Christophe Kolodziejczyk

The Impact of an Increase in the Non-Western Immigrant Population of Denmark on Health-Care Expenditures

The Influence of Ageing and Mortality

Danish Institute
for Local and Regional
Government Research

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Preface

This working paper is part of a project financed by Sygekassernes Helsefond on the impact of ageing and proximity to death on the use of the Health-care system by immigrants and native-born in Denmark. The aim of the project is to document the differences in use of the Danish health-care system.

The current part of the project investigates the likely impact on health-care expenditures of the demographic evolution of the Danish society in terms of its ethnic composition. A second part of the project, the results of which are reported in a working paper entitled "The Effect of Ageing and Proximity to Death on the Use of Health Care of Non-Western Immigrants of Denmark: A Comparison with the Native Born", investigates the differences in the evolution of health-care expenditures over the life cycle between native-born Danes and non-Western immigrants.

Christophe Kolodziejczyk has conducted the empirical analyses and written the present manuscript. The author would like to thank Terkel Christiansen, Torben M. Andersen and Jacob Nielsen Arendt for valuable comments.

Christophe Kolodziejczyk
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Contents

Summary

This paper investigates the impact of an increase in the population of immigrants from non-Western countries on health-care expenditures in Denmark over the years 2011-2100. Future health-care expenditures are simulated on the basis of an econometric model of health-care expenditures combined with demographic projections from official sources. The econometric model is estimated with individual data and is used to model the conditional mean of health expenditures as a function of age and proximity to death. Changes in technology and economic conditions and their effects on health-care expenditures are disregarded. The model is simulated to predict the likely impact of the expected increase in non-Western immigrants under two scenarios. The first scenario considers age effects by ignoring the impact of proximity to death, where the other scenario considers explicitly this variable. Counterfactual analyses are also performed to evaluate the share of the impact due to the ageing of the two populations and the share due to differences in use between Danes and non-Western immigrants. Under the scenario which ignores the role of proximity to death the results show an increase of 50% of the average health expenditures for non-Western immigrants against 11% for Danes for the years 2011 and 2090. Under the other scenario, Danes experience a decrease of 5% of their health costs, where immigrants experience an increase of 26% for the same years. This increase for immigrants is mainly due to the evolution of the age composition of this population. Differences in use and the increase of immigration play a minor role.

1 Introduction

Western societies will experience an increase of their foreign population in the future. This increase of the foreign population will potentially put under pressure public finances as non-Western immigrants use public services differently. One type of service under focus is health-care service. On the one hand, several studies have shown that non-Western immigrants have different behaviour in terms of use of the health-care system compared to natives (Bengtsson & Scott 2006; Solé-Auró & Crimmins 2008). On the other hand, health-care expenditures are generally positively correlated with age. Therefore, the ageing of society, through an increase of life expectancy and a drop in fertility rates, has the potential of making health expenditures per capita grow in the future. As the immigrant population is ageing and constitutes a higher share of the total population, it can have an impact on the global health-care expenditures. It is not clear, however, how these demographic changes will affect health-care expenditures in the future, as no information on how health expenditures develop over the life cycle specifically for natives and immigrants is available.

Different factors may affect the evolution of health-care expenditures in relation to the intrinsic differences between the two populations and differences in their use of health-care services. First of all, differences in morbidity between the two populations will affect the global bill. Second, differences in age distributions and an increase in longevity will affect the overall future age distribution of the population and also affect health-care expenditures. Third, differences in the cost of dying together with the evolution of mortality will also affect health-care expenditures. It is therefore important to evaluate the size of these factors in order to be able to predict the likely evolution of health-care expenditures due to an increase in immigration. These different effects are not mutually exclusive and can be combined. For example differences in morbidity between the two populations are likely to change with age and ageing will modify health-care expenditures through this channel as well. It is, therefore, important to disentangle these different effects. For example it is relevant to know the pure contribution coming from the aging of population. It is relevant because it will show the effect due to a catch up for the immigrant population in terms of the age distribution. This question can be answered by maintaining the effect of morbidity constant for the two populations. These kinds of questions can be answered with the help of a simulation model.

Projections for the population of Denmark predict an increase in the share of non-Western immigrants as well as an increase of the share of the individuals aged over 65. Since immigrants are expected to use the health-care services differently and health-care expenditures, it will potentially put the health-care system under pressure. This paper therefore tries to answer the following questions. What is the impact on the health-care expenditures of an ageing immigrant population? How can this potential impact be explained by differences in use and differences in ageing of the two populations? Answering this question can help us assess the potential threat of these factors on the health-care system and the role of these two different factors. These questions are of primary importance for policy analysis since financing the health-care system is expected to be one of the major challenges of public finances in the future.

These questions are answered by building a simulation model which includes the impact of ageing and proximity to death. The parameters of the model are estimated on individual data on health-care expenditures for non-Western immigrants and native born from Denmark. The model is then simulated until 2100 by using projections of mortality rates, births and migration flows for each group. Two scenarios are considered. In a first scenario a naïve approach is taken, where only age is used to predict health-care expenditures per capita. In a second scenario proximity to death and survival status are further included to the first scenario. It allows assessing the impact on health expenditures of an increase in longevity for all the different groups considered. For each scenario it is attempted to disentangle the effects coming from the difference in ageing of the two populations and from the differences in use of the health-care system.

