Warsaw School of Economics
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SELECTED IMPLICATIONS OF POPULATION AGEING FOR PRODUCTIVITY, ECONOMIC ACTIVITY AND HEALTH CARE EXPENDITURE

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Motivation and Theses

Population ageing is one of the most important structural socio-economic challenges faced by developed and developing economies. It origins come from the increase in life expectancy and the drop in fertility rates, and it results in a rising share of over 65s and over 80s in the population. The major economic concerns induced by this transition are the fall in the labour supply and rising public expenditure on the pension and health care systems. This dissertation focuses on the economic consequences of extending life expectancy in the following areas:

1. is the productivity drop over age or institutional conditions actually responsible for the premature leaving of the labour market?

2. does the concentration of health deterioration and health care expenditure before death remain stable when the life expectancy is increased?

There is an important gap in the understanding of employment and productivity during the life cycle with relation to the institutional conditions. Studies of the age dependency of productivity often focus on a single country or even sector and thereby disregard the out-of-employment selection process (Van Ours and Stoeldraijer, 2011; Mahlberg et al., 2013). The literature lacks the complete recognition of productivity by age in relation to employment, which would take advantage of cross-country differences. International variations allow us to quantify the role of institutional conditions and partially control the non-random selection of those leaving the labour market. The aim of the dissertation is to fill this gap.

In relation to the first research question the following thesis is explored:

T1 : The observed decline in economic activity in older age groups in European countries is hardly related to a decrease in productivity during the life cycle.

The detailed verification of thesis T1 is translated into two hypothesis with regards to productivity differences among countries:

H1a : The decline of productivity during the life cycle does not explain the decline of employment among older cohorts.

H1b : The differences in productivity and employment profiles among European countries are related to the characteristics of the pension systems.

The rise in productivity at the start of working life is much better understood than the decline or stabilization of productivity at later stages of life. The simple conclusion that productivity must approach 0 due to death does not help, because the life expectancy at 75 is still 10 years for men and 12 years for women.[1] The rise of mortality and morbidity after the age of 40, accompanied by changes in cognitive and manual skills, raises the question of the extent to which these changes affect productivity and the ability to work (hypothesis H1a). The further investigation of the life-cycle dynamics of productivity and employment attributes the differences to the variability of the institutional conditions in different countries. I directly relate the cross-country variations of employment and productivity patterns to the features of the pension systems in Europe (hypothesis H1b).

The popularity of ending working life between the age of 50 and 70 is a result of health, preferences, social norms and economic institutions. Hypothesis H1a questions the link between productivity losses and the decline in employment over age. The positive verification of this hypothesis could lead to the conclusion that if the social norms and institutions evolve adequately, the length of working life could be adjusted and some of the negative effects of population ageing could be mitigated. Hypothesis H1b sharpens the former and aims to disentangle the relationship of employment and productivity with the various institutional conditions in European countries. If it is possible to defend this hypothesis against falsification then it is expected that changes in social and economic institutions will be enough to increase economic activity sufficiently to mitigate the effect of population ageing.

The idea that extending life expectancy means longer life in good health, and that most health care expenditure is concentrated in the final stage of life is nothing new and was raised by Fuchs (1984). It has been researched empirically since 1999 (Zweifel et al., 1999). In this work, treating age and not time-to-death as the main determinant of health and health care expenditure was called a *red herring*. Recent evidence has, at least partially, supported the *red herring* hypothesis. Both age and the time-to-death play their role in explaining health expenditure, although their relative roles remain a topic of discussion. This is widely discussed in the literature, mostly with data from developed countries (Yang et al., 2003; Seshamani and Gray, 2004a; Weaver et al., 2009; Karlsson and Klohn, 2011; Atella and Conti, 2013).

There is still a need for empirical research on the impact of ageing on health care expenditure using population-wide data in various countries. Poland, where life expectancy has risen quickly in recent years and which has one national health insurance fund, serves as a good

[1] GUS data for Poland, 2013

example for the further investigation of the relationship between age and health care expenditure. The pattern of life-cycle health care expenditure is important from the perspective of population for two reasons. Firstly, the life-cycle dynamics of health care expenditure are an indication of changes in health deterioration and indirectly of the ability to work. Secondly, when the age structure of the population changes, the health care expenditure could have a large effect on public expenditure. On the other hand, if the life-cycle paths of health care expenditure are adjusted to longer life, then the net effect is not obvious. Contrary to the popular fear of the consequences of ageing, the following thesis T2 is stated:

T2 : The increase of aggregate health expenditure induced by the increase in life-expectancy is limited due to the concentration of medical expenses before death.

