and simplified version of the model to study the impact of different scenarios of pension reform on the government debt. Scenarios are based on different shares of the informal sector in the economy, different duration of the transition from PAYG to a fully-funded pension system, and different pension eligibility age. The results show that, first, the share of informal sector plays a crucial role in the determining the outcome of the pension reform. Second, the longer the duration of the transition, the better are the chances for successful reform. Third, pension reform has no chance to succeed unless the pension eligibility age is increased.

In another study, Dobronogov and Mayhew (2000) focused their attention on the large informal sector of the Ukrainian economy. The authors included a better described informal sector of the economy in the IIASA model. Using this extended model, they tried to determine the impact that social security system and its reform will have on the informal sector. Simulation scenarios were based on the size of the fully-funded component of the pension system, on the method of the transition financing (debt-financed and tax-financed), and the degree of the public trust in the reform. The results of the simulations showed that public trust plays a very important role in the impact of the pension reform on the informalisation of the economy; debt-financed transition will facilitate the decrease of the share of the informal sector of the economy; *ceteris* *paribus*, the larger the private fully-funded pension system, the smaller the informal sector of the economy. Thus, the introduction of a fully-funded component to the pension system may have a positive impact on the reduction of the informal sector.

In a later study, Lisiankova (2002) also used the IIASA model. This work concentrated on the impact that demographic changes will have on the balance of the public pension system. It provided the results of different demographic and pension system scenarios. Simulations revealed that if no changes are made to the system, it will become insolvent by 2030, according to two out of the three demographic scenarios. The results were rather sensitive to the assumptions about the share of employed labour that does not contribute to the pension system. The simulations also showed that, if the pension eligibility age is increased, the system will have a growing positive balance, but only under the assumption that the contribution rate will not be reduced.

The IIASA model shares some features with recursive dynamic CGE models, but it also has detailed treatment of the age-specific stocks and flows similar to those of OLG models. However, unlike the CGE model, this model is not calibrated on the initial data point and requires more initial information. It also relies 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.

## 4.4. Model Description and Calibration

### *4.4.1. 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. The discounted utility of the infinitely living household is maximized by choosing the optimal level of consumption and investment.

There are four agents: the household, the firm, the government and the rest of the world (ROW).

**The household** has an additive utility function which it maximizes over the infinite time horizon subject to infinite time budget constraint. There are five main sources of household income: labour income, capital rent, 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) and intermediate inputs in the production process. Technology is characterised by a nested production function. Value added is produced by the Cobb-Douglas aggregation of capital and labour, and final output is produced by a Leontief function of intermediate input and value added. The technology exhibits constant returns to scale.

The firm chooses the level of investment to maximize the value of the company, subject to the capital accumulation constraint. The value of the company is a net present value of the future dividends. Capital is accumulated in the process of investment and depleted by depreciation. Investment is financed from three sources: household savings, government savings and foreign savings. Investment expenditures include both acquisition and adjustment costs (quadratic in investment).

**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. Various assumptions can be made about the dynamics of the different components of the government spending.

The trade between 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 the international trade. The final product is allocated between domestic sales and exports through constant elasticity of transformation (CET) function. Total absorption is an Armington composite of domestic product and import, and is divided between four uses: private consumption, government consumption, intermediate input and investment.

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.

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. The model is implemented in GAMS software. It is solved as a non-linear problem (NLP) by the PATHNLP solver which has been developed specifically for large scale non-linear problems. A detailed algebraic description of the model is presented in Appendix 4.1.

### *4.4.2. Calibration*

The model is calibrated on the basis of the 2002 Ukrainian Social Accounting Matrix (SAM) (see Appendix 4.2) provided by the Institute for Economic Research and Policy Consulting (based in Kiev). The SAM is constructed from the corresponding Input-Output table (IO) and Income and Expenditure accounts, based on the Ukrainian National Accounts. The matrix was adjusted to take into account the specification of the model.

The calibration is based on the assumption that the initial data point is on the steady state growth paths. This is the standard approach in these types of models, and it allows the tracking of changes originating from the specified scenarios. In the final period of the simulation, the model has to return to steady state. This is ensured by the use of terminal conditions. On a steady state, the economy grows at the rate of population growth and capital stock grows at the rate of population growth plus depreciation.

Three types of input data are specified during the calibration stage:

- Initial values of the variables that are taken from the SAM (e.g. household consumption);
- Exogenous parameters (e.g. steady state interest rate);
- Initial values and parameters that are calibrated from the first two categories based on the assumption of the initial steady state (e.g. initial capital stock and depreciation rate).

The compete description of the calibration stage is presented in Appendix 4.3.

### *4.4.3. Modelling strategy*

The model presented in the previous section is based on a number of strong assumptions. This is inevitable for any modelling exercise. The researcher has to make a compromise between the tractability and realism of the model. It is important to understand which "facts of life" are important for the study of the subject at hand and which could be disregarded.

The selected model set up allowed the modelling of the most important process that this chapter considers – the changing age composition of the population. It is modelled as change in size of the labour force, the pension age population and the total population. The household sector is aggregated, and optimises its consumption/savings over the infinite horizon. However, household sector behaviour in some way depends on its age composition, e.g. amount of labour supply and size of the transfers received from the governments.

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. Any attempt to include them into the OLG model structure would significantly reduce model tractability. 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 significantly simplifies production and tax structure. The production sector is described by aggregate production function. In the earlier versions of the model, production was disaggregated to several sectors. This did not have a major impact on the results, but significantly increased computation time. Because production structure is not in the focus of this study, the decision was taken to aggregate the production sector.

There are three types of taxes and social contributions included in the model: indirect tax on production, income tax and workers' pension contributions. Of course, the taxation system in Ukraine is more complex than that. However, these three broad categories of taxes include all of them. Indirect tax includes all business taxes, like VAT, excise, trade tariffs, etc. Income tax includes all household taxes. Workers' pension contributions are singled out from the household payments to the government in order to model the revenue side of the Pension Fund.

Some models have a more elaborate tax structure. However, in this case, modelling additional taxes would increase the complexity of the model but not have a significant impact on our understanding of the population ageing effect. For example, if the focus of the model was international trade, then modelling trade tariffs would be more important than modelling pension contributions.

The modelling strategy was to concentrate on the most essential features, and neglect the things that do not play major role. As this is the first attempt of modelling population ageing in Ukraine in the CGE framework, the purpose was to identify the most important factors and possibly expand the model later if it seems reasonable. At this stage the tractability and intuitiveness of the model were given priority.

## 4.5. Simulations, Scenarios and Results

### *4.5.1. Simulations*

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

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-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.

The interaction of these three exogenous demographic processes has an impact on the trajectories of the endogenous macroeconomic variables.

It is important to understand that the simulations presented in this paper are not projections or forecasts. They leave aside many factors that will determine the development of the macroeconomic situation in Ukraine and concentrate on just one: population ageing. Thus, the results presented measure the potential impact of this one factor *ceteris paribus*.