This study offers two contributions. The first contribution is to give an assessment of the impact on the health-care expenditures of an increase in the population from non-Western countries and to identify the different sources of a potential increase in health-care expenditures. The second contribution is to provide an evaluation of the differences in these projections of the health-care expenditures under different scenarios concerning the impact of ageing. The results show that health-care expenditures for immigrants are likely to grow in the future, but the overall impact on the total health-care expenditures will be small. It also seems that convergence in the age distribution of the immigrants to that of the natives is the main driver of the increase in the health-care expenditures of non-Western immigrants.

The rest of the paper is organised as follows. Section 2 gives a brief review of the relevant literature. Section 3 presents the data used for this analysis. Section 4 presents the econometric methodology used. Section 5 presents the empirical results. Section 6 offers a discussion of the results and section 7 concludes.

2 Theory and models

In this section a review of the relevant literature with an emphasis on the different models and theories. First, a short enumeration of the different factors which may explain differences in health-care use between immigrants and native born as well as a short review of the empirical evidence of these differences. Then a short overview of the literature on the impact of ageing and proximity of death on health-care expenditures is provided with an emphasis on the so-called “red-herring” literature. Finally, some of the contributions related to the projections of health-care expenditures are reviewed.

2.1 Differences in the use of health-care services between non-Western immigrants and Danes

There is little theoretical work which tries to explain why there might be differences in the use of health-care services between non-Western immigrants and native born. A few sources of discrepancies can be mentioned by referring to existing theories on the demand for health. Andersen (1968) and Andersen (1995) provide a behavioural model for the use of health care. This model is a general attempt to explain health-care use, but it has been used in particular to explain differences between immigrants and native-born use of the health-care system (Solé-Auró, Guillén et al. 2009). The first source which comes into mind is related to differences in health status, prevalence and type of the diseases of the two populations. This source of discrepancy can be the result of differences in lifestyle or genetic components. A second potential source is the cultural and socio-economic differences related to the determinants in use of the health-care system. Cultural factors could be explained by language barriers, whereas socio-economic differences can be related to differences in education and income (Grossman 1972; 2000). Note that the causality between income and health status goes both ways (Smith 1999). Obviously changes in health status can affect future income, whereas income or education can affect lifestyles as well as the propensity to use the health-care system. A third source of determinants would be the different types of economic incentives the potential and actual users of the health-care system are facing such as co-payments and the different types of health insurance, which might affect differently non-Western immigrants and native born propensity to access health care for a given health status, mostly because of differences in socio-economic status.

Most of the studies on the use of health care by immigrants are interested in documenting differences in health status and in the access and use of the health-care system. For example, using data from the Survey of Health, Ageing and Retirement in Europe (SHARE) which documents health status and health-care utilisation of people aged over 50 in 11 countries in Europe. Solé-Auré & Crimmins (2008) investigate differences in health status between immigrants and native-born. Hernández-Quevedo & Jiménez-Rubio (2009) also investigate for Spain the health status and health-care status of immigrants and health-care utilisation. They find that patterns of health status and health-care use are related to nationality, but also that immigrants in general have difficulties to access specialised care. Dinesen, Nielsen et al. (2011) investigate for Denmark differences in health status between non-Western immigrants and native Danes and find that immigrants report poorer health compared to Danes. It is partly explained by a lower socio-economic status. However, the impact of ageing on health-care expenditures for immigrant populations has not been documented. It is necessary to have information about how health-care expenditures evolve with age for immigrants in order to be able to project the future's impact of the evolution of the immigrant population on the use of health-care services.

2.2 The impact of ageing and proximity to death on health-care expenditures

Recent literature on the impact of ageing has shown the importance of incorporating the cost of dying. Payne, Laporte et al. (2007) provide a review of this literature. Health-care costs are disproportionately high in the last months before dying and the proportion of decedents of a given age group is increasing with age. Therefore, if one wants to estimate the effect of ageing, it is important for a given age to distinguish between those who survive and those who are close to dying and to control for proximity to death. This literature is mostly empiricist, so it is worth mentioning one theoretical contribution which links the health-care expenditures to ageing and proximity to death (Felder, Meier et al. 2000). Chernichovsky & Markowitz (2004) discuss the implications of ageing on the evolution of health-care expenditures when proximity to death is taken into account. Zweifel, Felder et al. (1999) were among the first to conduct empirical analyses of the impact of proximity to death on health-care expenditures and found that for a group of decedents in their last two years of life, once proximity to death was included in the model age effects on health-care expenditures were statistically insignificant. It has led these authors to call it a 'red-herring', meaning that the argument of a potential threat of ageing on the sustainability of the health-care system was used to divert the debate on the real determinants of the growth of health-care expenditures like technological progress, failures in insurance markets and wrong incentives on the health-care sector (Zweifel, Felder et al. 1999). Salas & Raftery (2001) and Seshamani & Gray (2004a) have criticised the methodological approach used in the study of Zweifel, Felder et al. and have cast some doubts on the robustness and the credibility of their results. The critics where targeted at the use of a selection model instead of a two-part model to model the large fraction of zero expenditure in the sample as well as the fact that the sample only included decedents. Zweifel, Felder et al. (2004) in a study which takes into account these critics, especially the fact that they include survivors, conclude that age will not matter for decedents as in their study from 1999, but it may matter for survivors. Several other contributions which have refined the econometric techniques or which have used other data sources have confirmed that proximity to death plays an important role in the determination of health-care expenditures and omitting this variable overestimates the impact of age. Furthermore, taking into account the proximity to death tends to decrease age effects, mitigating the threat of ageing. Seshamani & Gray (2004b) find that proximity to death can have an impact up to 17 years on hospital expenditures. Werblow, Felder et al. (2007) have tested the same hypotheses and have extended these results to other types of health-care expenditures than hospital expenditures. They also find that proximity to death is a determinant of the different components of health-care expenditures, which led them to say that there was a 'school of red herrings'. Dormont, Grignon et al. 2006 reach similar conclusion in terms of the impact of ageing on health-care expenditures. They show that changes in practice and morbidity more than compensate for the effect of population ageing and conclude that the impact of ageing is rather small. In the Danish context Serup-Hansen, Wickstrom et al. (2002) have conducted the first study to relate proximity to death to health-care expenditures. Taking into account ageing and proximity to death Kildemoes, Christiansen et al. (2006) have performed projections of drugs purchases over the period 2003-2030

