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# FORECASTING NATURAL POPULATION CHANGE: THE CASE OF LATVIA

DISCUSSION PAPER

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**CONTENTS**



*ABBREVIATIONS*

CIS – Commonwealth of Independent States
CSB – Central Statistical Bureau of Latvia
EU – European Union
EU11 – Bulgaria, Croatia, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia and Slovakia
EU27 – EU countries from 1 January 2007 to 30 June 2013
FROOPP – frequent out-of-pocket purchases
GDP – gross dpmestic product
IBRD – The International Bank for Reconstruction and Development
pp – percentage point
UN – United Nations
WB – The World Bank
WHO – World Health Organization

## ABSTRACT

The paper is devoted to the natural population change forecast in Latvia for the time horizon until 2030. The motivation for this paper is twofold. First, population ageing is an obvious problem for the whole EU with a tendency to worsen in the future. However, for EU11 countries, including Latvia, the situation is more challenging. Second, historical population data have been revised based on the results of the last population census that took place in Latvia in 2011. This data correction could help to make a clearer vision of future tendencies in demographic indicators.

The approach developed in 2007 by Hyndman and Ullah is used for the natural population change forecasting. This approach combines functional data analysis and principal components decomposition. Although the applied approach is a technical one, it is useful for understanding what a policy maker could deal with in 15–20 years from now in the case of no-policy-change and no-population-habits-change scenario. By understanding this issue, it could be easier for the policy makers to make right decisions with a long-run perspective helping population and economy to be prepared well for the problems associated with population ageing that will accumulate in the future.

The model is used to forecast mortality rate schedules separately for males and females as well as fertility rate schedules. The main findings of the paper are the following. The total period fertility rate is forecasted to increase to about 1.6 by 2030. Life expectancy at birth is projected to increase for males and females by 4 and 3.4 years respectively. Nevertheless, the natural population decrease in 19 years will reach 200 thousand including the decrease of about 190 thousand in population aged 20–64, while the old-age dependency ratio will increase to 36.5%.



**Keywords:** functional approach, fertility rates, mortality rates, population forecasting

**JEL codes:** J11, C53, C14, C32, O11, O52


The views expressed in this publication are those of the author, employee of the Monetary Policy Department of Latvijas Banka. The author assumes responsibility for any errors and omission.

## NON-TECHNICAL SUMMARY

In this paper, we forecast natural population changes, i.e. we are trying to answer the question what the population size will be in Latvia in 2030 in the absence of migration, which are called mechanical population changes. Emigration has decidedly left its negative impact on population dynamics in Latvia since early 1990, especially during the moments of economic instability. The number of emigrating people diminished substantially after the last economic crisis. This tendency is expected to continue in the future, stimulated by steady economic development and income convergence processes. Therefore, net migration will affect population dynamics negligibly in the medium term and natural population changes will be the only factor influencing population dynamics in Latvia. Even if emigration remains an important issue in the medium term, it is still essential to realise the relative role of the natural factors influencing changes in the population structure and quantum in the future. Moreover, this forecasting exercise is of high importance, since, taking into account the very small average number of childbirths and the increasing length of life of men and women, Latvia faces the so called ageing population problems, and it is essential for the policy makers to have a clue about the size of ongoing problems in order to prepare and implement the policies to minimise negative effects betimes.

So, why is population ageing considered to be a problem? This is because of the economic and social complications that could arise in the future, if the policy makers do not succeed in preparing the economy and society for such a shift in the population structure. Population ageing has a straightforward effect on the size and structure of the labour force. With time, changes in women's behaviour towards having fewer children than their parents had led to a diminishing number of young people who enter the labour market. This may lead to a decline in the number of employed people and, as a result, to lower economic activity and population wealth growth. Lower output growth in line with a higher share of ageing population, in turn, will lead to a situation, when it is even harder for the working people to maintain proper welfare of the retired ones. Population ageing has also indirect effects that are much wider and influence most, if not all, aspects of economic development. One of the channels through which population ageing affects economic performance is private consumption. Consumption patterns change with age: older people tend to spend more of their income on housing and healthcare. Labour earnings tend to vary throughout the life cycle as well. There is a tendency of earnings to decline at an older age. Therefore, population ageing and, as a result, the increasing share of older consumers could negatively affect economic development via consumption. There are also other more specific economic consequences of ageing population that are discussed in this paper.

The purpose of this paper, as mentioned before, is to forecast natural population changes in order to realise what the demographic situation will be in 2030 in the absence of economic crisis, emigration or any additional incentives of the policy makers to improve the demographic situation in Latvia. To do this, we use the approach developed in 2007 by Hyndman and Ullah. It is used to forecast mortality rate schedules separately for males and females, as well as fertility rate schedules. Such an approach is called the technical approach. It means that in forecasting only the information captured by historical data is used. There are no expert judgments on future tendencies (e.g. changes in male or female behaviour when creating a family, another economic boom or bust). This approach is not useful for making any simulation to answer the question what will happen if we implement one policy or another. Nonetheless, the technical approach is useful for understanding what a policy maker could deal with in 15–20 years from now in the case of no-policy-change and no-population-habits-change scenario. By understanding upcoming problems, it could be easier for the policy makers to take right decisions with a long-run perspective, helping population and economy to be well prepared for the problems associated with population ageing that will accumulate in the future.

The main findings of the paper are the following. The total period fertility rate is forecasted to increase to about 1.6 by the year 2030. Life expectancy at birth is projected to increase by 4 years for males and by 3.4 years for females and, as a result, pushes the old-age dependency ratio up to 36.5% in 2030. Taking into account the forecasted fertility and mortality rates, the total population natural change was calculated: the natural population decrease until 2030 will reach 200 thousand, including the decrease of about 190 thousand in population aged 20–64 in the no-policy-change and no-population-habits-change scenario. Despite the projected improvement in the total fertility rate, the number of newborns will decline in the medium term. In such a situation, in the absence of immigration the population ageing problem will become even more urgent, having negative effects on economic performance and exerting additional pressure on the pension system in Latvia.

The paper discusses several pronatalist family policy measures: how the policy makers could stimulate improvement in birth rates in Latvia, such as direct cash payments, indirect transfers and improving work–family compatibility. The evidence of efficiency of these incentives is ambiguous; however, the policy makers should try to find the most suitable and efficient way to help Latvian women to have as many children as they wish.

## INTRODUCTION

Planning of long-term socio-economic policies (e.g. the reformation of the pension, education and health service systems or strategic planning of future economic development related to potential GDP growth) heavily depends on the population dynamics expected in the future. Despite ".. little need to emphasise the importance of future population estimates for countries attempting to plan their economic and social development" (UN (1956)), let us stress the major aspects of this importance for the case of Latvia.

Population ageing is an obvious problem for the whole EU with a tendency to worsen in the future. However, for EU11 countries the situation is more challenging, since the observed very low average fertility rates and improvement in death rates both worsen the problem of ageing in comparison with other EU Member States. One could mention several economic consequences of ageing population. The first consequence is the straightforward impact on the labour market – a reduction in the number of the working-age population. This could lead to a smaller number of workers and therefore induce negative implications for output growth and population well-being. The processes caused by population ageing will influence the economic activity and growth performance through other channels along with the labour market: consumption, savings, investment and even financial stability.

Thus, it is essential for the policy makers to have a vision about changes in population in the future to be well prepared in time. Since early 1990, emigration has decidedly left its negative impact on the population dynamics in Latvia, especially during the moments of economic instability. The number of people who emigrate diminished substantially after the recent economic crisis. This tendency is expected to continue in the future, stimulated by steady economic development and income convergence processes. Therefore, in the medium term net migration will affect population dynamics negligibly and thus natural population changes will remain the only factor influencing the population dynamics in Latvia. Even if emigration remains an important issue in the medium term, it is still essential to realise the relative role of the natural factors influencing changes in the population structure and quantum in the future.

In this paper, we focus on the forecasting of natural changes of population, projecting fertility and mortality rates for Latvia. The approach developed in 2007 by Hyndman and Ullah is used in the natural population change forecasting. This approach combines functional data analysis and principal components decomposition. We do not extend the mentioned approach by introducing any socio-economic variables to explain the dynamics of fertility and mortality rates because of very short time series of socio-economic indicators for Latvia. This implies that forecasts based on such estimation could provide results only for the no-policy-change scenario, giving the policy makers the information about what will happen in the future if they take no action to improve the current demographic situation and there is no change in habitual behaviour in Latvia.

The structure of the paper is as follows. In Section 1 the theoretical framework of the forecasting procedure is outlined. Sections 2 and 3 are devoted to forecasting the fertility and mortality rates. The baseline scenario of the natural population change is put together based on the previously projected fertility and mortality rates in

Section 4. Section 5 outlines some economic consequences of ageing population. Conclusions summarise the results of this paper.

## 1. THEORETICAL FRAMEWORK

The original functional data model was introduced by Hyndman and Ullah (2007). This concept combines functional time series analysis and principal components decomposition. Before starting a discussion on the mortality and fertility forecasting method, it will be useful to define the problem more precisely.

Let $y_t(x)$ stand for the logarithm of the observed mortality or fertility rate for age $x$ in year t. By assumption, there is an underlying smooth function $f_t(x)$ that we are observing with error and at discrete points of age $x$. Thus, we observe the functional time series $\{x_i, y_t(x_i)\}$ where $t = 1, \dots, n$ and represents years of historical data, $x_i \in [x_1, \dots, x_p]$ and represents single years of age:

$$y_t(x_i) = f_t(x_i) + \sigma_t(x_i)\varepsilon_{t,i} \quad (1)$$

where $\varepsilon_{t,i}$ is an independent and identically distributed standard normal random variable and $\sigma_t(x_i)$ allows the amount of noise to vary with age $x$. We are interested in forecasting $y_t(x)$ for $x \in [x_1, \dots, x_p]$ and $t = 1, \dots, n + h$ where $h$ is forecasting horizon.

In order to analyse fertility or mortality rates and produce their point forecasts, along with prediction intervals several steps should be taken:

1. Smooth the actual data for each period *t* using a non-parametric smoothing method to estimate $f_t(x)$ for age $x \in [x_1, \dots, x_p]$ from the functional time series.

2. Decompose the fitted curves using the following model:

$$f_t(x) = \mu(x) + \sum_{k=1}^{K} \beta_{t,k}\phi_k(x) + e_t(x) \quad (2)$$

where $\mu(x)$ is the mean of logarithm of mortality or fertility rate across years, $\phi_k(x)$ is a set of orthonormal basis functions, and $e_t(x)$ is the model error which is assumed to be serially uncorrelated.

a. The optimal orthonormal basis set is obtained via principal components. For a given K, this gives the basic functions $\{\phi_k(x)\}$ which minimise the mean integrated squared error. This basic set provides the best fit to the estimated curves. L1-median of the estimated smooth curves $\{\hat{f}_1(x), \dots, \hat{f}_n(x)\}$ is given by $\hat{\mu}(x) = \text{argmin}_{Q(x)} \sum_{t=1}^{n} \left\| \hat{f}_t(x) - Q(x) \right\|$, and the medina-adjusted data is denoted by $\hat{f}_t^*(x) = \hat{f}_t\ (x) - \hat{\mu}(x)$. In order to obtain robust principal components for $\hat{f}_t^*(x)$, two methods are used: the weighted principal components approach and an approach based on a projection pursuit algorithm.

b. Projection pursuit algorithm is used to obtain initial (highly robust) values for $\{\hat{\beta}_{t,k}\}$ and $\{\phi_k(x)\}$ $(t = 1, \dots, n;\ k = 1, \dots, K)$. Then integrated squared error for period *t* is defined and weights are computed. Afterwards, all these weights are used to obtain new estimates of $\{\hat{\beta}_{t,k}\}$ and $\{\phi_k(x)\}$ using the weighted principal components approach.