### *4.5.2. 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, discussed in greater detail in Chapter 2. Specifically, three population scenarios are created:

- Medium – uses medium fertility and mortality and zero migration assumptions;
- Low dependency – uses high fertility, low life expectancy and zero migration assumptions. This combination of factors results in the lowest old-age dependency;
- High dependency – uses low fertility, high life expectancy and zero migration assumptions. This scenario results in the highest old-age dependency.

All three scenarios assume zero migration. This is close to the low migration scenario of the Institute for Demography and UN migration assumption. 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.

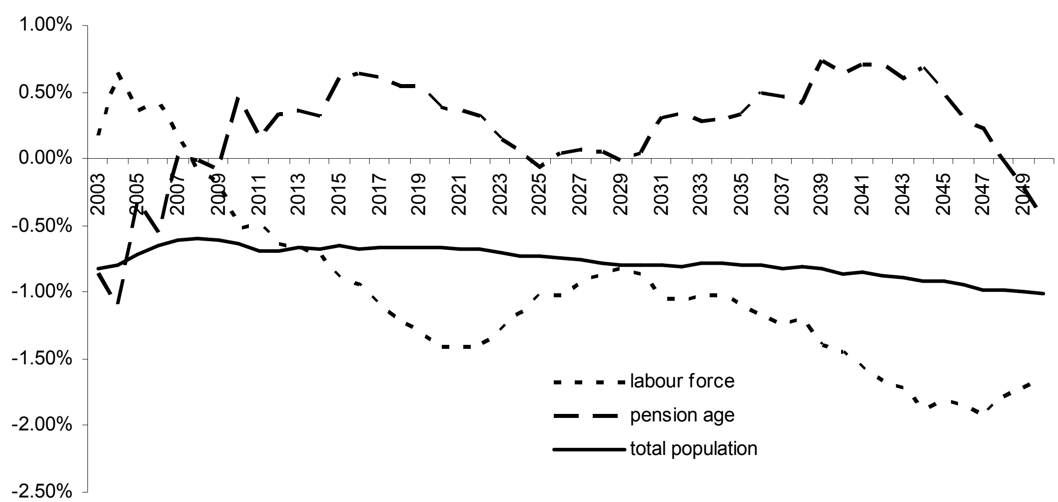
### *4.5.3. Steady state and stable population*

As mentioned above, the model is structured and calibrated under the assumption that in the initial and final periods, the economy is 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. 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. 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 2002. 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 2002. Each different population scenario (discussed below) assumes a different initial steady state (depending on population growth rate), which is only critical during the calibration stage when the level of initial capital stock and depreciation rate are calculated. All other variables and parameters are unaffected by this assumption. Out of steady state calibration would make things more complicated, but would not significantly change the results.

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 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. The Institute for Demography currently makes demographic assumptions only until 2050. At the end of this projection period, Ukraine is still far from having a stable population (see Figure 4.3).

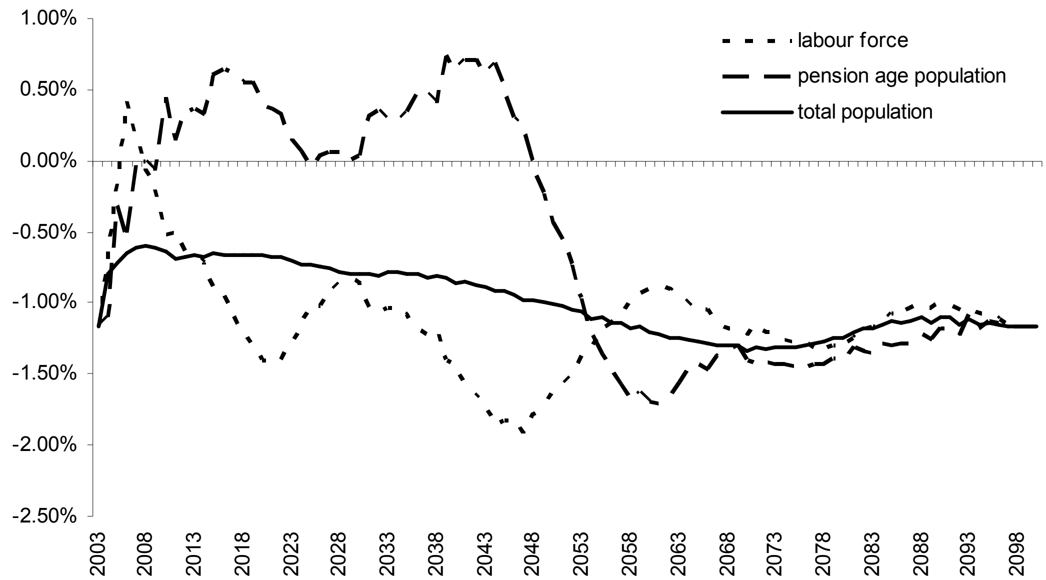
**Figure 4.3. Historical and projected growth rates of population groups, 2003-2050**




Source: State Statistical Committee of Ukraine, own projections (medium projection)

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 4.4.

**Figure 4.4. Projected growth rates of population groups 2003-2100**




Source: State Statistical Committee of Ukraine, own projections (medium projection)

**Figure 4.5. Change in demographic variables over the simulation period**


Source: own projections (medium projection)

From these growth rates, the model calculates the size of the labour force, the amount of pension benefits due to be paid out and the size of government consumption and transfers for each period of the simulation. The cumulative change in the demographic exogenous variables is presented in Figure 4.5.

As Figure 4.5 reveals, over the projection period, the labour force will shrink by 66%, the pension age population by 43% and total population by 62%. The deviation of working age population and pension age population decline from the total population decline represents population ageing.

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 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 period. This projection, based on the assumption of constant fertility and mortality pattern after 2050, however, serves one more useful purpose. It shows how unsustainable the current demographic situation is and how quickly a country of the size of Ukraine can become depopulated.

### *4.5.4. Counterfactual*

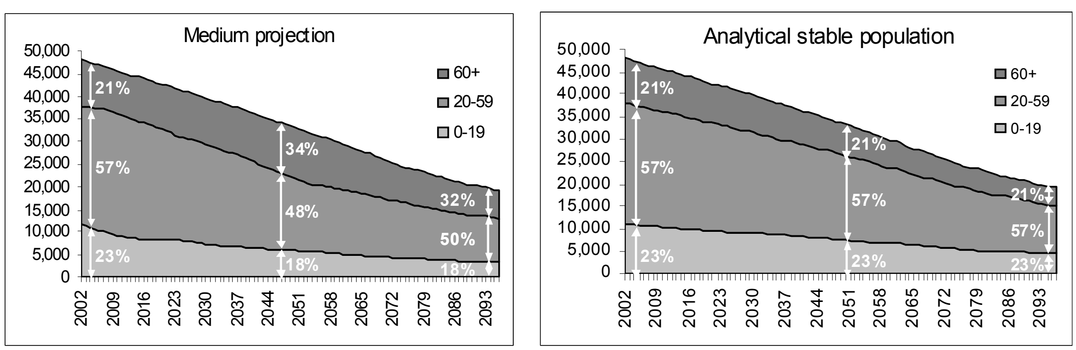
The choice of counterfactual is very important in CGE studies and depends on the research question under investigation. If selected correctly, it will isolate the effect of the factor that the researcher is interested in. If not, the results will show a mixed picture influenced by several factors.