2.3 Projections of future health-care expenditures

A related question to the impact of ageing on health-care expenditures is to quantify the differences in the projections of health-care expenditures when proximity to death is omitted. Miller (2001) gives for U.S.A. a first estimation of the impact of ageing on health-care expenditures when time of death is taken into account. Stearns & Norton (2004) show that including time of death will give different projections for health-care expenditures compared and the omission of proximity to death will overestimate the impact of ageing on health-care expenditures. Breyer & Felder (2006) perform projections of health-care expenditures for Germany using projections of the demographic evolution of this country. They consider two types of models which relate to two different hypotheses. According to these authors the first scenario corresponds to the hypothesis of expansion of morbidity (Olshansky, Rudberg et al. 1991), where new treatments potentially extend patients' lives without restoring completely their health and which in turn will require other treatments. As a consequence the average health status of the population will deteriorate with ageing. The other scenario is based on the time-to-death hypothesis, where it is conjectured that remaining lifetime explains the growth of health-care expenditures over the life cycle rather than calendar age. Therefore, it is important to distinguish between survivors and decedents and that the fraction of decedents is increasing with age.

A more extreme version of the time-to-death hypothesis is the so-called compression of morbidity assumption (Fries 1980; Fries 2002). In this scenario age effects and only proximity to death affect health expenditures. As the society are ageing and reaches the natural limit of longevity, the diseases are concentrated in a shorter period before death. A scenario which includes both the effect of age and proximity to death has been called by Miller a delay in morbidity and can be considered a middle path between the compression of morbidity and expansion of morbidity scenarios.

For Denmark (Pedersen & Hansen 2006) have discussed the potential threat for health-care expenditures which constitutes ageing and its financing through a universal welfare state. They conclude that increase in wealth and technological changes are the main drivers of health-care expenditures' growth. Hansen & Pedersen (2010) have integrated the role of proximity to death in their model for projecting health-care expenditures and studying the sustainability of the Danish fiscal policy based on the results from Arnberg & Bjørner (2010). The incorporation of these factors follows the discussion and the framework for projecting health-care expenditures proposed by Oliveira Martins & De la Maisonneuve (2006) which is applied by the OECD. These models try to project the evolution of health-care expenditures not only based on the predicted ageing of the Danish society and the evolution of mortality rates, but also on other factors such as technological changes in medicine and increase in income. Dormont, Oliveira et al. (2008) offer a further discussion of these issues and their implications in the debate on the impact of ageing on health-care expenditures. In the present analysis these factors have been ignored, as the main focus is to evaluate the consequences of a potential ageing population of non-Western immigrants.

3 Data

3.1 Source of the data

The data used in this study come from Danish administrative registers. All these registers are population based. The health-care expenditures (HCE) include four types of expenditures related to the use of the public health-care sector. These expenditures amount to around 80% of the health expenses in Denmark. The other 20% difference is explained by the fact that prices used to determine the individual hospital expenditures do not account for expenses related to the purchase of new equipment (Serup-Hansen, Wickstrom et al. 2002; Arnberg & Bjørner 2010). Furthermore, no data on long-term care were available. Health-care expenditures include hospital costs for ambulatory treatment and hospitalisations[1], visits to physicians, drugs prescriptions and psychiatric hospital stays (inpatient and outpatient). Hospital costs at the individual level are computed with the help of DRG/DAGS codes from the National Health Register. DRG and DAGS codes determine average prices for a defined procedure for respectively inpatient and outpatient care. These prices have been computed over the data period by the Board of National Health[2]. DRGs have been used in other Danish studies on health-care expenditures to construct hospital expenditures (Serup-Hansen, Wickstrom et al. 2002; Arnberg & Bjørner 2010). A description of how these DRGs can be used in this context can be found in Serup-Hansen, Wickstrom et al. (2002). Information on drugs purchases is obtained through administrative registers from the Danish Medicines Agency. Expenditures on drugs purchase only include the part which is actually paid by the public sector. Information on visits to physicians is also extracted from a population based registered and are the sum of all the consultation fees incurred by each individual during the year. HCE are computed on a yearly basis and measure the flow of medical expenses over the whole year. Furthermore, health expenditures have been deflated by medical CPIs. The time of death is obtained from the death causes registry. Demographic information is obtained from other registers, such as age, marital status and income. A more detailed description of the variables used in the econometric model is given in the section on the econometric results.

Data cover the year 2003. In this way there is variation in the remaining lifetime since HCE can be observed up to seven years prior to death. HCE are computed at the end of the year 2003. The data are extracted from the entire population aged above 16. A 5% sample of the Danish population and a 50% sample of the non-Western immigrants were drawn from this population. Remaining lifetime is computed in months and information on time of death is extracted from the death causes registry up to 31.12.2010, which means that time of death can be observed up to this date. For people who have survived up to this date or who died af-

[1] The expenditures include emergency ward visits.