3. Fit univariate time series models to each of the coefficients $\beta_{t,k}$, $k = 1, \dots, K$. In this case, we use univariate robust ARIMA models, since in the case of Latvia, we do not have sufficiently long time series of socio-economic indicators to estimate more comprehensive models. This implies that forecasts based on such estimation could provide results only for the no-policy-change scenario, providing a policy maker with information about what will happen in the future if they take no action to improve the current situation in demographic processes in Latvia.

4. Forecast coefficients $\beta_{t,k}$ using the fitted time series models.

5. Use the forecast coefficients with (2) to obtain projections of $f_t(x)$. From (1), forecasts of $f_t(x)$ are also forecasts of $y_t(x)$.

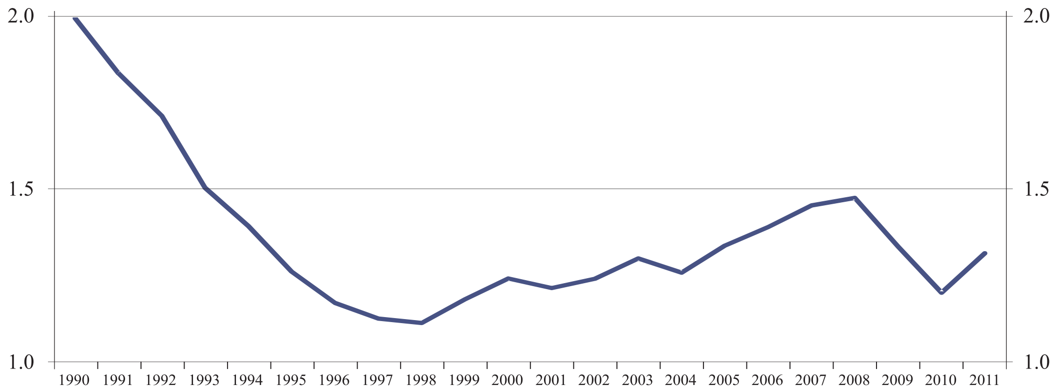
6. The estimated variances of the error terms in (1) and (2) are used to compute confidence intervals for the forecasts.

Annual age specific fertility rates of Latvian population by single years of age (15–49) as well as annual age specific mortality rates separately for males and females by single years of age (0–85+) for the period 1990-2011 were obtained from the CSB. The fertility rates are defined as the number of live births during each calendar year according to the age of the mother, per 1 000 female residents of the same age. In turn mortality rates are defined as the number of deaths of male/female residents at a given age per 1 000 male/female residents of the same age.

## 2. FERTILITY RATE FORECASTING

In early 1990, the total period fertility rate was close to the replacement fertility rate in Latvia. However, a sharp decrease in this demographic indicator has been observed afterwards, reaching a historical low of 1.1 in 1997 (see Figure 1). There were several factors that caused such dynamics: mechanical movement of the population, economic situation and sociological processes.

*Figure 1*
**Total period fertility rate (1990–2011)**




Sources: author's calculations and Eurostat.

At the beginning of 1990 when Latvia regained independence, the flows of mechanical movement of the population changed radically. Upon the re-establishment of independence, migration of population to the CIS countries increased significantly, while arrivals subsided. To a large extent, this tendency was caused by the fact that a major part of people employed in the soviet administration and those who served in the soviet army returned to their homeland. In 1992, about 80 000 Russian troops were still staying in Latvia (Bohlen (1992)). All these troops had been withdrawn back to Russia by 1994. As a result, many young people and young families (potential contributors to the fertility rate in Latvia) emigrated from Latvia. After all, about 15% of people who immigrated to Latvia from 1945 to 1990 left the country at the beginning of the 1990s (Bauls and Krišjāne (2000)). Emigration reached its peak in 1992 and went down rapidly in later years.

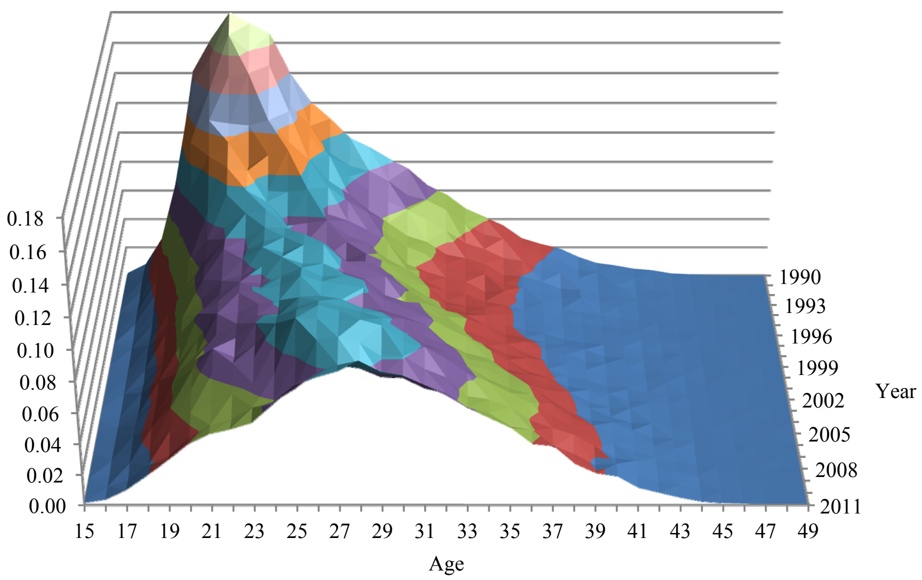
In the same period of time, the Latvian economy was in a critical situation, thus causing an additional stimulus for emigration. Economic transition to a market economy resulted in a strong recession accompanied by extremely high levels of inflation and unemployment. As a result, the volume of the economy diminished by about 45% in real terms in 1991–1995 (IMF (2003)).

A very high level of uncertainty during the economic restructuring as well as a very poor economic situation could cause postponing of childbearing or even refusing of having additional children. The structure of emigration could contribute to the worsening of demographic statistics as well. As a result, the time schedule of births changed significantly during the 1990s (see Figure 2). The time schedule of births continued to change afterwards but not so drastically. Analysing the whole period between 1990 and 2011, we can observe two major tendencies:

1. a very sharp decline in the period fertility rate of women aged 18–25 as well as a significant decline in the indicator of older women;

2. postponing childbearing to an older age – the mean age of fertility rate rose from 25.7 in 1990 to 29.3 in 2011.

*Figure 2*
**Period age specific fertility rates (1990–2011)**




Source: author's calculations.

The economic and financial crisis in 2008–2009 had an additional negative impact on the total period fertility rate dynamics in Latvia (see Figure 1). A strong decline in economic activity (by more than 20% in real terms in 2008–2010), a sharp increase in unemployment rate (from 6.0% in 2007 to 18.7% in 2010) and a very high uncertainty of households about future economic development induced females to postpone childbearing or even to abandon plans to increase the number of children.

There could be several reasons for postponing childbearing that have been mentioned in the scientific literature and could correspond to the case of Latvia. First, a very high uncertainty about economic development in the future, as it was in Latvia during the 1990s and during the most recent financial and economic crisis, stimulated women to postpone childbearing or made them refuse having more children in family, since most households require financial security and predictable future to start a family or to have more children (Adserà (2004), Luci and Thévenon (2011), Sobotka, Skirbekk and Philipov (2011)). This might be the major reason for such a dramatic decline in fertility rates for young women aged 15–25 during the 1990s as well as a sharp decline in the total fertility rate during the recent economic and financial crisis that negatively influenced the Latvian economy in 2008–2009. Additionally, low economic activity of young people combined with high unemployment rate for this population age group does not contribute positively to the financial security of young people, forcing them to postpone family-making and childbearing. Therefore, in order to give additional positive impulses to improving the demographic situation in Latvia, policy makers should maintain sustainable economic development and implement policy measures to improve the economic activity and employment rates of young people.

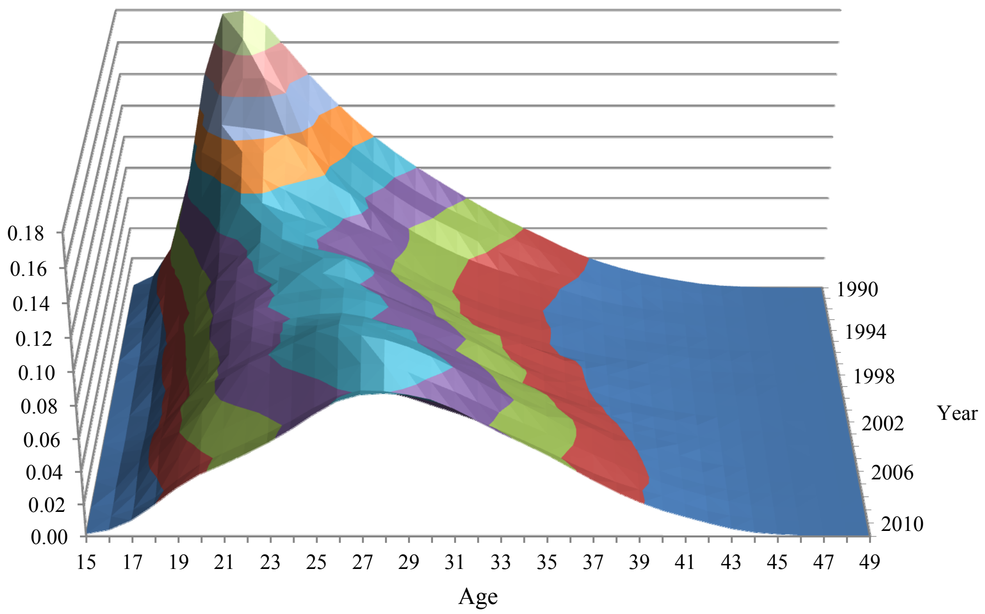
Second, economic transition caused changes in women's behaviour. According to the World Bank statistics, the percentage of women's enrolment in tertiary education has increased significantly during the 1990s (World Bank (2013)). This change in young women's behaviour could cause additional pressure to postpone parenthood (Liefbroer and Corijn (1999), Monstad et al. (2008), Ní Bhrolcháin and Beaujouan (2012)). Furthermore, better-educated women are likely to pursue careers and may postpone childbearing until they are well established on their career path (Amuedo-Dorantes and Kimmel (2004), O'Donoghue et al. (2011)). Many researchers have found that employment by itself decreases the likelihood that women would become pregnant (Mills et al. (2011)). Postponement of parenthood takes place not only because women are eager to make a career but also because of early childbearing being linked to a high "wage penalty" for motherhood, meaning that the postponement of motherhood results in a substantial increase in earnings, particularly for women with better education and those in professional occupations (Misra et al. (2007), Glauber (2007), O'Donoghue et al. (2011), Miller (2011)).