This study is concerned with the effect of population ageing, i.e. change in the age structure of the population. Thus, the counterfactual should be based on the same assumptions, only with no population ageing. The results of simulations are presented relative to the base run with no population ageing (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. This is called the "analytical stable population" because, although it satisfies the definition of a stable population (constant age structure), it is not projected based on the fertility, mortality and migration assumptions that would guarantee its stability. Moreover, while the rate of growth of all age groups is the same, it is not constant over time.

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. The declining population has lower consumption and output, and to conclude what happens with the welfare one has to compare the rates of decline of macroeconomic variables with population decline. In effect, it is equivalent to analysing the results in per capita terms. That is why the GDP and household consumption that are reported in both aggregate and per capita terms show the same relative dynamics.

Figure 4.6 illustrates the concept of analytical stable population. The left panel presents medium population projection and the right panel the corresponding analytical stable population. In medium population projection, the share of working age population increases in the initial years of the projection as a result of the rapid decline in population aged 0-19. In about 40 years, the same rapid decline is repeated for the working age population. During the simulation period, the share of the population aged 20-59 declines from 54% to 50%, and the share of population aged 60+ increases from 21% to 32%. In the analytical stable population, the age composition does not change.

**Figure 4.6. Medium population projection and analytical stable population**




### *4.5.5. Baseline scenario*

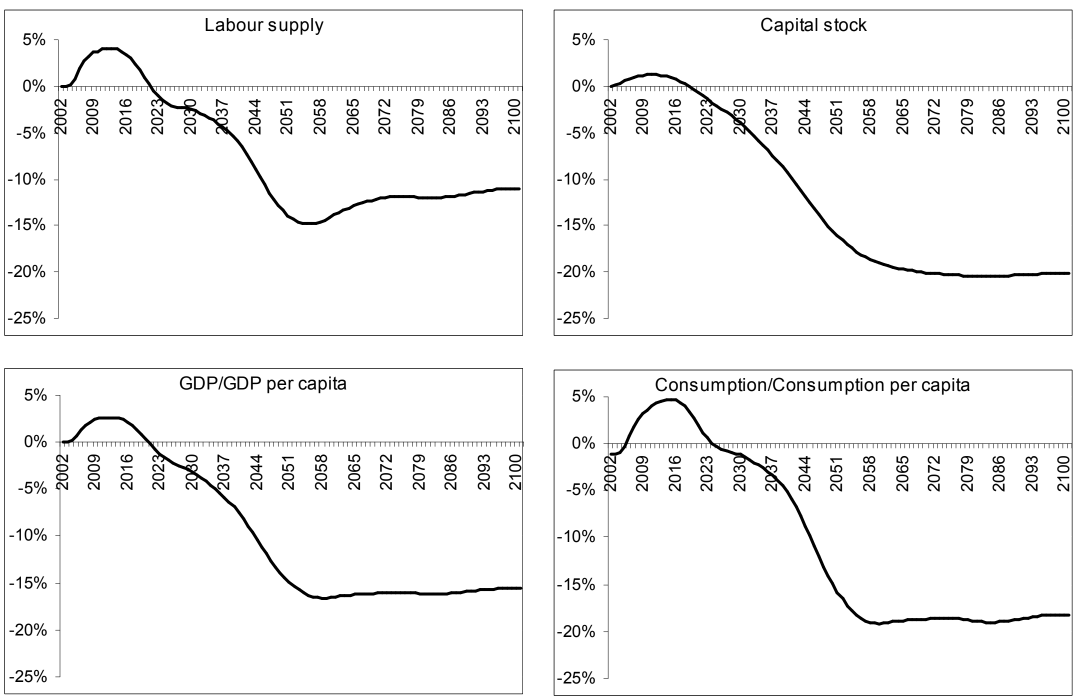
The baseline scenario is based on the medium demographic scenario described above. It applies the rates presented in Figure 4.4 to exogenous variables. The Pension Fund is financed on a PAYG basis, except for the constant fraction of government pension contributions fixed at the 2002 level (13%, obtained from the Pension Fund balance).

The replacement rate is constant at the 2002 level (33%). This scenario can be viewed as a *status quo* situation. It shows what would happen if no actions are taken and the demographic situation is developed according to the medium demographic scenario.

The results of the baseline scenario are summarized in Figures 4.7-4.9. All results are presented as a percentage difference with the stable population scenario, unless specified otherwise.

The labour supply is an exogenous variable and it is the driving force of the change in the other macroeconomic variables presented in the first panel (Figure 4.7). The capital stock adjusts in line with labour supply but much more smoothly, because investments are subject to quadratic adjustment cost; i.e. capital cannot adjust to a new equilibrium level instantly. As was explained before, because the results presented are relative to the stable population scenario, aggregated variables and per capita variables display the same relative dynamics.

**Figure 4.7. Results for base line scenario (1)**




Consumption per capita and GDP per capita both increase in the initial periods owing to an increasing share of the working age population, and then decline rapidly after 2022. These two variables reach their lowest level around 2060. Consumption per capita declines by 19% and GDP per capita by 17%.

Consumption does not exactly follow the path of GDP, because it depends on the GDP growth rate and short-run interest rates. During the simulation period, the interest rate is allowed to deviate from the long-run world interest rate. This happens because capital stock does not adjust instantaneously to the desired level owing to the existence of adjustment costs. However, the deviation of interest rate is not significant, and during the simulation period it fluctuates within the range 4.6%-5.2%, with 5% being the long-run level.

The situation with government finances is presented on the second panel of the graphs (Figure 4.8). Government spending is equal to government revenues in each period. The indirect tax rate adjusts to keep the government budget balanced. After a modest decline in the initial periods, it increases from just above 12% in the first period to 18% at its maximum in 2057, levelling off later at just below 17%. Following the same pattern, the share of government spending increases from 24.4% of GDP in the first period to 29.4% in 2057. By the final period, it slightly decreases to 28.7%.