[2] They are now computed by the Ministry of Health.

ter this date, their time of death will be right censored. It takes the value of 84 months in this case.

The other source of data for this analysis is the demographic projection performed by Statistics Denmark and the DREAM model (Hansen & Stephensen 2011). These data provide projections of the evolution of mortality, migration flows and births. These data allow computing projections of the aggregate populations for each ethnic group, i.e. ethnic Danes and first and second generation immigrants. It is further possible to distinguish between Western and non-Western immigrants. Demographic projections are available up to the year 2100. For each year predicted mortality rates are computed for each age group for men and women. In the simulation part of this analysis mortality rates are used to compute the number of decedents as a share of the population and measures of proximity to death. Population figures are available by age, gender and ethnic group. It allows taking into account the evolution of the age distribution of each population.

In this analysis immigrants are defined as the individuals who belong to the first and second generations of immigrants from non-Western countries. These definitions of immigrants are based on the definitions used by Statistics Denmark. An immigrant belongs to the first generation if the individual is not born in Denmark and both parents are not Danes. An immigrant belongs to the second generation if the individual is born in Denmark, but both parents are not Danes. The country of origin is defined as the country of origin of the parents and only immigrants with non-Western countries of origin are considered.

3.2 Description of the data

3.2.1 Health-care expenditures, age and survival status

This section gives a brief description of the data in terms of the differences between immigrants and native Danes for the use of the health-care system, the demographic composition and mortality. Summary statistics for the health expenditures, age and mortality are reported in table 3.1. Summary statistics are reported for Danes and non-Western immigrants and for every group the statistics are computed by gender and survival status. The group of decedents is the group of individuals who died between the 31st December 2003 and the 31st December 2010. The groups of survivors are those individuals who are observed alive the 31st December 2010. There are differences in terms of the level of health expenditures for both groups. In general, the level of health expenditures is lower for immigrants, but it is mainly due to the fact that immigrants are much younger, as shown by the difference in the average age of the two groups. This difference in the age distribution will also lead to a higher number of survivors as a share of the population in the sample of immigrants.

Table 3.1 Danes and non-Western immigrants – The effect of ageing and proximity to death – Summary Statistics

	Women				Men			
	Danes		Immigrants		Danes		Immigrants	
	mean	sd	mean	Sd	mean	Sd	mean	sd
Health-care expenditures	10452.62	33238.96	8895.63	28799.01	8510.33	36911.42	7792.90	71360.68
Share with positive HCE	0.98	0.15	0.93	0.26	0.93	0.25	0.87	0.34
Age	47.97	18.89	36.08	14.07	45.71	17.57	36.85	13.69
Survivor	0.91	0.29	0.98	0.13	0.91	0.29	0.97	0.16
Observations	100744		51996		96323		52247	

Survivors

	Women				Men			
	Danes		Immigrants		Danes		Immigrants	
	mean	sd	mean	Sd	mean	sd	mean	sd
Health-care expenditures	8536.00	28792.33	8488.97	27609.95	6412.48	32726.68	7182.44	71068.66
Share with positive HCE	0.98	0.15	0.93	0.26	0.93	0.26	0.86	0.34
Age	45.17	17.12	35.54	13.45	43.27	16.05	36.26	13.13
Observations	91272		51034		87221		50844	

Decedents

	Women				Men			
	Danes		Immigrants		Danes		Immigrants	
	mean	sd	mean	Sd	mean	sd	mean	sd
Health-care expenditures	28921.11	58194.21	30468.98	62589.62	28613.23	60902.11	29915.60	78109.19
Share with positive HCE	0.98	0.13	0.96	0.18	0.96	0.19	0.95	0.22
Age	74.91	13.02	64.90	16.18	69.05	13.96	58.12	16.37
Proximity to death	42.04	24.31	43.74	23.62	42.31	24.31	43.09	23.41
Observations	9472		962		9102		1403	