Third, cultural and ideational changes could be another reason for postponing childbearing in Latvia. The emergence of higher desires for self-fulfilment, choice, personal development and emancipation that correspond to the second demographic transition framework drives many fertility decisions (Mills et al. (2011), Coleman (2007)). In addition, children might influence the partnership and economic well-being of their parents, hence they should be carefully planned. Anticipated costs related to one's career and spending power and anticipated rewards in terms of one's sense of security and quality of the partner relationship affect the timing of entry into fatherhood (Liefbroer (2005)). This, probably, has led to a sharp increase in non-marital cohabitation in Latvia. In the case when non-marital cohabitation is viewed as a trial stage before marriage, the increase in the mean childbearing age is obvious.

Unfortunately, in the case of Latvia it is impossible to prove the significance of any of the factors mentioned above that could influence the change in women's behaviour and fertility dynamics. The major reason for that is the very short time-series describing economic and social processes in Latvia. More or less plausible data are available from 1993–1995. Therefore, in 2013 we had about 20 observations for data on annual frequency for econometric modelling, which is an extremely small number to get unbiased results for a non-panel regression. This is why we employ the Hyndman and Ullah approach (Hyndman and Ullah (2007)) in fertility (and mortality) forecasting, without any attempt to enrich it with additional socio-economic indicators.

Returning to the fertility forecasting process described in the previous Section, we can observe smoothed period age specific fertility rates in Latvia for 1990–2011 (see Figure 3). The smooth curves were estimated using a weighted median smoothing B-spline, constrained to be concave (see He and Ng (1999)) for details).

*Figure 3*
**Smoothed actual period age specific fertility rates (1990–2011)**




Source: author's calculations.

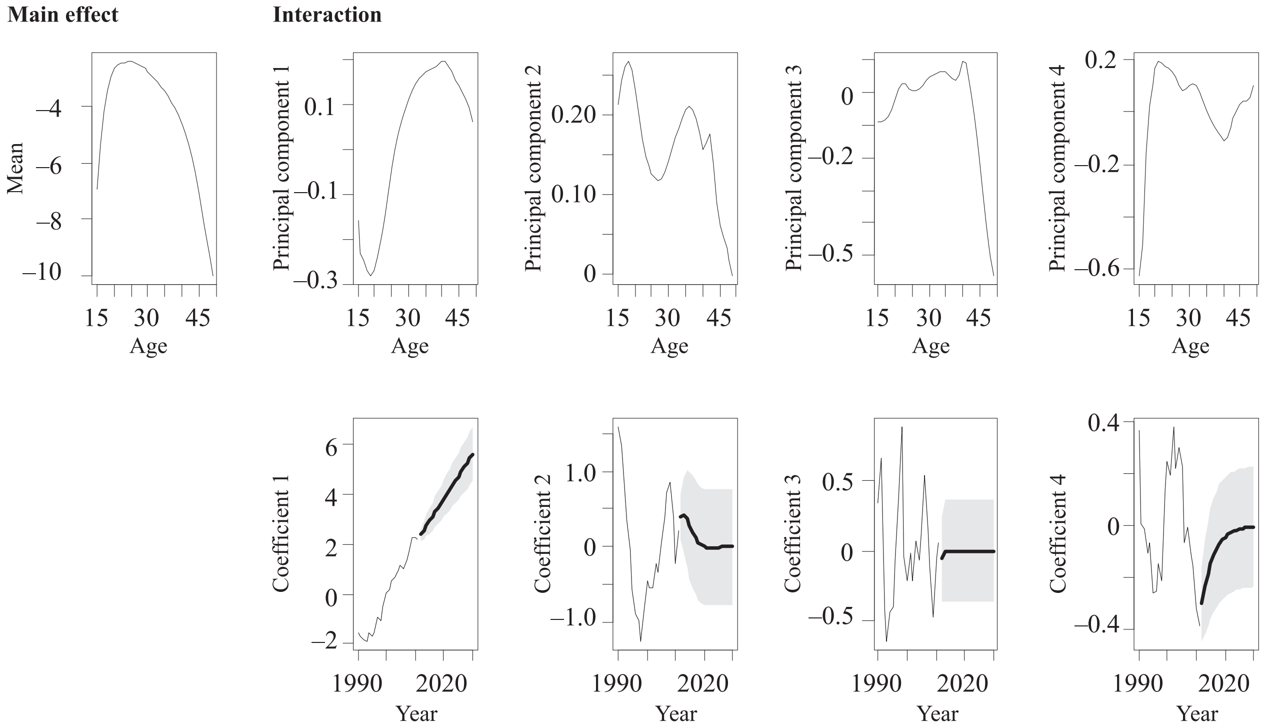
The results of fertility forecasting step 2 to 4 are shown in Figure 4[1]. During the functional principal components analysis, four principal components have been extracted, explaining 97.7% of the variation in fertility. We will discuss the meaning of the first two principal components, since they explain the major part of the variation (89.9%) and have simple and direct demographic interpretation.

[1] Here and further on, the shaded area corresponds to ±1 standard error confidence interval.

The first principal component ($\phi_1(x)$) explains 69.9% of the variation in fertility. It models female behaviour related to the childbearing age or the so called tempo effect (for the definition of tempo as well as quantum effect see Appendix). When coefficient $\beta_{t,1}$ diminishes, the mean age of birth decreases and vice versa, if coefficient $\beta_{t,1}$ increases, the mean age of birth increases as well, reflecting the postponement of childbearing to an older age.

As shown in Figure 4, the estimated coefficient $\beta_{t,1}$ has an upward dynamics that started in late 1990s. The implemented econometric model assumes that the tendency of postponing childbearing to an older age will continue in the future, increasing the mean age of childbearing from 29.1 in 2011 to 31.3 in 2030.

*Figure 4*
**Functional principal components, estimated and forecasted coefficients**




Source: author's calculations.

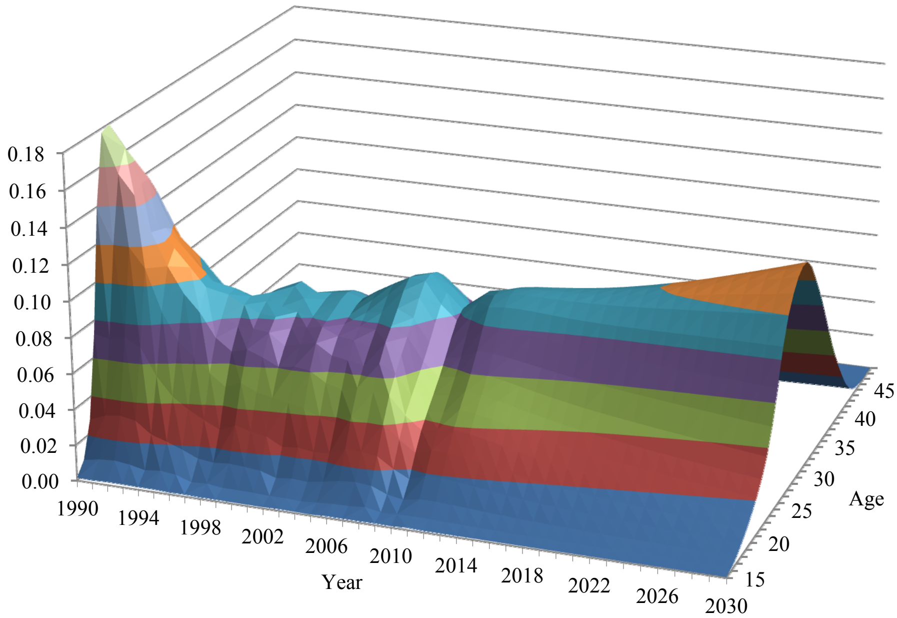
The second principal component ($\phi_2(x)$) explains 20.0% of the variation in fertility and models sensitivity of women behaviour response, e.g. to the economic situation or perception of economic conditions. As is suggested by Figure 4, in Latvia women aged 15–20 and 33–40 demonstrate more sensitivity in terms of having a baby. The dynamics of the estimated coefficient $\beta_{t,2}$ reflects the economic condition of the Latvian economy:

- economic development instability during the 1990s;
- improvement in the economic situation afterwards;
- economic overheating in 2006–2008; and
- economic crisis in 2008–2009.

The forecasted dynamics of coefficient $\beta_{t,2}$ suggests diminishing improvement in fertility for all age groups up to 2015 when it disappears. The expected improvement in fertility could be explained by the increase of births following birth postponements during the most recent economic crisis.

Employing forecasted coefficients and estimated principal components, the dynamics of fertility schedules has been forecasted (see Figure 5). On the one hand, some improvement in fertility is forecasted for women over the age of 28. On the other hand, younger women also are likely to continue to postpone parenthood and having more children in the family to an older age.

*Figure 5*
**Smoothed period age specific fertility rates (actual and forecasted; 1990–2030)**

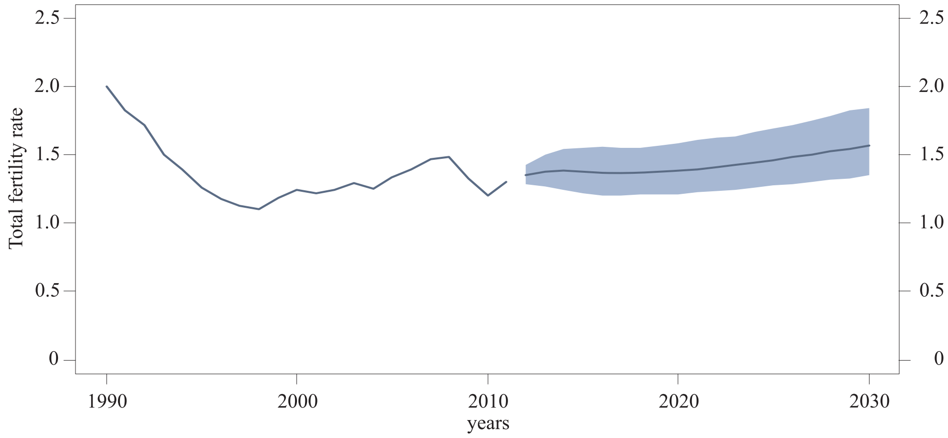



Source: author's calculations.

As a result, some improvement in the total period fertility rate is projected: the fertility level of 1.6 will be reached by 2030 (see Figure 6). The total fertility rate is projected to improve slightly faster during the period of 2012–2015, which could be explained by the reaction of females who postponed childbearing because of the financial and economic crisis in 2008–2009 to the improvement of the economic situation in Latvia. Afterwards, the total period fertility rate is projected to increase gradually. Despite forecasted improvements in the fertility rate, it will remain far below the reproduction fertility rate with an effect on the population structure and dynamics to be discussed further on in this paper.

It would be interesting to compare the obtained forecasts with those produced by other institutions. We are not taking into account the European Commission's forecasting results published in their report "The 2012 Ageing Report: Underlying Assumptions and Projection Methodologies" (European Commission (2011)), since forecasts for Latvia were based on the data that have not been adjusted to the results of the latest census. The latest available forecasts of the Ministry of Economics (Ekonomikas ministrija (2012)) show that the total period fertility rate could be at the level of 1.519 by 2030, i.e. close to the rate obtained in this paper (1.6).

*Figure 6*
**Total period fertility rate (actual and forecasted; 1990–2030)**




Source: author's calculations.

The observed total period fertility projection is based on the no-policy-change and no-population-habits-change scenario. Taking into account the fairly slow improvement in fertility forecasted for the future and the fact that more than 80% of women in Latvia aged 25–39 wish to have 2 or more children (OECD (2014)), policy makers could be prone to implement additional initiatives in order to stimulate some improvement of this demographic indicator. There are some possible pronatalist policy incentives that could be implemented to improve fertility like direct cash payments, indirect transfers and improving work–family compatibility; however, evidence of the efficiency of such incentives is ambiguous.