Death-related costs and the time-to-death undermine the role of age in shaping health care expenditure. The verification of the following hypotheses enables thesis T1 to be tested:

H2a : An increase in health care expenditure with age is driven by the rise of decedents to survivors ratio.

H2b : The life-cycle cumulative health care expenditure does not depend on the age of death.

Apart from the affecting economic activity, ageing influences also public expenditure on health. If both hypotheses H2a and H2b fail to be falsified, then the lengthening of the average life span would have limited effect on aggregated health care expenditure and consequently on the sustainability of health financing schemes. Changing the age structure of the population would only affect health care expenditure due to the fact that there would be more people close to death, but not as a result of the extended life expectancy itself. If health care expenditure is treated as an indicator of health, accepting hypotheses H2a and H2b would have also implications for economic activity. Accordingly, the increase in life expectancy is connected with the prolonging of life in good health. Therefore, the health limitation on economic activity is also shifted to the later stages of life.

The structure of the dissertation mirrors the theses and hypotheses. The introduction chapter presents the wider context of the dissertation, motivation and theses. The second and third chapters are devoted to exploring thesis 1 and hypotheses H1a and H1b. The review of literature (chapter 2) is followed by the empirical analysis of the LFS and EU-SILC datasets (chapter 3). I present the age-employment and age-productivity profiles of 28 European countries and study their characteristics using semi-parametric regressions. The results are then discussed

with relation to the differences between pension systems among European countries. Thesis 2 is researched and hypotheses H2a and H2b are verified in chapters 4-6. They focus on the relationship between health care expenditure and age. After the discussion of literature in this field in chapter 4, the data on Polish public health care expenditure is investigated in the following chapters. With the use of combined NFZ and GUS data, we show the importance of death-related costs (chapter 5) and the inclusion of time-to-death (chapter 6) as a determinant of health care expenditure. The final chapter of the dissertation summarises the conclusions on productivity, employment and health care expenditure and relates them to the theoretical framework and relevant strands of literature.

Data and methods

The international variation of the productivity patterns in European countries is researched with the use of EU-SILC micro-data. EU-SILC is a harmonized household income survey. It is conducted in 28 European countries and delivers reliable data on labour income, working time and job-related characteristics. It includes all sources of personal and household income, with a distinction between wages and self-employment, and also indicates the earnings structure (wage, taxes and social security contributions). In the clustering procedures the statistics on employment by age were obtained from Labour Force Data. The data on institutional conditions in European countries were obtained from OECD, ILO and Eurostat.

I have used non-parametric kernel estimators and semi-parametric regression models. I estimated the wage equation for every country separately with no assumptions on the functional relationship between wage and age. To provide a deeper analysis, semi-parametric regression models are estimated. In the semi-parametric approach, an assumption is made about functional relationships among some variables, but the key relationship between age and earnings remains free of functional assumptions. The semi-parametric double residual estimator of Robinson (1988) has been applied. As a result, I can present the changes in the smooth wage-earnings profile after factoring out some variables. These control variables are: gender, education, NACE sector, occupation, subjective health and tenure.

The data on health care expenditure was obtained from the Polish National Heath Fund (NFZ) and data on mortality and population from the Central Statistical Office (GUS). The NFZ data covers most public healthcare expenditure broken down by gender, age, type (e.g. inpatient, outpatient, medication) and information about whether a person died within a year

or later.

Firstly, I will quantify the contribution of changes in the structure of age groups on the dynamics of health care expenditure. The crucial factor is the share of decedents in a cohort. This is done by applying the total derivative with respect to time to the determined identity. The decomposition is run on total expenditure as well as selected types of expenditure: hospital costs, medication, ambulatory care and long-term care. The contribution allows the quantification of the role of the following factors in the changes to health care expenditure in consecutive cohorts: expenditure per incident, incidence per patient, patients in population, share of decedents and population size.