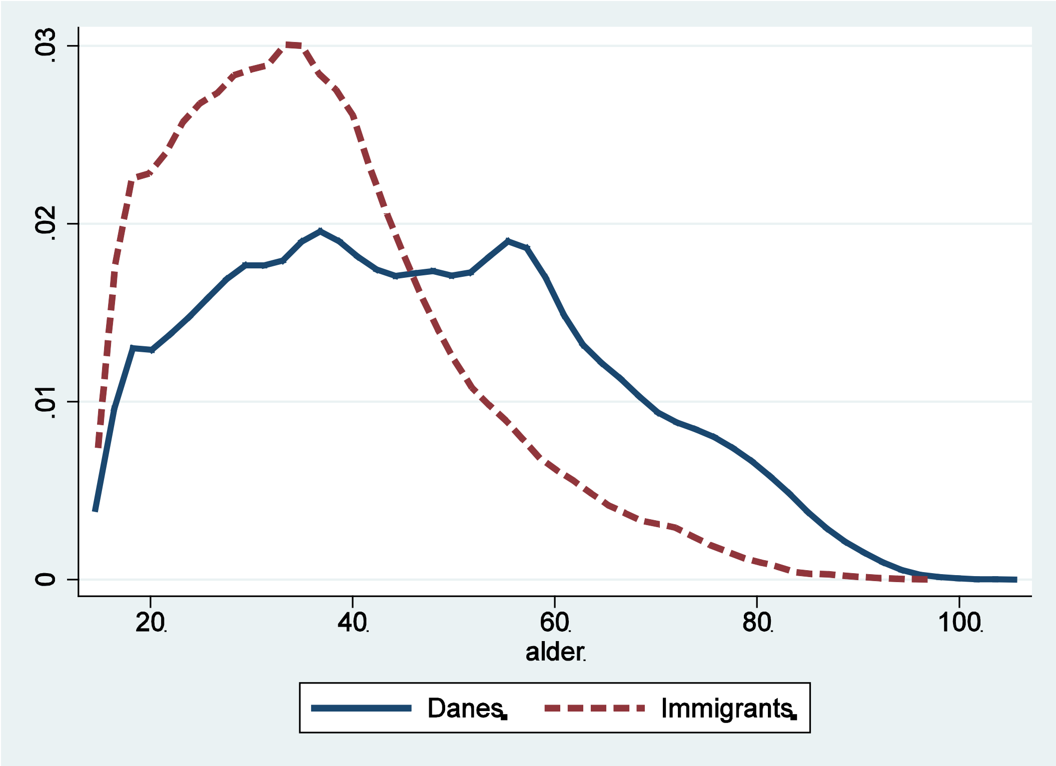
Figure 3.1 is a plot of the age profile of the observed health-care expenditures for Danes and non-Western immigrants. The plot is computed for men and women and is the result of a non-parametric regression of age on health-care expenditures performed with the Nadaraya-Watson kernel regression estimator in order to smooth the average by age. This figure illustrates that the age profile for non-Western immigrants lies above that of the native Danes until the age of 65 where this pattern is reversed beyond that age. This observation is valid for men and women. The difference appears to be larger for men. For women there is a peak in HCE between the age of 25 and 35, which corresponds to the period of fertility. Generally, immigrants of working[3] age tend to have higher expenditures than native Danes.

[3] The official pension age in Denmark was 65 in 2003.

Figure 3.1 Danes and non-Western immigrants' observed age profiles – men and women, year 2003

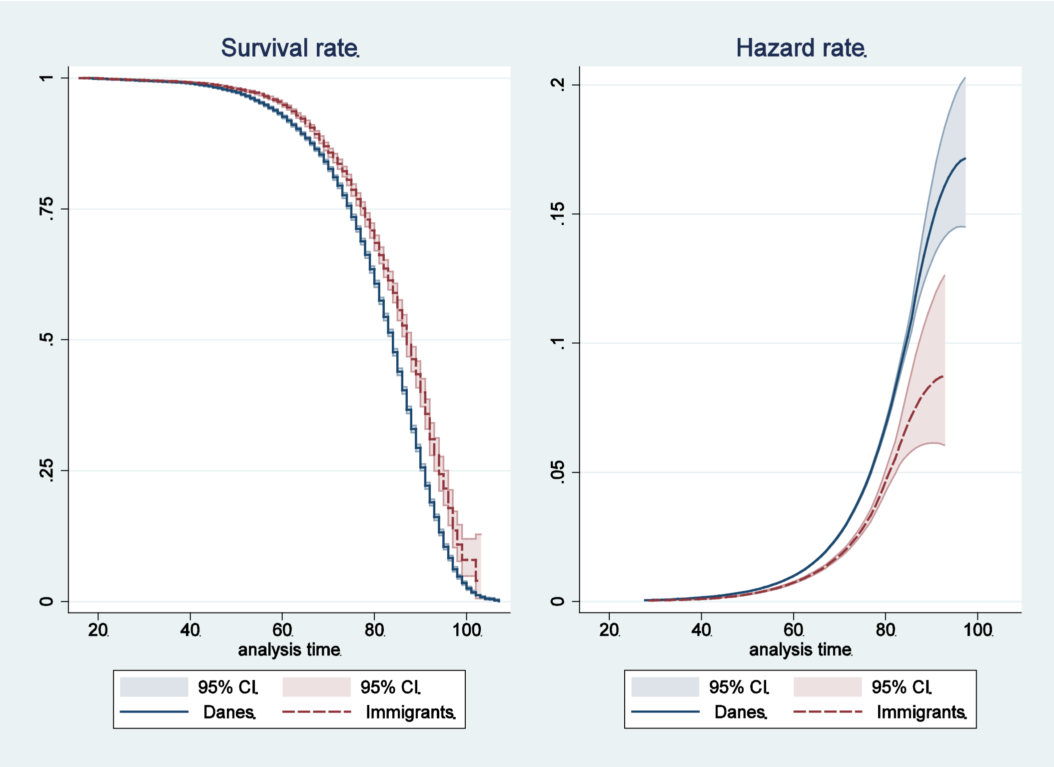
Figure 3.2 illustrates with a plot of the age distribution of the two populations that non-Western immigrants are much younger than native Danes. This figure explains why the unconditional average of HCE is lower for immigrants. Although immigrants below the age of 65 cost more than Danes, they cost less than Danes over the age of 65 and younger people constitute a larger weight in the immigrants' population compared to the natives.

Figure 3.2 Age distribution for Danes and non-Western immigrants



Finally, figure 3.3 presents estimates of the survival curves and the mortality hazard rates for the two populations. These curves have been computed with the Kaplan-Meier estimator. It looks like immigrants have a higher survival rate compared to the natives. Compared to Danes a larger fraction of immigrants have survived past the age of 80. This could be explained by the fact that a large fraction of immigrants will migrate out of Denmark before the age of 65. It is also likely that the estimates for immigrants have a large variance because a lot less immigrants at old age are present in the sample. A log-rank test of equality of survivors was performed and the test rejected the null hypothesis of equality (χ^2=220.75). Estimates of the hazard rate give a similar picture, where the hazard rate for Danes is above that of the immigrants at all ages. So there might be some selection effects which could explain these higher survival rates for immigrants.