There is no common empirical evidence on how and to what extent family-friendly labour market policies affect the fertility rate. For example, Adsera (2004) proved that the maternity-leave duration has a positive effect on the fertility rate for a panel of OECD countries. Studying OECD countries in 2005, d'Addio and d'Ercole (2005) found out that there was a significantly negative effect of the parental leave duration. d'Addio and d'Ercole stated that childcare arrangements, transfers to families that reduce the direct costs of children and provisions that allow mothers to better cope with their family and career responsibilities all can help in removing obstacles to childbearing decisions.

Another researcher was not so optimistic about the positive effect of child care subsidies on fertility rates. Thus, Kalwij (2010), summarising the results of his research, concluded that an increase in child care subsidies through a family allowance[2] programme's increased generosity does not have a significant impact on the timing of births or on completed fertility. The author explained this phenomenon by the fact that a family-allowance policy subsidises the direct costs of children and not the opportunity costs of children, which have arguably become much more important for fertility decisions in recent decades, during which changing gender roles have increased the demand for policies that facilitate women's economic

[2] Family allowance is an income policy programme targeted at households with children that aims to alleviate the financial burden of having children and consequently increase the quality of children.

empowerment. Kalwij found out that a 10% increase in maternity- and parental-leave benefits results in about a 3.2% reduction in childlessness at age 36–40 but has no significant effect on completed fertility. Conversely, a 10% increase in childcare subsidies does not have a significant effect on the proportion of women who have children but results in about a 0.4% increase in completed fertility.

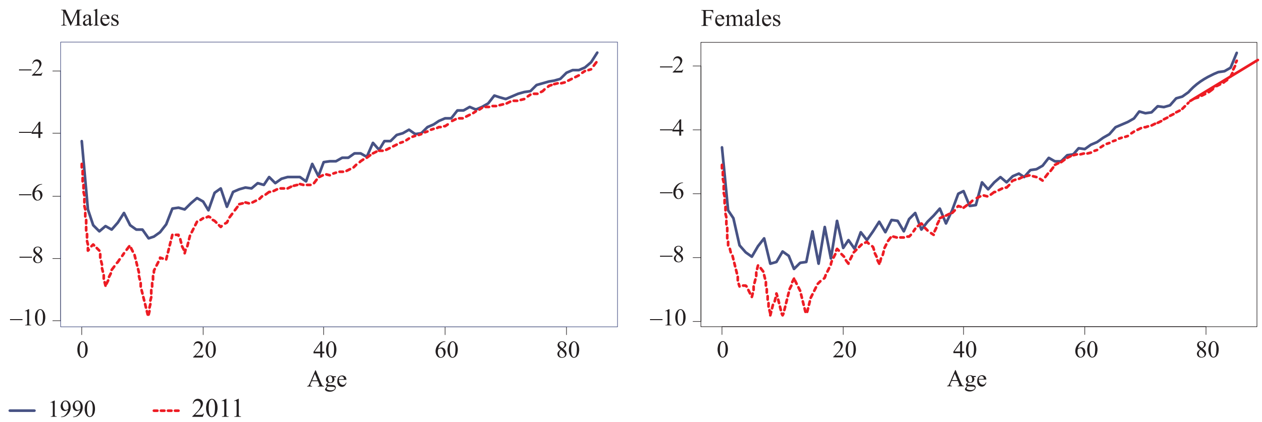
The findings by Kalwij are very similar to those by Neyer (2006) who stated that, even if family policies have an impact on childbearing behaviour, they should neither cause an increase in the total fertility rate nor have a long-term effect on the level of fertility. Neyer concluded that labour-market developments and women's opportunities for employment may be more important determinants of fertility than specific family-policy regulations. Second, the major conclusion that Neyer made in his paper is that policies that support a woman's access to work, secure her employment retention and ensure her sufficient income in most cases seem to be a pre-requisite for her to consider having another child. According to Neyer, it is essential that policies of this kind aim at mother's labour market integration.

Based on Neyer's research, lack of childcare services, low benefit levels, long parental or care leaves, and gender segregating policies (these conditions are very similar to what we can observe in Latvia) signal to women that it might be difficult, if not impossible, to combine employment with motherhood, re-enter the labour-market after parental or care leave, and maintain the standard of living in the short and long run. This is likely to lead to reduced fertility. Thus, in order to improve the demographic situation in Latvia, policy makers should ensure more adequate provision of childcare services, high levels of benefits, parental leaves with options to take piece-meal leaves of moderate length flexibly, and gender-equality oriented policies.

## 3. MORTALITY RATE FORECASTING

The dynamics of male mortality rate schedule demonstrates some improvement in this indicator since 1990 (see Figure 7). The improvement in female mortality rates is not so obvious. For the purpose of forecasting procedure and proper data analysis, actual death rates for both males and females have been smoothed using weighted penalised regression splines with a monotonicity constraint.

*Figure 7*
**Total period mortality rate (males and females; logs; 1990 vs 2011)**

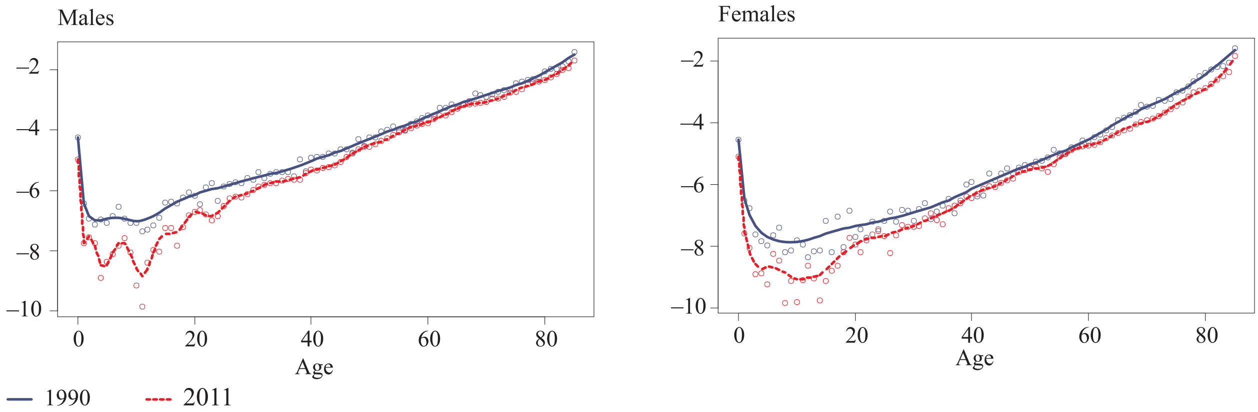



Source: author's calculations.

The results of smoothing 1990 and 2011 year male and female mortality rates are shown in Figure 8 below. Over the last years, a positive tendency in death rates is observed mainly for young males and females. In both cases, there is a strong decrease in mortality rates for people aged under 20 in Latvia, if we compare data for 2011 with those for 1990. There are some differences in the death rate dynamics for males and females that should be focused on.

First, the decline in death rates of young females is more homogeneous than and not as volatile as in the case of males. Second, the improvement in death rates for older females is more pronounced than for males of the same age (see Figure 8).

*Figure 8*
**Smoothed and actual total period mortality rate (males and females; 1990 vs 2011)**



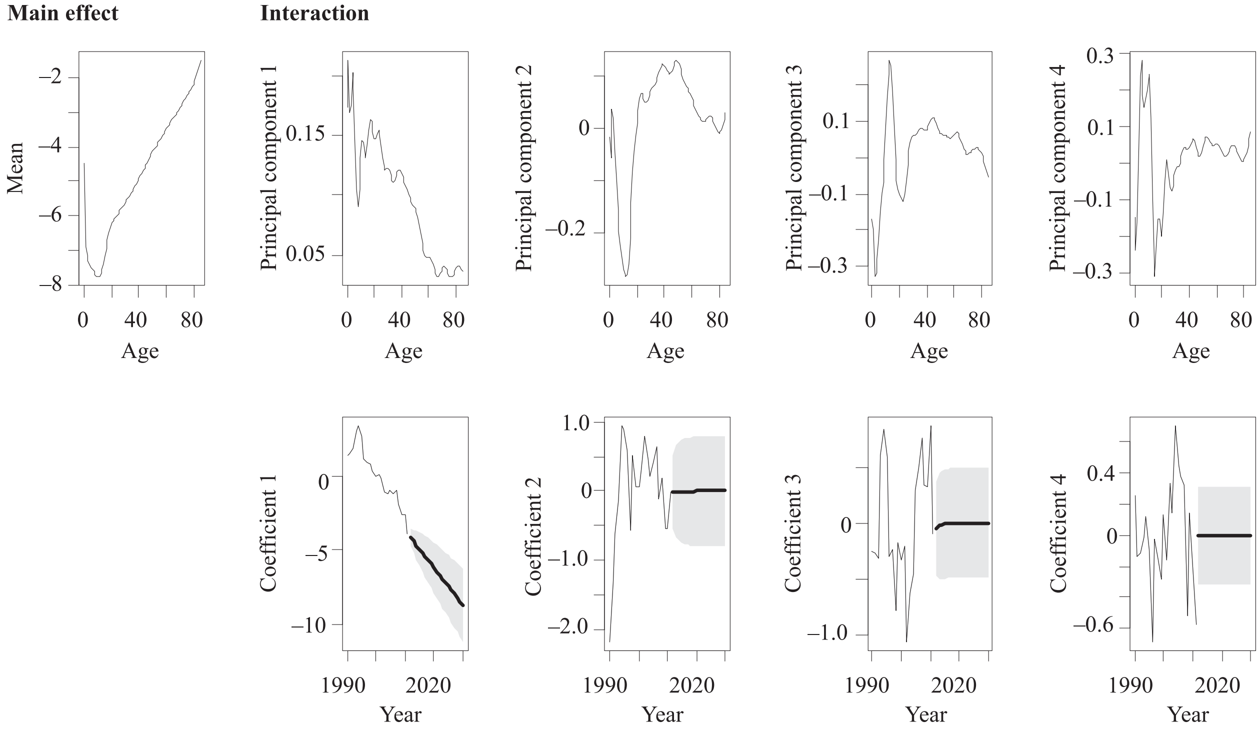

Source: author's calculations.

The results of male death rates forecasting steps 2 to 4 are shown in Figure 9. During functional principal components analysis, four principal components have been extracted that explain 93.8% of the variation in male mortality. As in the case of fertility, the meaning of the first two principal components will be discussed, since they explain the major part of the variation (85.0%) and have simple and direct demographic interpretation.

The first principal component ($\phi_1(x)$) explains 73.8% of the variation in male mortality. It models change in mortality mainly for males aged 0–50 and represents the long-term tendency of male mortality rate improvement. Estimated $\beta_{t,1}$ coefficient dynamics indicates a strong male mortality diminishing trend for the mentioned group since the mid-1990s (see Figure 9). This tendency is projected to continue for the entire forecasting horizon.