**Figure 4.8. Results for base line scenario (2)**

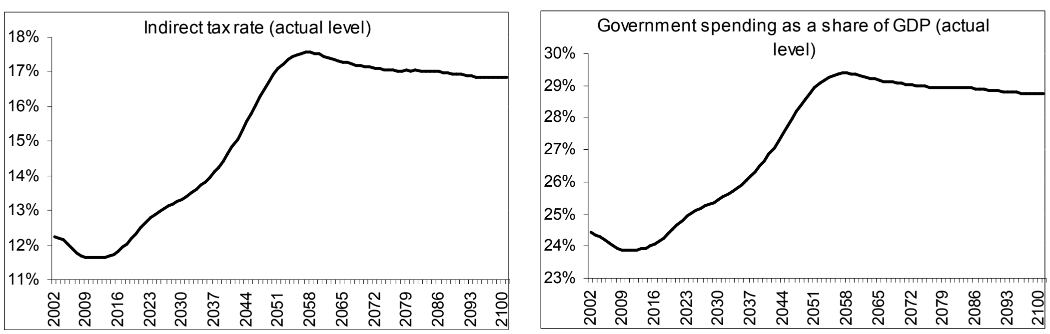
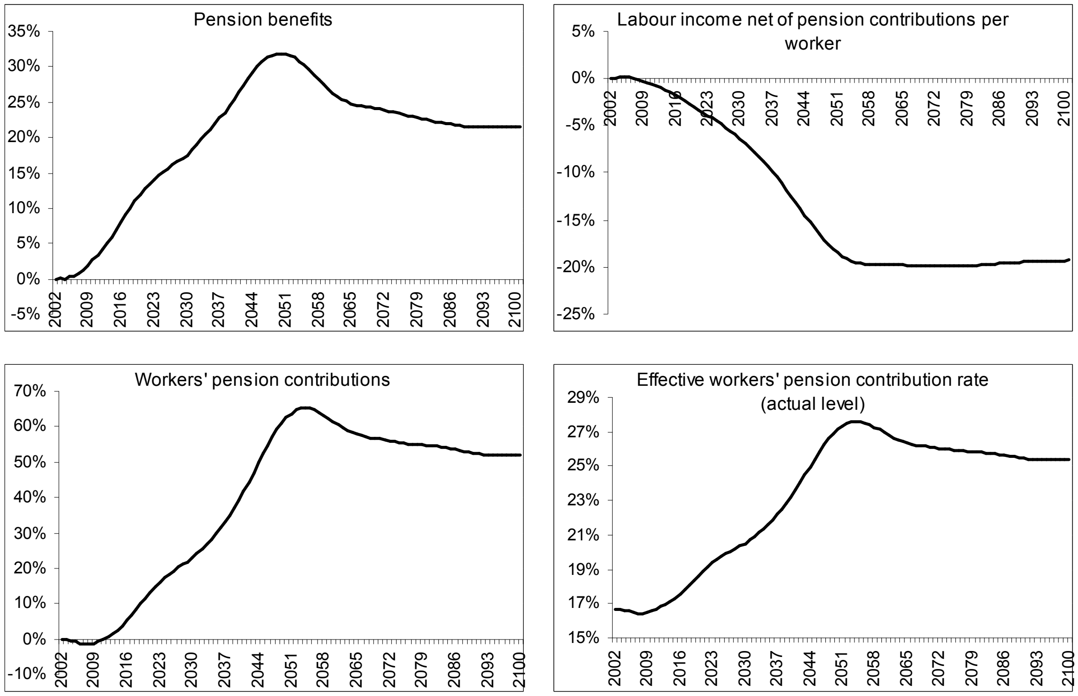



Figure 4.9 presents the third panel of results of the baseline simulation. In this group of charts, the exogenous variable is the aggregated level of pension benefits. It depends on two variables: the number of pensioners and the replacement rate. As mentioned above in the baseline scenario, the replacement rate is held constant at the 2002 level (33% of the average wage).

**Figure 4.9. Results for base line scenario (3)**




As the population ages, the total amount of pension payments increases compared with the stable population level, exceeding it by 32% around 2050. 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 22% above the stable population level.

In the baseline scenario, 87% of pension payments are financed on a PAYG basis. The remaining 13% 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 17% of the labour income at the beginning, to 25% at the end of simulation period, peaking at 28% in 2054. The pension system is discussed in more detail in a later section of this chapter.

Thus, the baseline scenario shows that population ageing may lead to a significant decline in consumption per capita, deterioration of public finances and an increase in the pension system burden on the economy. In the next section, the sensitivity of the results to demographic assumptions is considered.

### *4.5.6. Sensitivity analysis*

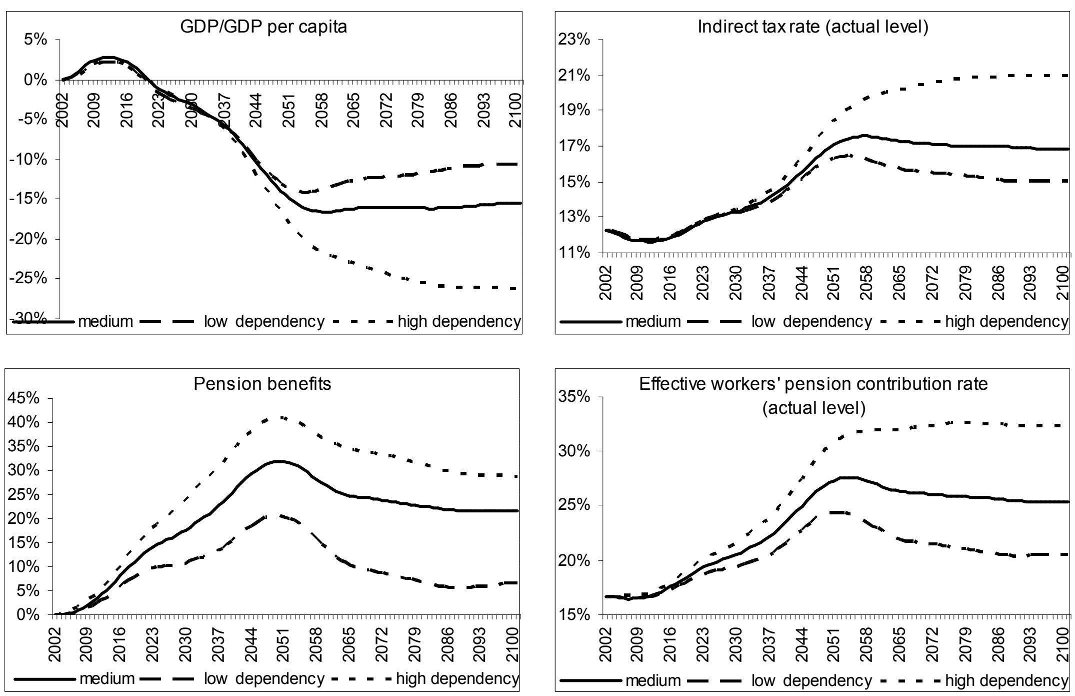
#### *4.5.6.1. Demographic assumptions*

The previous section revealed that demographic change will have a significant negative impact on the Ukrainian economy. However, the results of the simulations depend on a number of assumptions made about the future. This section examines how sensitive the results are to some of these assumptions.