Figure 3.3 Mortality for Danes and non-Western immigrants, year 2003 – Survival and hazard rates with 95% confidence intervals



3.2.2 Demographic projections of migration flows in Denmark

This section gives a brief description of the data covering the projections of the demographic evolution of Denmark. These projections have been performed by DREAM and Statistics Denmark (Hansen & Stephensen 2011). Projections of the evolution of the population are available from the year 2011 to the year 2100. The two key elements for this analysis are the evolution of life expectancy and the evolution of the immigrants' share of the population in the total Danish population. The data consist of projections of mortality rates by age, differentiated by gender as well as projections of the evolution of the total population. The former is used to compute a measure for proximity to death for each year and for each group. The latter is used to measure the evolution of the age distribution of the different groups composing the population. Mortality rates are forecasted using the Lee-Carter method (Lee & Carter 1992; Alho & Spencer 2005). The total population consists of the sum of all the survivors, the number of births and the number of migrants minus the total number of deceased and the total number of individuals leaving the country. These projections both expect an increase in the immigrants' share of the population as well as an increase in the average age of the population, as illustrated in figure 3.4. The increase of the share of non-Western immigrants is forecasted to grow almost linearly during the period 2011 to 2070 from 7% to 12% of the total population composed of Danes and non-Western immigrants[4]. This share is expected to decline after 2070. Ageing[5] is of course due to two factors which are the evolution of fertility and the evolution of life-expectancy. The expected evolution of life-expectancy is illustrated in figure 3.5.

Figure 3.4 Evolution of the average age and non-Western immigrants' share of the population over time, 2011-2100

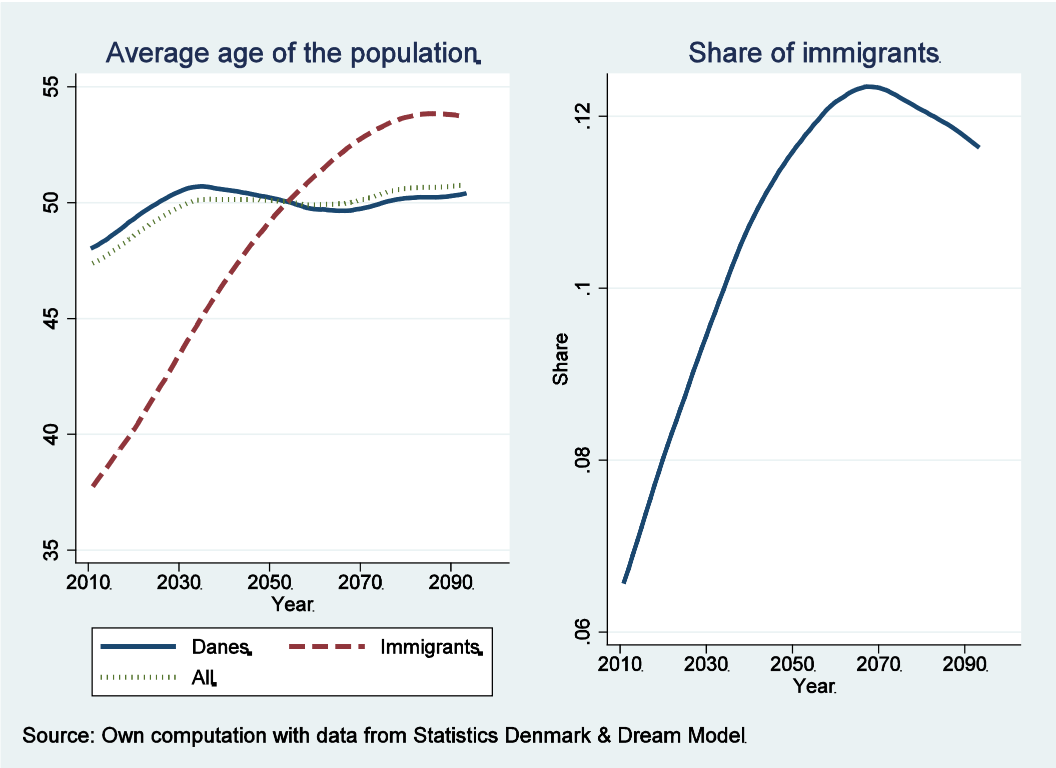
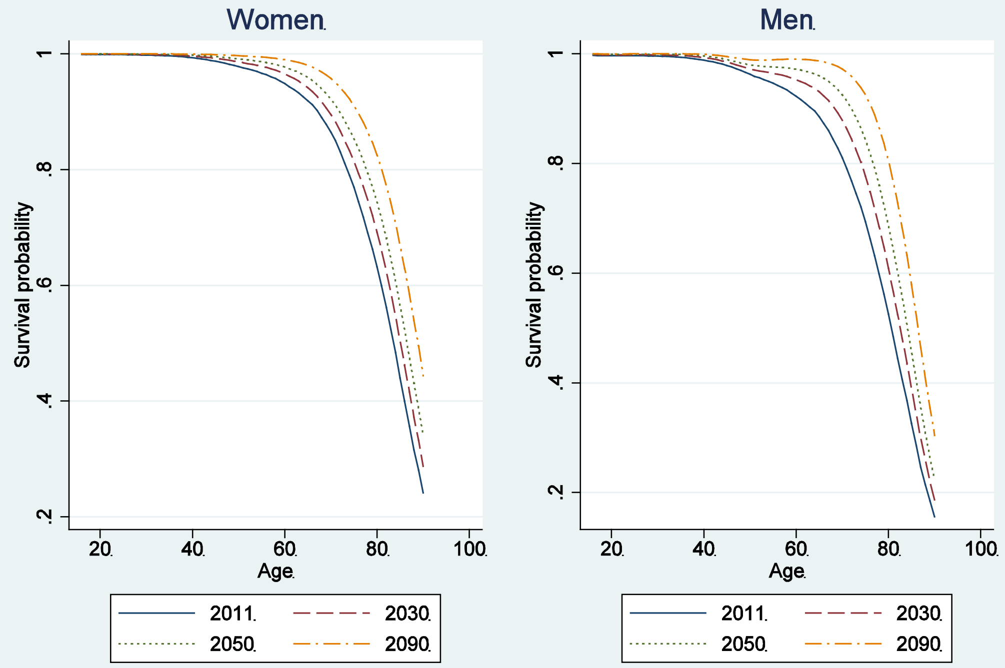