The second principal component ($\phi_2(x)$) explains 11.2% of the variation in male mortality. This component models mainly young age mortality rates for males aged 5–17 and represents the medium term deviations from the long run trend in historical data. Estimated $\beta_{t,2}$ coefficient dynamics indicates some increase in male mortality for the mentioned group in the early 1990s (see Figure 9). Afterwards, the situation normalised and some improvement (diminishing in mortality) was observed. The second principal component is forecasted to have a neutral impact on changes in male mortality rates for the forecasting horizon.

*Figure 9*
**Functional principal components, estimated and forecasted coefficients; males**




Source: author's calculations.

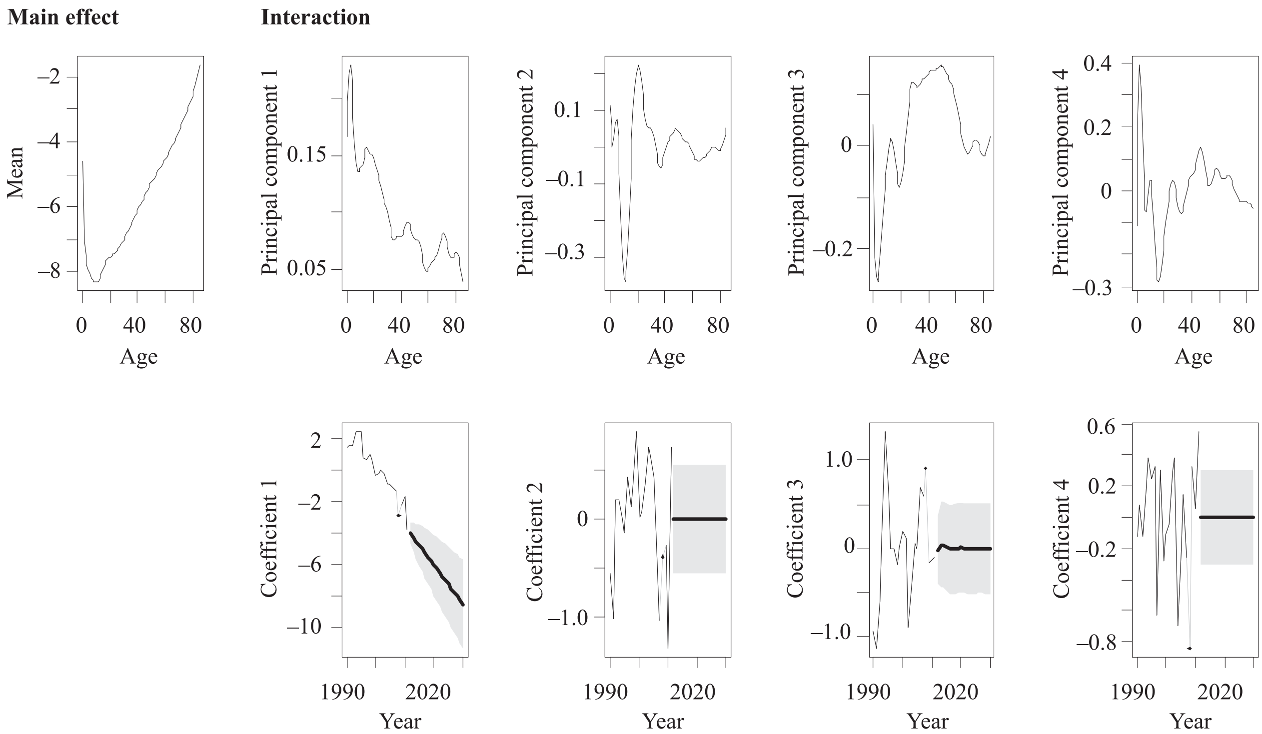
Principal components estimated for female death rates and tendencies of $\beta$ coefficients, on the other hand, are very similar to those of males (see Figure 10). Four principal components that have been extracted explain 92.6% of the variation in female mortality. The first principal component ($\phi_1(x)$) explains 70.8% of the variation in female mortality rates and models change in mortality rates mainly for young females aged 0–30. Similar to the results of $\beta_{t,1}$ estimation for male mortality rate dynamics described by the first principal component, here we can see strong improvement in female mortality rate since the mid-1990s. Further improvement in female mortality rates is projected in the medium run.

The second principal component ($\phi_2(x)$) explains 10.0% of the variation in female mortality rates. It models mainly young age mortality rates for females aged 5–22. This principal component has no effect on the projected female mortality rate dynamics for the forecasting horizon.

Summarising the obtained results, we can conclude that the diminishing of death rates for males forecasted in the future is more significant than in the case of females (see Figure 11). The major improvement in mortality is forecasted for males aged 20–50. This may indicate that currently Latvian policy makers do not make enough effort to improve the health of elderly people to ensure its improvement in the future.

*Figure 10*

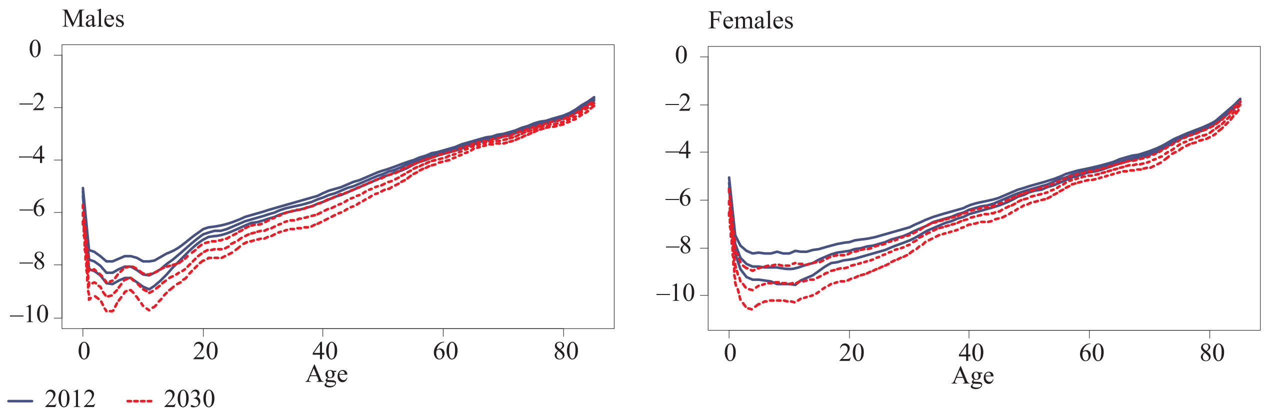
**Functional principal components, estimated and forecasted coefficients; females**




Source: author's calculations.

*Figure 11*

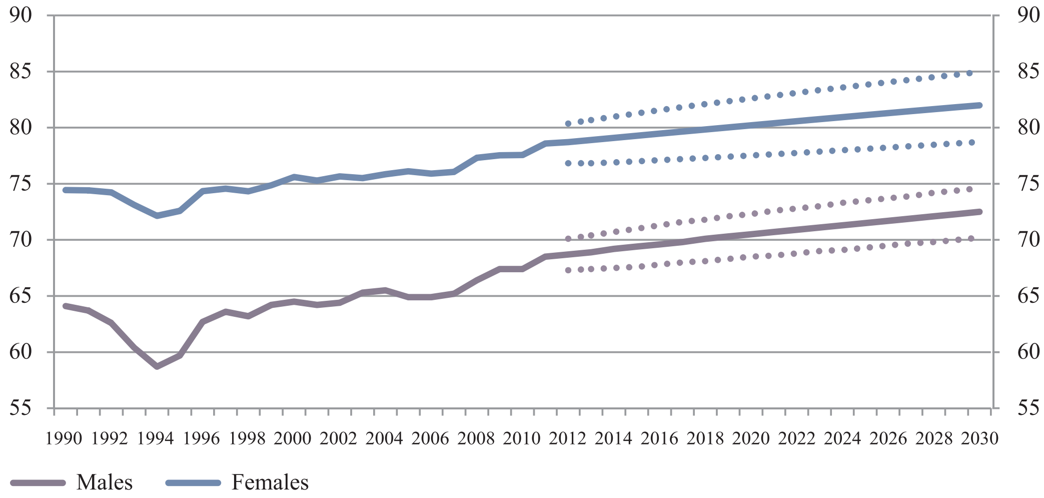
**Total period mortality rate forecast, males and females, 2012 vs 2030**




Source: author's calculations.

Taking into account the forecasted diminishing in death rates for males and females, life expectancy at birth is supposed to increase in the medium run. Thus, life expectancy at birth for females is projected to increase from 78.6 years in 2011 to 82.0 years in 2030, while life expectancy at birth for males – from 68.5 to 72.5 years (see Figure 12). The increase in males' life expectancy at birth projected to be more pronounced as a result of the gap between males and females' life expectancy at birth will narrow gradually from 10.1 years in 2011 to 9.5 years in 2030.

*Figure 12*
**Actual and forecasted life expectancy at birth (males and females; 1990–2030)**

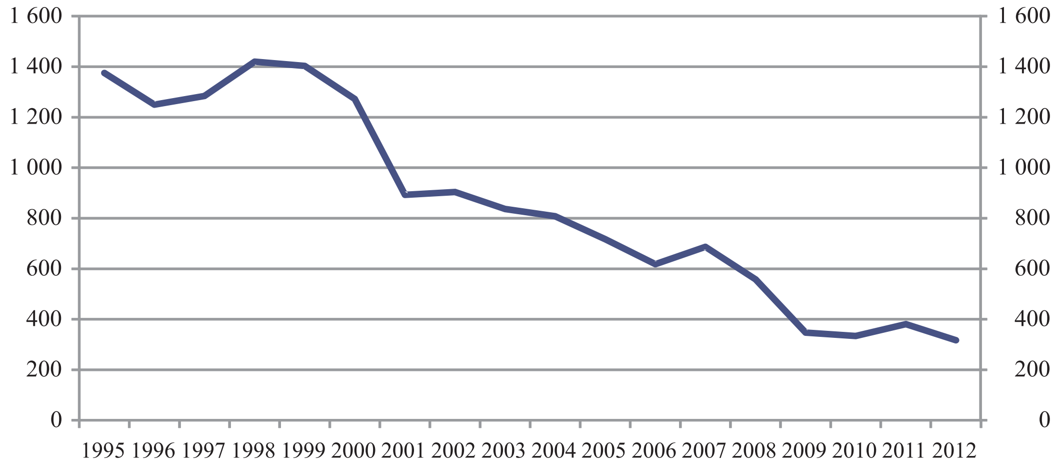



Source: author's calculations.

There are several reasons for the observed and forecasted improvement in life expectancy in Latvia. One of them is welfare of population. The wealthier the population is, the more opportunities inhabitants have to consume healthier food and obtain better medical care. Comparing the purchasing power parity-adjusted net national disposable income per inhabitant with the average level of this indicator for the euro area, the wealth of Latvian inhabitants has more than doubled since 1995. In 1995, it was more than 4 times lower (24.0%), while in 2012 it was already at the level of 59.8%, according to the Eurostat database. Another positive socio-economic improvement that the Latvian economic development managed to ensure is the diminishing share of people who are at risk of poverty or social exclusion over time. The earliest available date for this indicator is 2005 when the share of such inhabitants was slightly less than half of the total population (46.3%). Statistical data show that by 2013 it diminished by more than 10 pp, reaching the level of 35.2%, according to the CSB database. This is still a very high level, but the improvement is very promising, especially taking into account the economic crisis that was observed in the middle of the given period. Further income convergence in line with stable and sustainable economic development should positively contribute to the population's health and life expectancy.