The dynamics of macroeconomic change in this model are driven by the demographic assumptions. In the baseline simulation, a medium demographic scenario was used. Figure 4.10 compares it with simulations based on low and high dependency scenarios.

It is important to remember that the results are presented relative to a stable population with fixed age structure. Each demographic scenario has its own corresponding stable population scenario.

**Figure 4.10. Results for different demographic scenarios**




As Figure 4.10 reveals, for the first 50 periods different demographic scenarios result in very small variations in GDP per capita and indirect tax rate. During this period, the low dependency demographic scenario has a slight negative effect on the per capita welfare variables and government finances. This happens because higher fertility increases the number of dependants in the short run. However, the situation changes to the opposite after larger new cohorts reach the working age. The much larger variation of results in the second half of the simulation period is explained by accumulated demographic momentum. That is, the same fertility rate will result in a larger number of children in a population with more women of reproductive age, so an initial increase in population has a multiplicative effect in the future.

The growth of the outstanding pension benefits better demonstrates the change in age structure. Here the low dependency demographic scenario is clearly preferable. This is because it leads to the smallest increase in the share of the pension age population.

The effective rate of the workers' pension contributions in all simulations is 17% of labour income in the first period. If, as is assumed in these simulations, the arrangement of the pension system stayed the same and the constant replacement rate was to be maintained, then by the middle of the simulation period, when the demographic situation is the worst, the workers' pension contribution rate would have to increase to 24% for a low dependency or 32% for a high dependency demographic scenario.

This sensitivity analysis allows us to make some important conclusions:

- The main findings are largely robust to demographic assumptions;
- Different variables display different sensitivity to demographic assumptions. It is important to analyze broad rage of parameters as concentrating on only some of them could be misleading;
- Increase in fertility level give substantial positive results only in the long run and in the short run have a detrimental effect on per capita welfare parameters. This does not mean that an improvement of demographic situation can be neglected, as this may result in a worsening of the situation in the future.

#### *4.5.6.1. Government consumption*

Much of the discussion in academic and public circles is devoted to the effect of population ageing on public spending, with special emphasis on growing health expenditures (Waldo *et al.,* 1989; Schneider and Guralnik, 1990; Dang *et al.,* 2001).

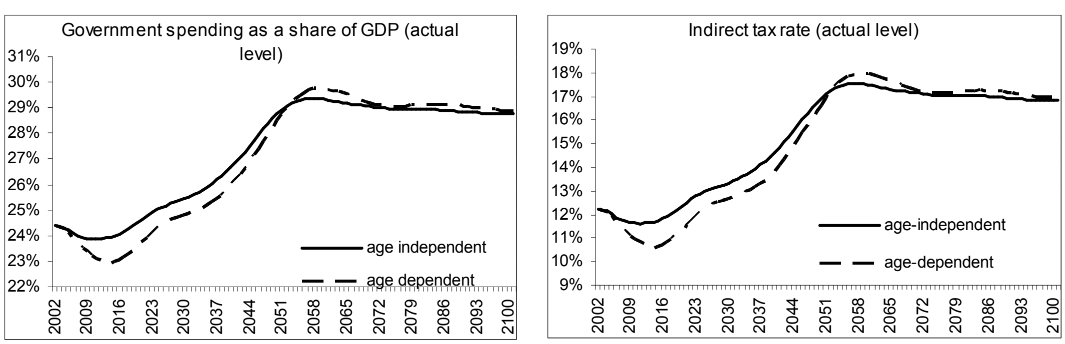
The argument is that the size of the government spending depends not only on the size of the population but also on its age composition. Some age groups require higher government spending on health (65+), others on education (6-19).

It is very difficult to estimate age-specific government consumption. But several attempts have been made, as the issue of population ageing raises uncertainty about the future of public finance (Cutler *et al.,* 1990). There are no such estimates for Ukraine. In the base line scenario, the implicit assumption is that government consumption per person is fixed and age-independent.

In alternative scenario with age dependent government consumption, it is divided into three categories:

- Education expenditures (around 30% of all government consumption in 2004-2006 (System of Nation Accounts of Ukraine)) – assumed to be proportional to the number of people aged 0-19;
- Health expenditures (around 20% of all government consumption in 2004-2006) – per capita health expenditures for age group 0-19 assumed to be 18% of 65+ expenditures and for age group 20-64 8% of 65+ expenditures. These proportions are taken from Cutler *et al.* (1990), who calculated them based on the 1989 US data;
- Other expenditures – depend on total population.

**Figure 4.11. Results for age-dependent and age-independent government consumption**




The results of the baseline scenario are compared with the new scenario with age-dependent government consumption in Figure 4.11. The introduction of the age component into the government consumption has a noticeable effect on government finances. During the first 50 years of the simulation period, the government consumption share in GDP is lower if we take into account age structure of population; consequently, indirect tax rate is also lower. During this period, the decline in educational spending dominates the effect. Only after 2053, will increasing health expenditures result in a higher overall level of government consumption in the scenario with age-dependent spending. However, the difference is not very big, and it does not change our overall conclusion that population ageing will result in a growing share of government consumption in GDP.

## 4.6. Pension System Reform

### *4.6.1. Modelling pension system*

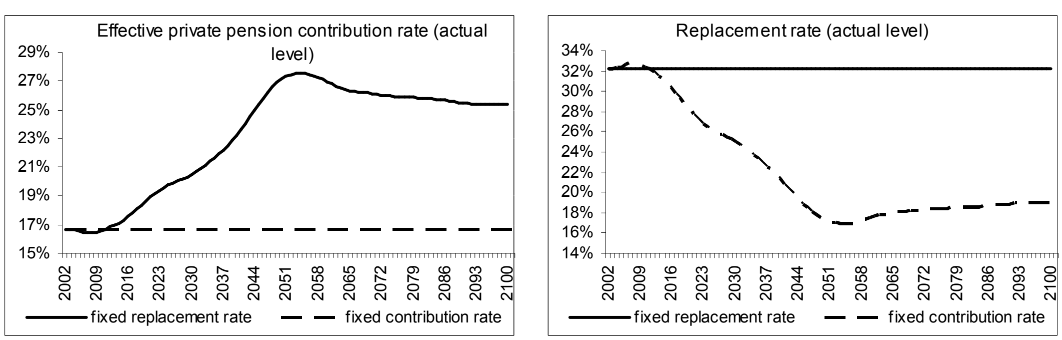
As mentioned before, the PAYG component of the pension system is included in the model. In fact, it is only partially PAYG, as part of the pensions administered by the Pension Fund is financed from the state budget. In the model, this system is preserved, as there is no political discussion about changing it. The pensions are financed by workers' pension contributions out of labour income and government pension contributions. Government pension contributions in 2002 were 13% of the total expenditures.

Three variables determine the size of the contributions and the size of the benefits: 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.