Due to data limitations, the decomposition technique can only take expenditures in the last year of life into account. In order to account for longer periods before death econometric models have been specified. They have been estimated using the non-linear least squares algorithm. The variable on the left hand side is the health care expenditure of a single year age group and on right hand side are share of the population that will die in $1, 2, .., T, T+$ years. They were obtained from the conditional mortality rates. The crucial assumption here is that expenditure increases exponentially before death. In order to fit the model to the data, the model has been expanded with a logistic transformation of parameters for every $T \in 1..23$. The model was fitted to the one-year age group of National Health Fund expenditure in 2012 in Poland.

Results

Based on the LFS employment rates of people over the age of 50, I have applied statistical procedures to cluster the countries. This classification creates a framework for further analysis. The clusters of countries are best characterized in two dimensions: the employment rate at the age of 51-55, and the expected length of employment. The first group (Austria, France, Czech Republic, Slovakia and Bulgaria) is called high-short because it contains countries with high employment rates of 50 year olds which drop sharply thereafter. The second group is called low-long (Ireland, Cyprus, Portugal, Spain, Greece, Lithuania and Romania). The employment rate in this group is not as high at the prime age, but remains quite high after the age 50. Countries with the weakest labour market are named low-short (Belgium, Luxembourg, Italy, Hungary, Slovenia and Poland) as they have low employment rates which drop quickly after the age of 50. The final group of countries with the healthiest labour markets is characterized by high employment rates at all ages, and is called high-long (Norway, Sweden, Finland,

Netherlands, Denmark, Germany, Latvia, Estonia, Iceland and the United Kingdom).

Averaging the productivity profiles within clusters reveals the relationship between employment and earnings age patterns. For the countries with the healthiest labour market (high employment rates and long employment) the hourly productivity profiles are flattest, and hardly change between the age of 35 and 67. Contrary to this, for all the remaining clusters there are quite interesting dynamics after the age of 45. In low-long countries there is no flat interval in the whole profile; the peak of average earnings comes at the age of 50 and drops quickly afterwards. In countries with low-short employment, the average hourly wages start to increase at around the age of 50, reach their peak at 60 and then drop sharply after 65. The profile for countries with a high-short employment pattern combines features of high-long and low-short countries. It is flat until the age of 55 like in high-long countries, and then resembles low-short countries as it increases until the age of 60 and then drops. The joint analysis of age-employment and age-productivity patterns shows new results. In countries with earlier retirement, the average productivity rises strongly after the age of 50. The higher the level of employment among older people, the weaker the observed effect.

The results of the semi-parametric regression differ greatly among the clusters. For high-long countries, the profiles do not change when the control variables are taken into account. For all other clusters this is not the case. The effect of factoring out gender, education and occupation generally influences the patterns much more than also including general experience and a recent job change. Taking into account all the characteristics has a flattening effect on the earning profiles in all clusters. In high-short and low-short countries, the hump-shape noticed after the age of 50 almost disappears and the resulting profiles become much more similar among the clusters. In low-short employment countries, there still seems to be a more important drop in hourly earnings after the age of 65.

The differences between the institutional conditions in countries confirms that it is the generous out-options that drive people to leave the labour market. The mean replacement rate is 47% in long employment countries and 54% in short employment countries. Similarly the official and actual age of retirement is highest in high-long and lowest in low-short countries. The drop in productivity does not seem to shorten the employment life. In countries with high-short and low-short employment patterns, the growth of average productivity results from low-paid workers leaving the labour market prematurely. In these systems, the availability of early retirement benefits discourages lower-paid workers in particular from working. The replacement rate is high compared to higher paid workers. The average replacement rate in countries with

short employment is around 53%, whereas in countries with long employment it is around 45%. Unfortunately, the OECD only reports the average replacement rate and does not show the replacement rate by age or wage-decile. Additionally, the effective retirement age for short employment countries is around 60 and for long employment is almost 65. Therefore, the rising average productivity before the age of 60 is a result of both (1) acquiring the right to benefits at a younger age and (2) higher replacement rates.