Policy measures oriented to changing population habits towards a healthier and safer life could be mentioned as another reason for the observed improvement in life expectancy in Latvia. As a result of different anti-smoking measures implemented by the government during the last decade, the share of adult population smoking daily diminished by more than one third in the period from 2000 to 2010 (OECD (2012)). There are many other government initiatives to change inhabitants' habits and, consequently, diminish the risks related to people's health. Improving the quality of school meals and making them healthier is one of positively valued steps. Organising public sport events (such as marathons), social campaigns against consumption of alcohol and tobacco, creating new places and improving the environment fostering an active lifestyle have a positive impact on a further increase in the life-expectancy-at-birth indicator in Latvia in the future. One of bright examples of efficient advocating and field work to increase the safety of inhabitants and making them change their habits is the fall in the number of alcohol-caused road accidents from a historical high of 1 420 in 1998 to just 317 accidents in 2012 (latest available CSB data), following a stable downward trend (see Figure 13).

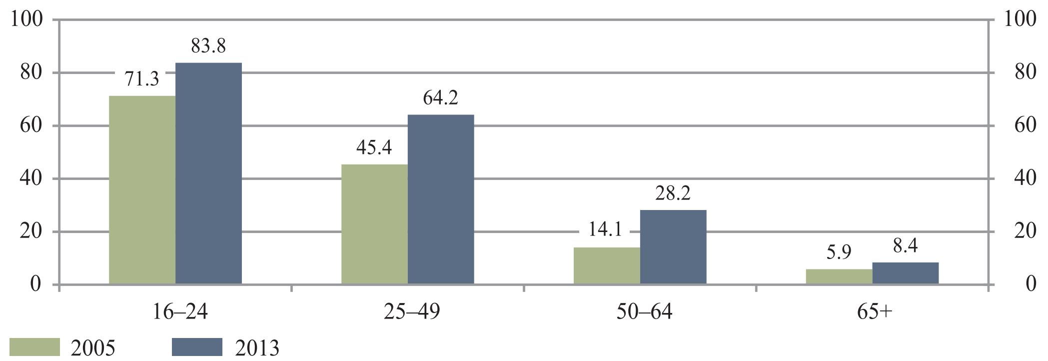
*Figure 13*
**Alcohol caused road accidents (1995–2012)**




Source: CSB.

As a result of improved population's well-being and various implemented policy measures, population's health has improved in the last years (see Figure 14). The most significant improvement has been observed for the population aged 25–49. It is a very positive factor, since this is the age group representing most economically active population. Health improvements in age groups 16–24 and 50-64 are also very valuable from the labour market development perspective. Some improvement in the health condition of people aged 65 and older can also be observed, yet it is not so significant and does not reflect much betterment of the very poor health situation in this age group.

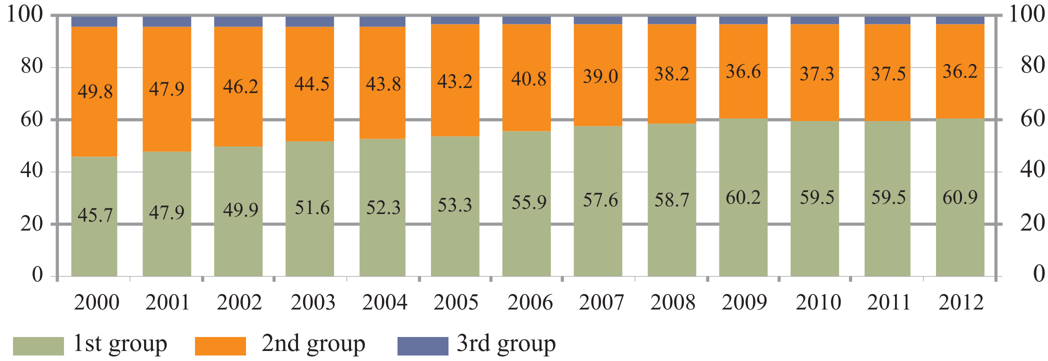
*Figure 14*
**Self-perceived health status (very good and good; share; %)**




Source: CSB.

Another statistical indicator that represents the situation with health is healthy life years in absolute value at birth. It has positive dynamics over the last years as well. In 2012, the number of healthy years for females increased to 59.1 years (from 53.2 years in 2005) and to 54.8 years for males (from 50.8 years in 2005), according to the Eurostat database. The healthier people are, the healthier are their children. This very positive tendency in demographic processes has been also observed in Latvia over the last years (see Figure 15).

*Figure 15*
**Newborns by health groups (share; %)**



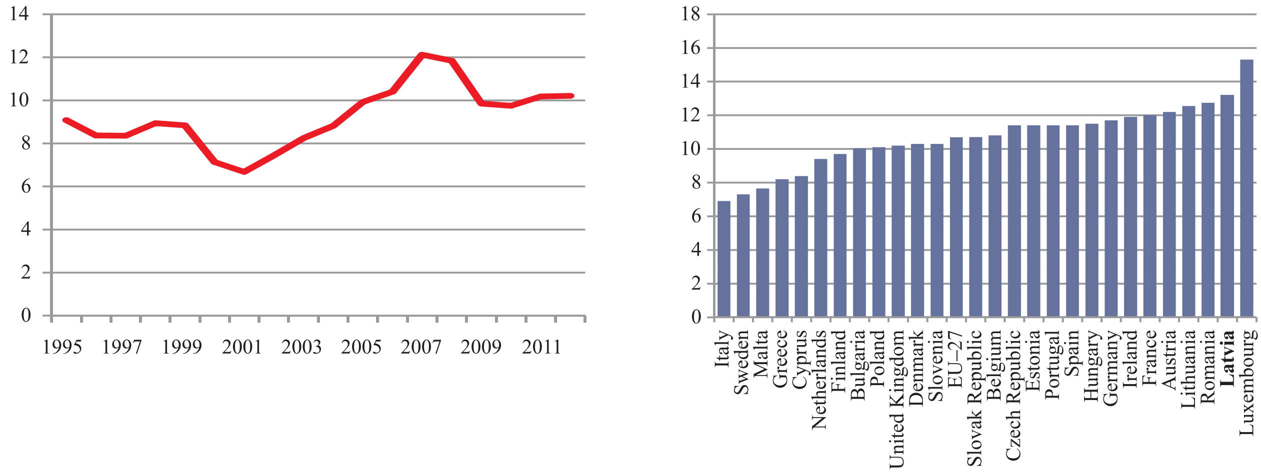

Source: Slimību profilakses un kontroles centrs (*Centre for Disease Prevention and Control*; 2012), Labklājības ministrija (*Ministry of Welfare*; 2014).

There are many positive factors and tendencies in demographics and socio-economic indicators in Latvia. However, there is still much room left for the improvement in the future. Thus, according to the Global Youth Tobacco Survey, 40.5% of children aged 13–15 used some form of tobacco in 2011, while 76.2% of pupils have tried smoking cigarettes (World Health Organization (2012)). According to the results of this survey, about 60% of respondents have been instructed at schools about the dangers of smoking during the year preceding the survey, 55.0% have discussed in class the effects of using tobacco, and only 50.7% have discussed the reasons why people of their age smoke. Therefore, one can conclude that in Latvian schools children's education about the harmfulness of smoking is not as systematic as it should be. Another aspect related to smoking at a young age is that despite persons under 18 in Latvia are forbidden to buy and consume tobacco goods, the purchase of cigarettes in a store was not refused, because of their age, to 70.4% of respondents.

The overall share of daily smoking adult population in Latvia is about 28%, which is the 4th worst result in the EU. Regardless of some policy initiatives implemented over the last years, alcohol consumption is still a problem for the Latvian society. In 2010, the Latvian population was declared the second most drinking nation in the EU (after Luxembourg), and the statistical data do not reflect any positive tendency indicating inefficiency of the measures applied to solve this problem (see Figure 16).

As a result of these and many other factors, the health condition of Latvian population is very poor compared to other EU nations (see Figure 17). This situation mainly occurs because of elderly persons who report a very low quality of their health. This is a problem for them and for the economy. Increasing the retirement age in order to keep the pension system sustainable could be inefficient or insufficiently efficient, if a major part of elderly people could not afford to continue to work because of their health condition.

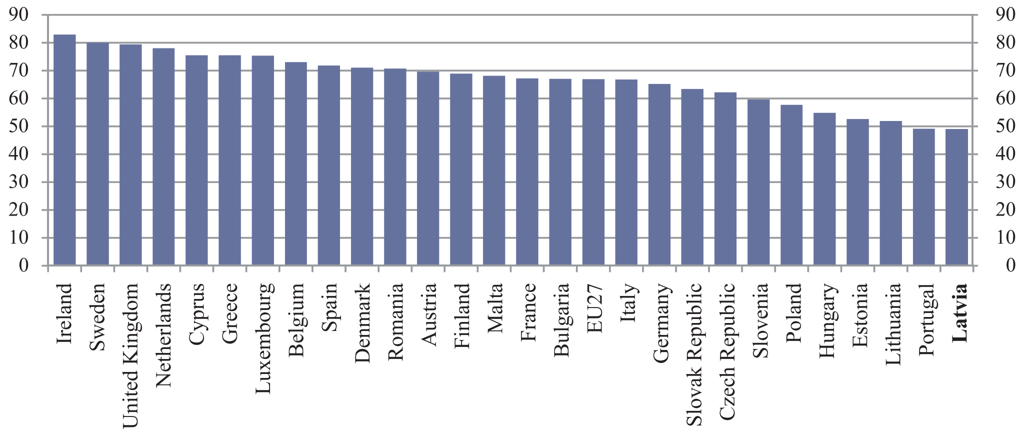
*Figure 16*
**Recorded alcohol per capita (15+) consumption (in litres of pure alcohol)**




Source: WHO.

Source: OECD (2012).
Note. 2010 data.

*Figure 17*
**Adults' self-reported health status (2010)**




Source: OECD (2012).

Nevertheless, if the incentives of the government to improve health conditions of Latvian inhabitants and economic convergence processes remain at the level and rate observed during the last decade on average, life expectancy at birth is projected to continue its gradual increase for males and females in Latvia. Taking into account these forecasts as well as the forecasts on fertility rates, we can calculate and discuss the future trend in the natural population change in Latvia. The next Section is devoted to this theme.

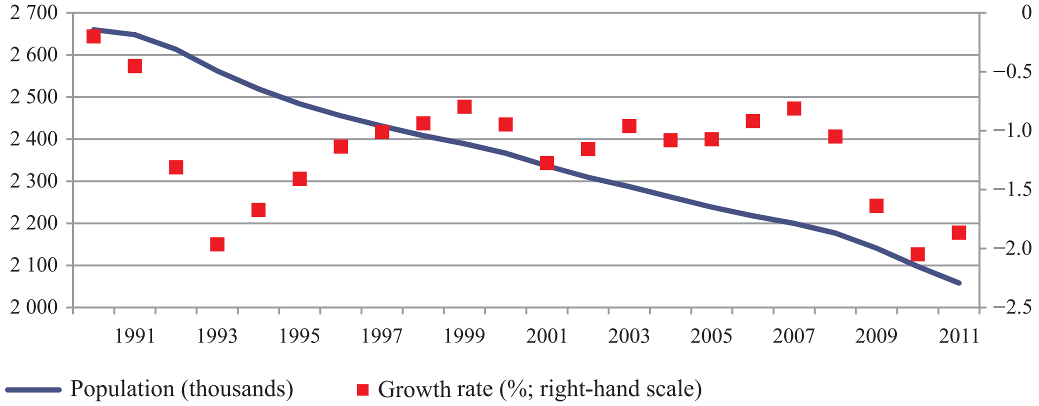
## 4. PROJECTED NATURAL POPULATION CHANGE

Before starting the discussion about future natural changes in Latvia's population, some information about past developments could be useful. In early 1990, the unfavourable socio-economic situation caused changes in female behaviour, leading to tempo and quantum effects influencing the fertility rate dynamics as has been discussed in the previous chapter. Massive emigration from Latvia was observed at the same time (see Figure 18). Afterwards, the population decline was more or less stable (about 1% per year in 1996–2008). The negative impact on population dynamics of the economic and financial crisis in Latvia in 2008–2009 was comparable to the one that had been observed in early 1990.