Figure 3.5 illustrates that current projection models expect an increase of longevity. Figure 3.5 plots the probability at a given age of surviving at least seven years for men and women and for selected years between 2011 and 2090. These survival rates lie above one another as time goes by. An individual aged 80 in 2090 has therefore a higher probability of surviving seven years than an individual aged 80 in 2011.

4 This analysis does not consider immigrants from western countries. Therefore, these figures reflect the weight of the immigrants compared to the native Danes and not the weight in the total population projected by DREAM.

5 Ageing is understood in some studies as an increase over time of people aged over 65 as a share of the population.

Figure 3.5 Evolution of projected seven years survival rate by age for men and women, 2011-2090



Source: Own computation with data from Statistics Denmark & Dream Model

4 Method

This paper investigates the effect of ageing and mortality on health-care expenditures as a consequence of an increase in the population of non-Western immigrants. A model of health-care expenditures is estimated for the different subpopulations relevant for this analysis. The model includes age, proximity to death and survival status as covariates for the year 2003. Recent contributions from the literature on the impact of ageing on health-care expenditures have shown the importance of controlling for the proximity to death (Zweifel, Felder et al. 1999; Werblow, Felder et al. 2007). As people get older a higher share of the same age group will die. Therefore, omitting the cost of dying will overestimate the effect of ageing. Furthermore, as mentioned (Miller 2001) age is a poor predictor of health status. In the case of projections of health-care expenditures, this effect is important to include, because life expectancy is expected to increase in the future and will therefore moderate the effect of ageing. This study uses Danish data and the econometric model is estimated for ethnic Danes and non-Western immigrants. Furthermore, the model takes into account gender differences in the use of the health-care system.

The model is then simulated until 2100 by using projections of mortality rates, births, migration flows for each group. This model can help to assess the impact of the future migration flows on the health-care system, especially an increase in immigration from non-Western countries. Two scenarios are considered. In the first scenario a naïve approach is taken, where only age is used to predict health-care expenditures per capita. In a second scenario proximity to death and survival status are further included compared to the first scenario. It allows assessing the impact on health expenditures of an increase in longevity for all the different groups considered. For each scenario it is attempted to disentangle the effects coming from the difference in ageing of the two populations and from the differences in use of the health-care system.

4.1 The econometric model

The purpose of the econometric model is to estimate the conditional mean function for health expenditures. The results of the estimations of these models will be used in the simulation part to project health-care expenditures. Generally, the literature on the econometrics of health costs considers the estimation of two-part models, where the decision of using the health-care system is modelled separately from the modelling of the amount of expenditures given that the individual is consuming health-care services. These issues are ignored in this study and a simpler model is estimated. This is done for two reasons. First, the interest of this analysis is to predict the health-care expenditures of different age groups. Second, the share of people who do not use health-care services is very limited, about less than 5%. Therefore, the results of a simple model of health-care expenditures which ignores the dichotomy of the two-part model and which is estimated on a sample including zero expenditure will not be very different from those obtained from the two-part model. Angrist & Pischke (2009) have similar arguments when it comes to identifying the causal effect of specific variables on the conditional expectation function. In this analysis the object of interest is the partial effect of age and proximity to death on the conditional mean of health expenditures and not whether individuals decide to consume health-care services.

However, it is taken into account that health-care expenditures are always positive and have a highly skewed distribution. Health-care expenditures are characterised by a highly skewed distribution. The health econometrics literature on the modelling of health expenditures and health outcomes has focused on how to estimate regression models where the outcome is highly skewed. In order to decrease the level of skewness of the outcome's distribution, a popular strategy is to transform the model by taking the logs of expenditures and estimate the model of those with positive expenditures by linear regression. According to Manning & Mullahy (2001) this method will provide biased estimators of the marginal effects of the original outcome. It is therefore necessary to retransform afterwards the estimates by applying a smearing factor. Such a method can lead to large biases in the marginal effects and in the predictions of the outcome on the raw scale if the model is heteroscedastic and the model of the heteroscedasticity is misspecified. This has led to the use of GLM models with a log-link (Seshamani & Gray 2004a). Following Manning & Mullahy (2001), Seshamani & Gray (2004b), a GLM formulation is adopted in order to have a model which has good prediction properties for health-care expenditures. The conditional mean function is modelled as

$$E(y|x) = \exp(x\beta).$$

The variable y denotes health-care expenditures, x is a set of covariates, which will include age, proximity to death and survival status, and β is a parameter vector to be estimated.