### *4.6.2. No change in pension eligibility age*

If pension eligibility age is not increased, there are two options for keeping the Pension Fund balanced without an increase in state contributions: increase workers' pension contributions (baseline scenario) or decrease the replacement rate. Figure 4.12 summarizes these two options. In the former case, the effective rate of workers' pension contributions would have to be increased from 17% to 28% by 2050. In the latter case, the replacement rate would have to decrease from 33% to 17% by the same period.

**Figure 4.12. Scenarios with no change in pension eligibility 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 eligibility age is not only necessary but also inevitable.

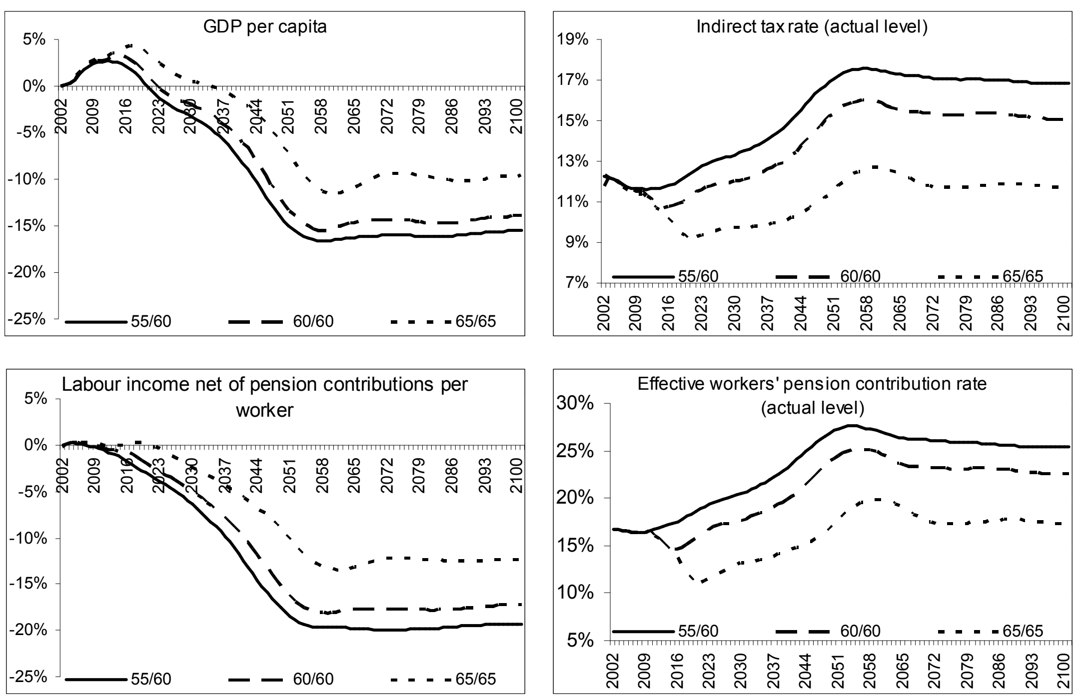
### *4.6.3. Increase in pension eligibility age*

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

- Increase of pension age for females to 60;
- Increase of pension age for males and females to 65.

In each case, the pension age increase starts in 2011 after the next presidential elections in 2010. It is assumed that before 2011 such a reform is not possible for political reasons. In each case, pension age is increased gradually by one year each year: i.e. for the first scenario, it takes 5 years for the female pension age to increase from 55 to 60 years.

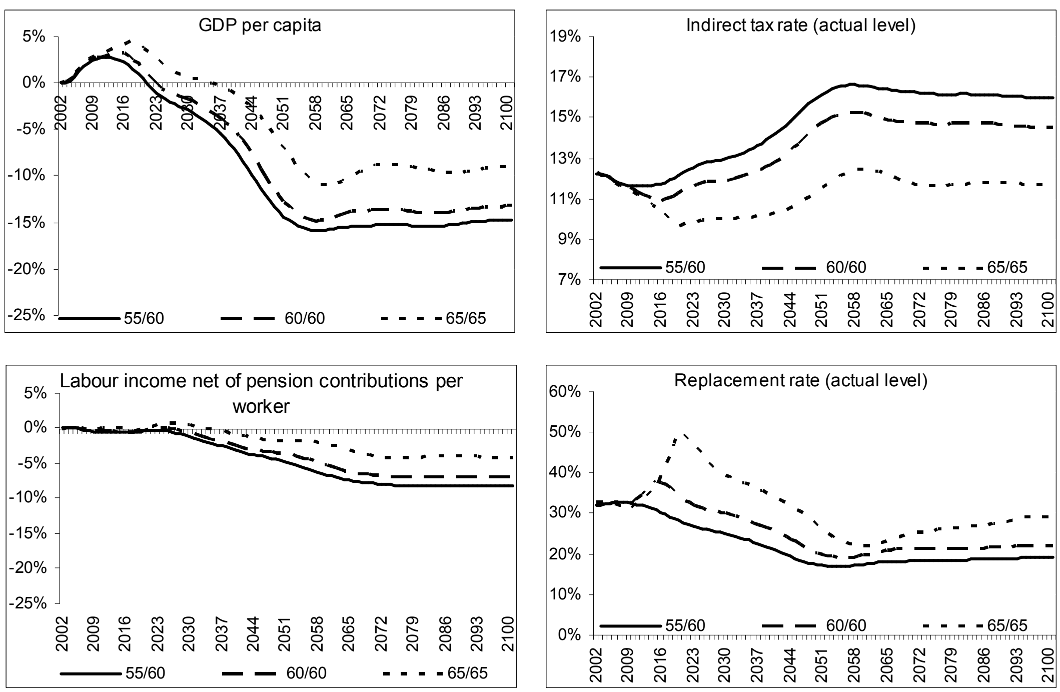
**Figure 4.13. Scenarios with increase in pension eligibility age (fixed replacement rate)**




The results of these scenarios together with the baseline are presented in Figure 4.13. 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, distribution of income between workers and pensioners, GDP per capita and government finances.

A gradual increase of pension age to 65 years for both sexes has a greater positive impact. GDP per capita by 2055 declines by 11% compared with 17%, if the pension age is not changed. The indirect tax rate exceeds the initial level for only 10 years (in the middle of the simulation period). The labour income net of pension contributions per worker declines by 13% by 2055 compared with 20% in the baseline case. The effective rate of worker pension contributions would have to increase to 20% at the highest point, and at the beginning of simulation period they could be reduced.

**Figure 4.14. Scenarios with increase in pension eligibility age (fixed contribution rate)**




The results for the same three scenarios with a fixed contribution rate are presented in Figure 4.14. The dynamics of the GDP per capita do not change. The indirect tax rate is slightly 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 8% if the pension age is not changed, or by 4% if the pension age is increased to 65 years for both sexes.

The replacement rate in the baseline scenario decreases from 33% to 17% by 2050. If the pension age for females is increased to 60 years it decreases to 19%, and if the pension age is increased to 65 years for both sexes to 22% during the same period (after the initial significant increase).