The decomposition of the drivers of health care expenditure with age provides important insights into health expenditure and ageing. From the age of 35 to 60 health care expenditure rises at an accelerating rate, mainly due to the rising number of procedures per patient. It is much more important than increasing the cost of procedures for older patients. From the age of 50 to 70, per capita expenditures rise by almost 10% a year. On the other hand the rising death rate is the factor that stops costs from exploding. The rising incidence of treatment and the share of decedents play a minor role. Thereafter the rate of growth drops firstly due to the declining expenditure per survivor, and later per decedent. Cohorts over the age of 70 generate lower costs, as the size of the cohort declines due to rising mortality rates. This factor continues to dominate until the age of 100. From the age of 80 the decline in costs generated by decedents and survivors is counterbalanced by the rising share of decedents. Only taking into account the increase in costs two or three years before death would make the ratio of decedents an important driver of the health care expenditure in older age groups. With the available data, it is clear that age is the primary driver of healthcare expenditure. I have also shown that the size of cohorts plays an important role in shaping health care expenditure.

The econometric models, which enable a longer time-to-death than one year, deliver even stronger results. The estimated models support the *red herring* hypothesis that health care expenditure is weakly related to ageing and should have a much smaller effect on health care expenditure than if health care expenditure were to be determined solely by age. The difference in the lifetime health-related spending of people dying at the age of 20 and those dying at the age of 100 is 2-3-fold and not 10-30-fold as a model with age-specific costs would suggest. Therefore the inter-generational and inter-age group transfers through the health systems are much smaller than could be expected.

Furthermore, the model estimates show that health care expenditure starts to rise 12 years before death. This is consistent with the results from studies from other countries (Seshamani and Gray, 2004b; Wong et al., 2011). My results show evidence in favour of the *red herring* hypothesis: the costs would increase slower than if they were purely driven by age, with a

huge chance of ageing being cost-neutral. The costs of death are mostly driven by people under the age of 60, for whom the death-related-costs dominate all other costs during their life-time. From the age of 70 the death-related costs start to drop and for those aged 90 they do not differ significantly.

Contribution

This dissertation provides evidence that the negative economic consequences of prolonging life expectancy could be counteracted with proper institutional changes. Firstly, the drop in productivity with age is smallest in countries where employment rates remain high in older age groups. Secondly, when the characteristics of employees and companies are taken into account, the age profiles of productivity become flatter. Drops in productivity could only be observed for 60 year olds and there are hardly signs of an important drop in productivity until the age of 70. The process of leaving the labour market is highly selective in countries with short employment. Finally, the deterioration of health and the rise of health care expenditure are closely related to the time-to-death. Living longer is not necessary connected with higher spending on health. The extending life duration roughly means extending life in good health, without high expenditure on health care. Therefore extending the life expectancy should have a limited impact on public finances. Furthermore, health is not a binding constraint for prolonging the working life.

The innovative contribution of this dissertation is mainly the understanding of employment and productivity in the life cycle. This has been done by applying statistical and econometric methods that allow for a combined analysis of productivity and employment by age. A simultaneous analysis of this kind is hard to find in the literature. Semi-parametric methods allow the differences between countries to be exploited in order to answer the question about the importance of productivity limitations in increasing economic activity among older age groups. International variations allow the role of institutional settings to be quantified and the partial control of the non-random selection of labour market leavers. Studies about the age dependency of productivity often focus on individual countries or even sectors, and thereby disregard the out-of-employment selection process. The literature lacks a complete recognition of productivity by age in relation to employment, which would take advantage of cross-country differences. This dissertation helps to fill this gap.

The extension of the current state of knowledge on the impact of population ageing on

health expenditure growth is possible thanks to the use of unique data sets on health care expenditure. The National Health Fund has provided data on health care expenditure with breakdowns by age, gender, type of care and whether the person is a decedent or survivor. This data has been merged with the National Statistical Office data on population and mortality. Firstly, decomposition was applied, followed by a non-linear econometric model. They prove that those living longer do not cause higher health care costs in the life-cycle. Therefore, the increasing life expectancy could have a neutral effect on the aggregated health care costs. The results obtained confirm the findings of Spillman and Lubitz (2000) for the USA. (Spillman and Lubitz, 2000) have found that cumulative health care expenditure financed by Medicare for those over the age of 65 did not rise significantly with the age of death. Only long-term costs are strongly affected by age. The results obtained from NFZ data reinforce these conclusions, since health care expenditure can be observed in Poland for the whole population. To the best of my knowledge, this is the first paper investigating the role of age and the proximity to death in a country from Central and Eastern Europe with a fast-ageing population.

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