If we have a look at Figure 19, it is possible to compare two negative historical events that had an adverse effect on Latvia's population and its structure:

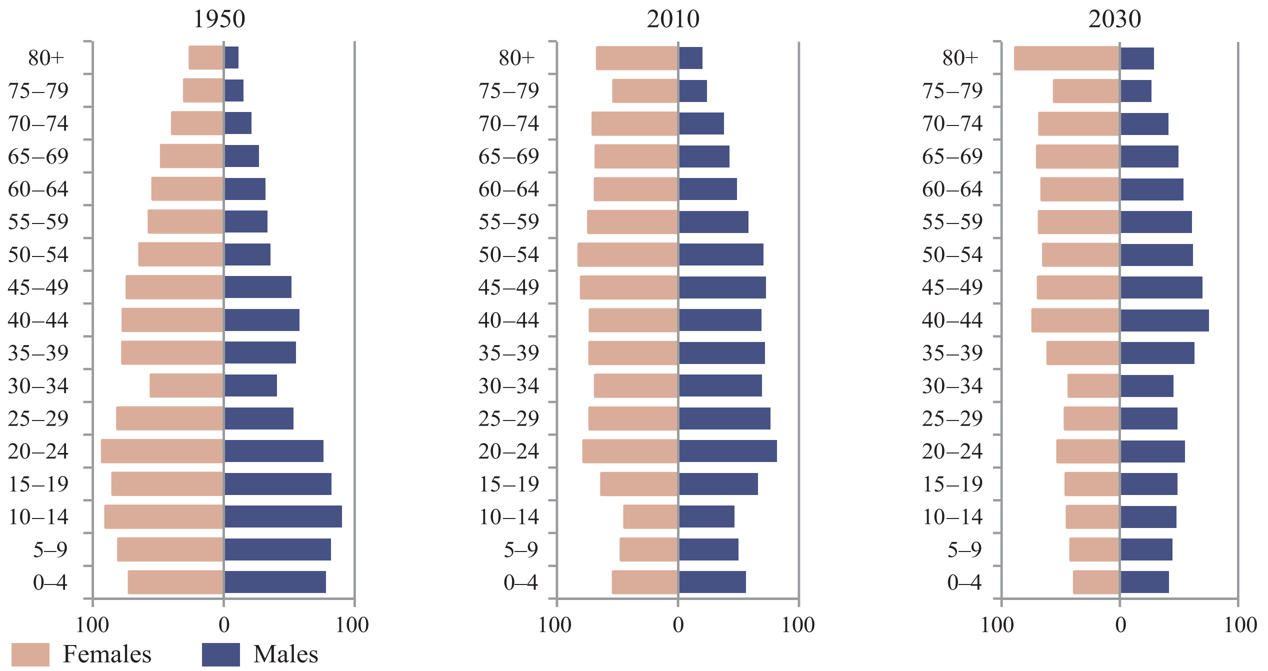
- repressions and the World War II effect on people aged 25–34 in the population pyramid of 1950;
- the socio-economic shock in 1990 with effects on people aged 10–19 in the population pyramid of 2010.

*Figure 18*
**Population dynamics (thousands; 1990–2011)**




Sources: CSB and author's calculations.

*Figure 19*
**Population pyramid (thousands)**

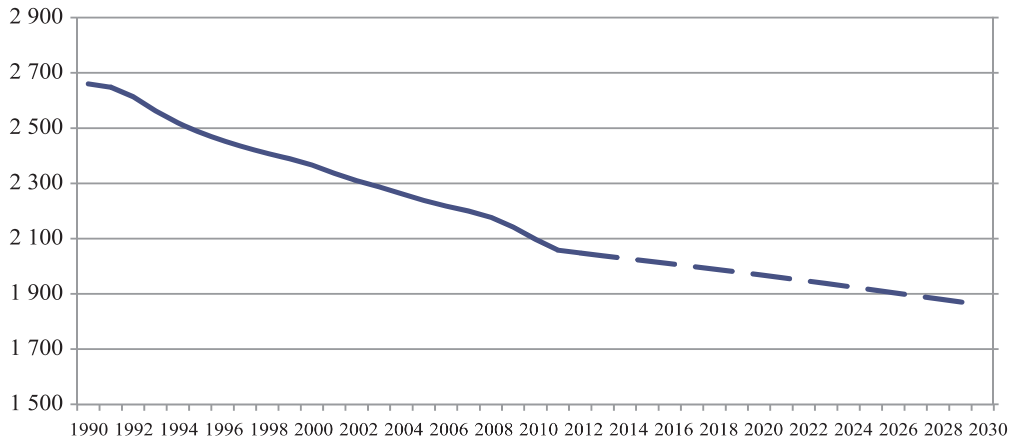



Sources: UN database, CSB and author's calculations.

The latter has been dramatically stronger, even taking into account that positive mechanical movement of population between 1945 and 1950 compensated, to some extent, the negative shock of repressions and World War II on the population dynamics in Latvia.

Both negative shocks observed in Latvia since 1990 have a long-lasting effect on population dynamics. Taking into account fertility and mortality forecasts, it can be calculated that in the course of 19 years Latvia's population will shrink by 200 thousand due to a natural decrease (see Figure 20). Despite the projected improvement in the total fertility rate, the number of newborns will decline in the medium term. In such a situation and without immigration, the problem of ageing population will become even more urgent, thus negatively influencing economic performance and exerting additional pressure on the pension system. The old-age dependency ratio is estimated to increase from 27.5% in 2011 to 36.5% in 2030, while the total-age dependency ratio is likely to increase from 48.7% in 2011 to 58.5% in 2030.

*Figure 20*
**Population dynamics (actual and forecasted; thousands; 1990–2030)**




Source: CSB, author's calculations.

Population ageing has not only a direct effect on the size and composition of the labour force but also indirect effects that are much wider and influence most, if not all, aspects of economic development. Population ageing might cause labour market tightening, since the working age population is shrinking. This may have a negative implication for output growth and for securing the well-being of the population. Lower output growth in combination with a higher proportion of older people, in turn, will lead to a situation, when it is even harder for the working people to maintain proper welfare of the retired people.

Another channel through which ageing affects economic performance is private consumption. Consumption patterns change with age: older people tend to spend a higher share of their income on housing and healthcare. Labour earnings tend to vary throughout the life cycle as well. There is a tendency for earnings to decline at an old age. Therefore, population ageing and consequently the increasing share of older consumers could negatively affect economic development via consumption (National Institute on Aging & National Institute of Health (2007), (Lee et al. (2010)).

The next channel that should be mentioned is savings, both private and public. From one point of view, the ability to save may diminish with age. Thus, a shift in population age structure may leave its impact on the generation of savings in the economy. From another point of view, higher life expectancy may increase the volume of savings that an individual desires to accumulate during his/her working life. This could, to some extent, compensate but not offset the negative effect of population ageing. Speaking about public savings, it should be noted that the population ageing process has its negative impact on public finances as well, since population ageing means higher healthcare and long-term care costs. At the same time, population ageing has some positive effect on public finances, given that expenditures on education decrease. As in the case of private consumption, this could compensate only a part of the decrease in public savings (National Institute on Aging & National Institute of Health (2007), (Mc Morrow and Roeger (1999)).

Population ageing has negative effects on investment processes as well. Ageing generates a contraction in the size of the labour force; hence the production process becomes more capital-intensive. Thus, the relative productivity of new capital purchases decreases and the investment rate declines resulting in slower growing capital stock. In such a way, population ageing causes a decline in the potential economic growth rate in the long-run (Mc Morrow and Roeger (1999)).

Last but not least, another effect of population ageing that we would like to discuss in this paper is the effect it could have on financial stability. Pension reforms and new investment products oriented towards individuals who want to invest for their retirement could cause a change in the allocation of savings across different financial intermediaries. On the one hand, this could stimulate the development of the financial system and may help reduce the risk of contagion. On the other hand, the increased exposure to financial markets could make other risks (e.g. liquidity risks) more important and the surveillance of the financial system more challenging (National Institute on Aging & National Institute of Health (2007), (IMF (2005)).

## 5. SOME ECONOMIC CONSEQUENCES OF AGEING POPULATION

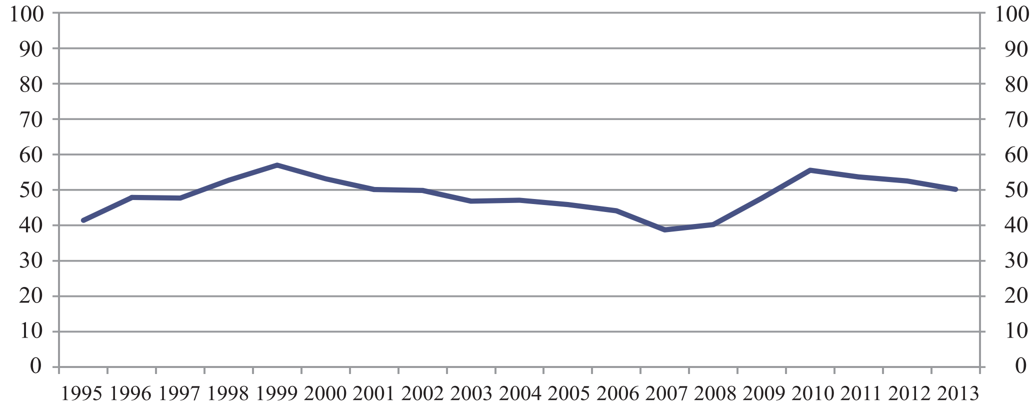
Based on the estimated change in the population structure and quantity by 2030 in Latvia, some aspects of economic consequences, such as consequences for the labour market, potential GDP growth, purchasing power of population and changes in the structure of consumption expenditure, have been evaluated.

One of the most important determinants of the improvement in population's wealth in the long run is the potential economic growth that is determined by the dynamics of total factor productivity, real capital and employment. Population ageing will definitely negatively affect the dynamics of total factor productivity and real capital in the long run in comparison with the no-structural-change scenario; however, it is difficult, if not impossible, to quantify this impact. Therefore, we will concentrate efforts on the quantification of population ageing effects on the potential GDP growth only through the direct labour market channel, keeping in mind that direct effects are usually much stronger than indirect ones.