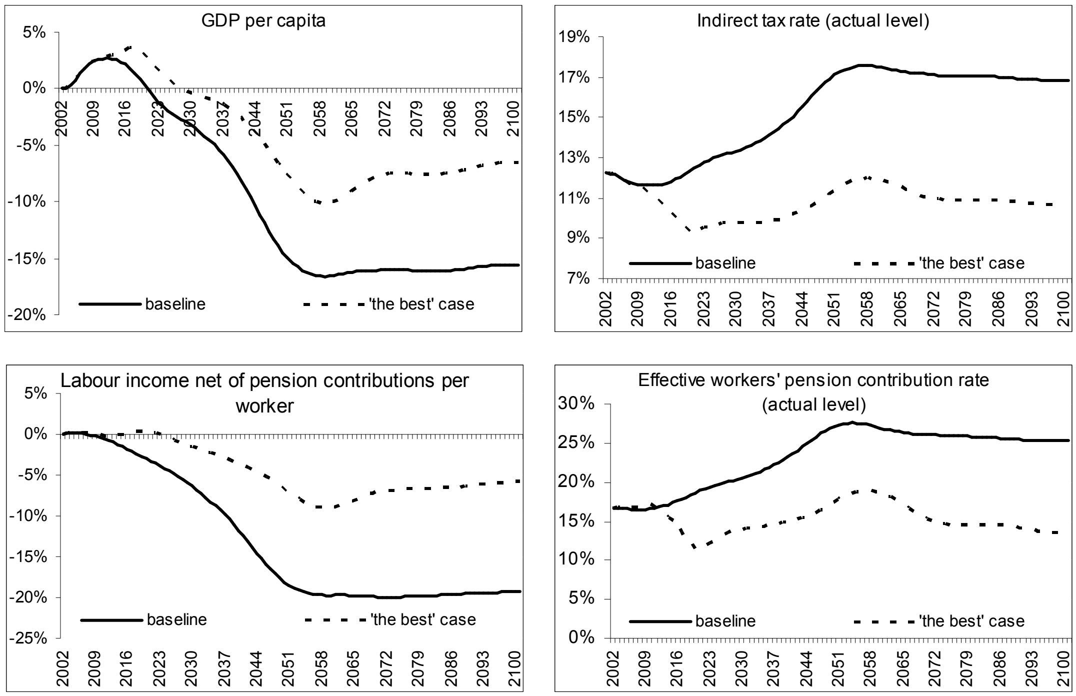
#### *4.6.4. The "best case" scenario*

The simulations presented in this paper cover a very long period of time and are based on a number of crucial assumptions. The two key assumptions affecting the macroeconomic variables and pension system are demographic development over the next 100 years and political decisions about the structure of the pension system, such as the pension age and replacement rate. The results presented so far have examined the impact of these two factors separately, and show a significant negative impact of population ageing on the Ukrainian economy. Because of the high uncertainty of these two factors (especially the population projections), it is hard to predict which of the number of potential combinations will be realized. In this section, the most favourable combination of demographic and pension scenarios is presented in order to consider whether sound political policy and positive demographic shift combined will be enough to overcome negative impact of population ageing.

The "best case" scenario presented combines the most favourable demographic scenario – low dependency population projection – with the most favourable pension scenario – an increase of pension age to 65 for both sexes. In Figure 4.15, it is compared with the baseline.

In the "best case" scenario, GDP per capita, fiscal and pension parameters significantly improve compared with the baseline scenario. However, even a combination of the most favourable demographic and pension scenarios will not guarantee against the macroeconomic loss. GDP per capita declines by 2055 by 10% compared with 17% in the baseline scenario. The labour income net of pension contributions per worker declines by 9% at its minimum, compared with 20% in the baseline. The effective rate of workers' pension contributions in the "best case" scenario needs only to be marginally increased from 17% to 19% by 2060, and by the end of the simulation period can be reduced to 14%. Only the indirect tax rate can be set below its initial level throughout the whole simulation period.

**Figure 4.15. The "best case" scenario**




### *4.6.5. Implications for pension reform*

The simulations presented in the previous section 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 eligibility age has to be increased. Increasing the female pension eligibility age by 5 years to match that of males has a small positive effect on the pension system and the wider economy. An increase in pension age to 65 for both sexes significantly improves the stability of the Pension Fund, and has a large positive impact on other macroeconomic parameters.

The second tier of the pension system will be financed by diverting some of the contributions that are currently directed to the PAYG fund. 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 contradicting requirements can be met at the same time. As was explained above, contributions to the Pension Fund are not paid from all of the labour income. This happens partially as a result of the preferential treatment of some categories of workers. The explanation is partially in the shadow economy. As a result, while the standard pension contributions in 2002 were 34% of the gross wage, calculated from the SAM and Pension Fund balance, the effective rate was only 17%. Thus, it should be possible to decrease the contributions rate to the PAYG component for those who pay the standard rate, and increase it for those who use the privileged systems or do not make contributions at all.

Two types of simulations were presented: with fixed replacement rate and with fixed contribution rate. They represent two extreme cases. The most likely pension reform will involve a combination of both. Nevertheless, it is important to determine a long-term strategy for a pension system with stable rules, and consistently implement them. 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.

## 4.7. Concluding Comments

### *4.7.1. Model limitations and further development*

The work undertaken in this chapter is the first attempt to model the demographic change in Ukraine in a CGE framework. The chosen intertemporal CGE approach proved useful for evaluating the direction of expected changes and broad quantification of the impact. The model developed is rather simple, but provides very important first results.

There are two main disadvantages of the chosen approach in studying population ageing. The first is the fixed labour force participation rates and no explicit leisure/work choice. The simple utility function used in the model formulation does not include preferences for leisure. In the situation modelled, the shrinking labour force leading to the higher price of labour could result in higher labour force participation and alleviate the problem. This effect is not taken into account, and so the negative results are potentially overestimated.

The second disadvantage is the inability to account for differences in age-specific behaviour. According to the life-cycle hypothesis, saving/consumption choices are age-dependent. The large changes in age structure described above should have an impact on saving and consumption behaviour. Cross-country empirical evidence suggests that an ageing population should have lower aggregate savings rate, although some household surveys found that recent retirees save more than middle-age workers (for a discussion of macro and micro evidence see Miles (1997), Weil (1994)). Also, age-specific labour force participation resulting from the endogenous work/labour choice would allow the endogenisation of retirement decisions.

Taking into account the limitations of the model, the logical way for further investigation would be to use the OLG approach. It would also allow the tracking of changes in the welfare of different age groups in response to different policy options. This approach would bring more insight and realism. However, I do not expect that the results obtained with the simple intertemporal CGE model would change significantly. The reason for that is a very strong negative impact of population change. It is unlikely that marginal changes in age-specific labour force participation would reverse it. Thus, the chosen approach provided an important tool for evaluating the relative magnitude of different effects, and provided useful platform for future, more elaborated modelling.