Assuming that the economic activity rate by age groups will remain at current levels, the total economic activity rate, *ceritus paribus*, will be about 2 pp. lower because of population ageing by 2030. In absolute terms, this means that the number of economically active persons aged 15–74 in Latvia will decrease by about 150 thousand by 2030. All this will lead to a gradual diminishing in potential GDP growth in the long run. As a result, the potential GDP growth will be about 0.5 pp lower in comparison with the non-ageing scenario by 2030. In other words, nominal GDP will be by more than 7 billion euro lower due to expected population ageing in 2030, while an accumulated loss will exceed 45 billion euro. The contribution of the decrease in the number of the working age people (15–74 years of age) is estimated to reduce the long run potential GDP growth by about 0.3 pp, while the decrease in the number of economically active population aged 15–74 will contribute negatively another 0.2 pp to the long run potential GDP growth.

Purchasing power of pensioners vis-à-vis employed people is rather stable over time in Latvia (see Figure 21). As can be seen from Figure 21, pensioners, on average, can afford to buy twice less goods and services than employed persons. As has been stated above, the structure of the population in Latvia will change because of its ageing: the share of the retired people will increase, while the number of the working age people will decrease. Therefore, the purchasing power of the population is estimated to be by about 3% lower by 2030 in comparison to the hypothetical case with no changes in the demographic structure of population in Latvia over time.

*Figure 21*
**Purchasing power of pensioners over purchasing power of employed (%; 1995–2013)**




Sources: CSB and author's calculations.

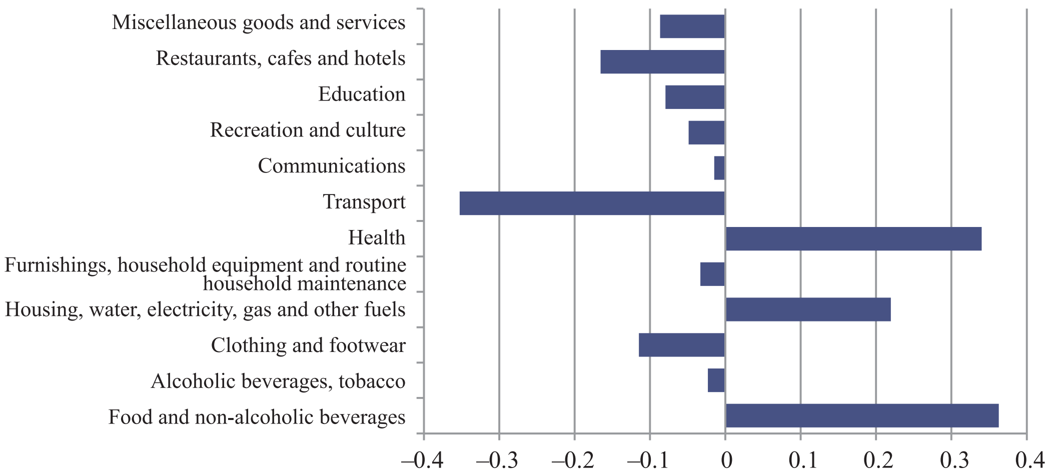
Another economic issue that is closely related to population ageing is a change in the structure of consumption expenditure. Different households have different necessities depending on the socio-economic group they belong to (see Figure 22). In comparison with wage and salary earners and the self-employed, pensioners spend most of their income on food and beverages, housing and health but less on transport, restaurants and clothing.

In order to quantify changes in consumption, some assumptions had been made about further development in the structure of households by their socio-economic groups in Latvia. Thus, taking into account the forecasted population ageing, the share of pensioner households will increase from about 30% in 2012 to about 35% and the share of working (both wage and salary earners and self-employed) households from 65.0% in 2012 to 61.5% in 2030. Because of population ageing and consequently a change in the households' socio-economic structure, there will be additional changes in the structure of consumption in Latvia by 2030 in comparison with the hypothetical case with no changes in the demographic structure of population in Latvia over time (see Figure 23). However, these changes will have little additional effect on the proportion in the consumption of tradable and non-tradable goods.

*Figure 22*
**Structure of consumption expenditure by socio-economic group (%; 2012)**


Source: CSB.

*Figure 23*
**Changes in the Structure of Consumption, pp, 2030 vs 2012**




Sources: CSB and author's calculations.

Population ageing can affect another aspect of inflation in Latvia called "frequent out-of-pocket purchases" (FROOPP). "Frequent purchases" are purchases which are typically done at least on a monthly basis. "Out-of-pocket purchases" are those purchases which are considered to be typically paid for by the consumer directly and actively (Mile (2009)). Therefore, there is a possibility that inflation expectations can be more dependent on this component of headline inflation. Because of population ageing, *ceritus paribus*, the share of FROOPP could increase by about 5 pp, meaning that in the future inflation perception and expectations could play a more important role than in the hypothetical case with no changes in the demographic structure of population in Latvia over time.

Summing up, it is obvious that population ageing will affect negatively the economic development of Latvia in comparison with no-structural-change-in-population and no-policy-change scenarios. Potentially decelerating GDP growth rates will make it more difficult for the economy to converge towards more wealthy EU countries. This clearly indicates that policy makers should start to implement policy measures (such as improving health care, child care and pension systems, promoting economic activity and employment of young and old people, promoting fertility and remigration, etc.) already now, in order to diminish the negative impact of population ageing on the economy in the future.

## CONCLUSIONS

In this paper, the forecasting procedure developed by Hyndman and Ullah (Hyndman and Ullah (2007)) has been implemented to produce fertility and death rate forecasts for Latvia. The socio-economic restructuring in 1990 caused changes in cohorts' behaviour causing a long-lasting negative effect on the demographic situation in Latvia. According to the results of econometric modelling and projection, the total period fertility rate will increase from 1.3 in 2011 to about 1.6 by 2030. However, despite the projected improvement in the total fertility rate, the number of newborns will decline in the medium term. This suggests that more active pronatalist family policies should be implemented in Latvia. Although there is not a universal rule stating what kind of pronatalist policies are most efficient, Latvian policy makers should make more effort to take appropriate measures for the Latvian society. In addition to pronatalist family policies, Latvian policy makers should improve the situation with economic activity and employment of young people, since insufficient financial security forces them to postpone family making and childbearing.

According to the results of econometric modelling and projection, life expectancy at birth for males will increase from 68.5 years in 2011 to about 72.5 years by 2030 and for females from 78.6 years in 2011 to about 82.0 years by 2030. The major improvement in mortality is forecasted for males aged 20–50. Despite some observed and forecasted improvement in life expectancy in Latvia, there is much work still to be done. Regardless of some policy initiatives implemented over the last years in Latvia, alcohol consumption is still a problem for the community. There is a very high proportion of smoking children and adults in Latvia. Due to these and other factors, the health condition of Latvian population is very poor compared with the other EU nations. This situation is mainly on account of elderly persons who report a very low health quality. This is a problem for them and for the economy. Increasing the retirement age in order to keep the pension system sustainable could be inefficient or insufficiently efficient if a major part of elderly people cannot afford to continue working because of their health condition.

Putting together the estimated future dynamics of fertility and mortality rates, we have calculated the natural population change in the medium run. According to our calculations, the natural population decrease will reach 200 thousand in the course of 19 years in Latvia. The major decrease is expected for the population aged 20–64. Most of the population at this age are still likely to be in the workforce, and this part is projected to decrease by about 190 thousand. While by 2030 the young-age-dependency ratio will have remained roughly the same as in 2011, the old-age-dependency ratio is expected to increase by 9 pp, placing additional pressure on the pension system.

Based on the estimated change in the population structure and quantity by 2030 in Latvia, some aspects of economic consequences have been evaluated. By 2030, the potential GDP growth is estimated to be by about 0.5 pp lower in comparison with the non-ageing scenario. Purchasing power of the population is estimated to be by about 3% lower by 2030. Furthermore, future inflation perception and expectations could play somewhat more important role than nowadays because of the changes in the consumption structure.

## APPENDIX

### Definitions of Cohort and Period Changes in Fertility

Four ideal types of changes in age-specific fertility rates by birth order can be identified (Bongaarts and Sobotka (2012)).

1. A period quantum change in period fertility is defined as an increase or decrease from one period to the next that is independent of age or cohort. As shown in Figure A, this change in quantum simply inflates or deflates the period fertility schedule proportionally at all ages.

2. A period tempo change is defined as an increase or decrease in the mean age at childbearing from one period to the next, with a shift in the fertility schedule independent of age or cohort. As shown in Figure B, this tempo change involves a move up or down the age axis of the fertility schedule, while its shape remains invariant.

3. A cohort quantum change in fertility is defined as an increase or decrease from one cohort to the next that is independent of age or period, resulting in an inflation or deflation of the cohort fertility schedule proportionally at all ages.

4. A cohort tempo change in fertility is defined as an increase or decrease in the mean age at childbearing from one cohort to the next, with a shift in schedule independent of age or period, resulting in a move up or down the age axis of the cohort fertility schedule, while its shape remains invariant.

*Figure A*

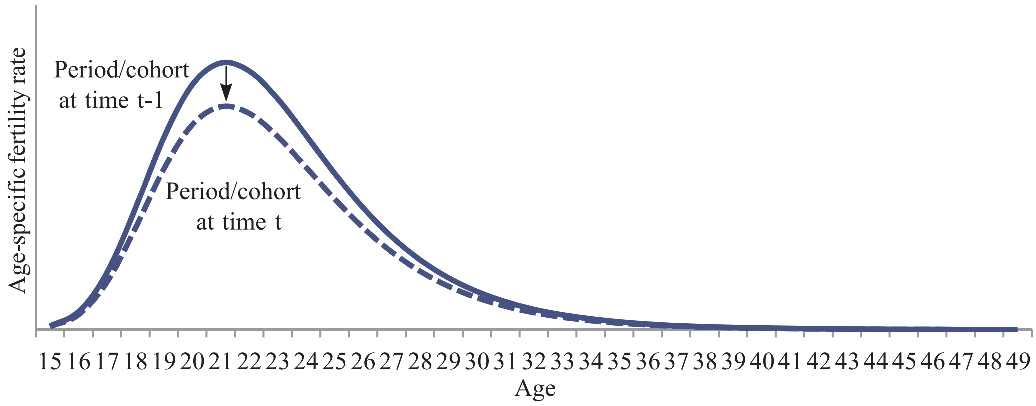
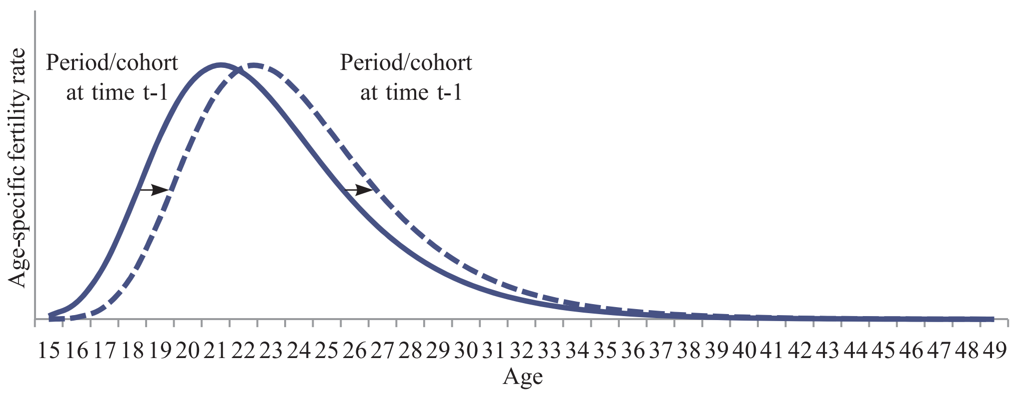



*Figure B*



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