#### *4.7.2. Summary*

According to population projections, the Ukrainian population is going to decline and age rapidly during the next 50 years. None of the experts making population projections doubt this. However, the pace of population ageing varies considerably based on the assumptions. This will have important consequences for the Ukrainian macroeconomic outlook. The Ukrainian pension system, which at the moment is organized on the Pay-As-You-Go principle, will be especially vulnerable as the number of contributors declines and the number of beneficiaries increases.

In this chapter, the macroeconomic effects of population ageing were studied in a CGE framework. A standard intertemporal CGE model, with a representative indefinitely living household, was used to model the effect of a changing age structure on major macroeconomic variables, with special focus on the pension system. Population ageing in the model is introduced by the changing age structure of the household sector.

The conclusions are not very promising, as even in the "best case" scenario (an unlikely combination of the best demographic and the best pension scenario), GDP per capita will decline by 10% in the next 50 years (compared with the base run with no population age structure change).

On the side of the pension system arrangement, the analysis presented demonstrated a few things. First of all, an increase in pension age is essential. An increase of the pension age to 65 years for both sexes is virtually enough to keep the pension system with the current replacement rate (which is still quite low by European standards) and with the current contribution rate (which, on the other hand, is rather high).

Another factor of the Ukrainian pension system that needs to be addressed is the uneven contribution burden across different categories of workers (privileges for agricultural workers and self-employed) and the large shadow market. Solving these interlinked problems should allow the decrease in contribution rates for those workers who currently pay full contributions. 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 decrease 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. It is essential to go through with it, and the time is of crucial importance as the process of population ageing is going to accelerate in the future.

## Chapter 5. Conclusions

This dissertation has examined the process of population ageing in Ukraine from different perspectives. It starts with the analysis of past and potential future demographic trends, and then continues with the study of the impact of population ageing on wage structure and pension system.

Analysis of Ukrainian demographic trends has shown that this country is unique in many respects. Over the past 20 years, it has experienced very low fertility. This is the most important factor behind the process of population ageing in Ukraine. Unlike in developed countries, where increasing longevity plays important role in population ageing, Ukraine has not shown significant improvement in life expectancy since the mid 1960s.

Low life expectancy and the large gender gap in Ukraine is explained by the exceptionally high mortality rates of working age males. This has a significant negative economic impact, as the most productive age groups suffer the most. The analysis of mortality patterns and causes suggests that this could be linked to alcohol consumption and other risk factors associated with it.

All population projection scenarios of the UN Population Division and the Institute for Demography and Social Studies at the Academy of Science of Ukraine assume an increase in life expectancy during the next 45 years. This, together with sub-replacement fertility, will result in rapid population ageing. Many developed countries rely on the flow of immigrants to combat these negative processes. However, at the moment, Ukraine does not have a migration policy that would address this issue. A sensitivity analysis of population projections with respect to migration scenarios showed that even a large –by Ukrainian standards – increase in net migration will not reverse, but may slow down, the demographic trends of population decline and population ageing.

All the population projections discussed in Chapter 2 forecast population decline and population ageing. By 2050, the consumption-adjusted total dependency ratio will have increased from the current level of 60% to 67%-90%, depending on projection scenario. A sensitivity analysis of fertility and mortality assumptions showed that life expectancy assumptions influence this parameter more during the projection period.

Two combination scenarios that result in high dependency (high life expectancy and low fertility) and low dependency (low life expectancy and high fertility) were extended until the end of the century, under the assumption that fertility and mortality will not change after 2050. During this period, the population of Ukraine will almost reach a stable state. It has been shown that, depending on the scenario, the stabilized level of dependency will be very different. It will be 100% in the case of the high dependency scenario and 70% in the case of the low dependency scenario.

The process of population ageing also affects the age structure of the labour force. The proportion of younger workers decreases and the proportion of older workers increases. If these two groups of workers are not perfect substitutes, this can lead to changes in the age-earnings profile shape. The analysis presented in Chapter 3 has shown that cohort size has a significant negative effect on earnings, but it diminishes with age. This means that the larger the cohort the lower earnings it will receive. The negative cohort size effect is the strongest at the beginning of career. If we reverse the statement, it can be argued that if new cohorts entering the labour market are unusually small then they are going to experience higher earnings and put older larger cohorts at a relative disadvantage.

It has been shown in Chapter 3 that if we apply estimated age-earnings profile coefficients to the future age structure of the Ukrainian labour force, then we get a profile of unusual shape, with the wages of younger workers exceeding those of older workers. It is of course impossible to predict future age-earnings profile based on such estimates, as they are based on the data from a rather short period and do not take into account other factors that will influence the labour market. However, it does provide a valuable first estimate of potential change, and shows that the effect could potentially be very significant.

The main argument against this sort of projection is that workers with more experience can perform the work of workers with low experience (at least in some professions), and this would not allow the earnings of younger workers to increase so much. However, this would still lead to a flattening of the age-earnings profile. One potential consequence of this could be decreasing investment in human capital if the return on it decreases.

Population ageing will also have consequences for the Ukrainian macroeconomic performance. The Ukrainian pension system, which at the moment is organized on the Pay-As-You-Go principle, will be especially vulnerable, as the number of contributors will decline and the number of beneficiaries will increase. In Chapter 4, the effects of population ageing were studied in a CGE framework. A standard intertemporal CGE model with a representative indefinitely living household was used to model the effect of changing age structure on major macroeconomic variables, with special focus on the pension system. Population ageing in the model is introduced by the changing age structure of the household sector. The conclusions are not very promising, as even in the "best case" scenario (an unlikely combination of the most favourable demographic and the most favourable pension scenario), GDP per capita will decline by 10% in the next 50 years (compared with the scenario with no population age structure change).

The analysis of the pension system arrangement demonstrated a few things. First, an increase in pension age is essential. An increase of the pension age to 65 years for both sexes is enough to keep the pension system with the current replacement rate and the current contribution rate.

Second, the uneven contribution burden across different categories of workers (privileges for agricultural workers and self-employed) and the large shadow economy needs to be addressed. Solving these interlinked problems should allow a decrease in contribution rates for those workers who currently pay full contributions. However, this will only be possible if public trust in the pension system is restored. At the moment, with almost flat-rate benefits, there is little motivation 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 decreases this motivation.

The process of population ageing also has many other macroeconomic effects that were not studied in this dissertation. It changes the demand composition, as our consumption preferences depend on our age. It affects national savings, because, at different stages in their life cycle, people have different saving/consumption patterns. There can be significant impacts on the size, composition and productivity of the labour force. It may even potentially affect the speed of technological progress, as new technology comes with new investments, and, if the labour force is shrinking, this will decrease the required investment level. These processes were not addressed in this dissertation but should attract the attention of other researchers and policymakers.

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