In the empirical section a GLM model with a log-link and a Poisson distribution is estimated. Flexible functions of age and proximity to death are estimated. For age a 5^{th} degree polynomial is used whereas a quadratic specification for proximity to death has been chosen (see section 5.1 for more details). The covariance matrix is corrected for the presence of an unknown form of heteroscedasticity. This is necessary in the case of the Poisson model, as this model assumes that the variance is equal to the mean[6]. In this case the standard errors will be overestimated.

4.2 The simulation model

It has also been experimented with a Gamma distribution, but the Poisson distribution gave better results in terms of mean-squared error. These two models belong to the class of exponential regression, where the error term is assumed to be multiplicative instead of additive. Although these models are parametric, they provide consistent estimates of the model and are robust to violations of the assumed distribution. They are therefore models suitable for

6 Note, however, that the Poisson model is a heteroscedastic model.

highly skewed and always positive outcomes. Although the Poisson model was originally designated for count-data models, it can also be used with continuous outcomes[7].

The simulation model gives projections of health-care expenditures according to the projections of the demographic evolution of Denmark from the DREAM model[8] for the year 2011 (Hansen & Stephensen 2011). DREAM provides projections for mortality rates, births, migration flows until the year 2050. Mortality rates are differentiated for gender and age. The number of births is available for each ethnic group. Finally, the absolute flows of migration are given for each age and ethnic group. These projections are used in the model to predict the impact of the changes in the age distribution and the differences in the use of the health-care system of the different groups of the population. The model consists of two steps. First for each group the proximity to death and age distribution are computed. In a second step the weights of the different populations are computed for each year. In this way it is possible to compute the overall effect on health-care expenditures resulting from future demographic changes.

4.2.1 Mortality and proximity to death

A method similar to the ones used by Breyer & Felder (2006) to simulate proximity to death is implemented. Data from DREAM provide projections of mortality rates from the years 2011 to 2050. From these mortality rates it is possible to compute the distribution of proximity to death in the population for each year. Let $q_t(A)$ and $S_t(A) = 1 - q_t(A)$ denote the probability of respectively dying and surviving at age A. If i denotes proximity to death in years, the probability of dying at age A+i given age A in period t is computed according to the following formula:

$$p_t(A + i|A) = \left[\prod_{j=0}^{i-1} S_{t+j}(A + j)\right] q_{t+i}(A + i)$$

The probability $s_t(A + I|A)$ of surviving after I years given age A in period t is given by

$$s_t(A + I|A) = \prod_{j=0}^{I} S_{t+j}(A + j)$$

For each group it is possible to compute the conditional expectation function for health-care expenditures at time t$E_t(HCE|A, s, m, ptd, D)$, where A is age, s gender, m the ethnic group, ptd proximity to death measured in years and D an indicator for decedent status. This conditional expectation contains two elements. The first element is the conditional expectation for the decedents which takes into account the probability of dying at different points in time, whereas the second element is the conditional expectation for the survivors. For the dece-

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7 Wooldridge, J.M. (2010). Econometric analysis of cross section and panel data. Cambridge, Mass., MIT Press provides a discussion of this issue.

8 The data related to these projections and used in this analysis have been provided by Statistics Denmark.

dents it is computed as the sum of health-care expenditures for each value of proximity to death weighted by the probability of dying. Proximity to death varies between 0, which corresponds to dying within the year, and I which is determined by the maximum number of years of observed proximity to death in the data. The second element is simply the conditional expectation of health-care expenditures for the group of survivors. The conditional expectation for health-care expenditures is therefore equal to

$$E_t(HCE|A,s,m) = \sum_{i=0}^{I} p_t(A+i|A)\, E_t(HCE|A,s,m,ptd=i,D=1) + s_t(A+I|A) E_t(HCE|A,s,m,ptd=i,D=0)$$

The next step is to compute the conditional expectation function of HCE given age for each year given the projected weights of the different groups in the population. In other words the conditional expectation of HCE given age will change due to the demographic changes, i.e. the changes in mortality. It is also possible to compute the expected HCE of the population. The conditional expectation given age is given by

$$E_t(HCE|A) = \sum_{m=1}^{M} \sum_{s=0}^{1} w_t(A|s,m) E_t(HCE|A,s,m)$$

where $w_t(s,m|A)$ is the weight of group m with gender s in age group A.

4.2.2 Ageing of the population: Migration, mortality and births

In order to compute for each year the age distribution of each group it is necessary to take into account migration flows and the number of births. The age distribution for each group is computed from the projections of the population provided by DREAM and Statistics Denmark. These projections take into account for each group the number of deaths, the number of births, the number of immigrants and the number of emigrants. If $N_t(A|s,m)$ denotes the number of people at time t in group m of gender s and aged A, then the weight of group m of gender s with age A within the group of people of sex s and belonging to group m is equal to

$$w_t(A|s,m) = \frac{N_t(A|s,m)}{\sum_{a=0}^{\bar{A}} N_t(a|s,m)}$$

These weights are then used to compute the different relevant expected health-care expenditures.

5 Result

In this section the results of the estimation and the simulation model are presented. The first section is dedicated to the estimations of the parameters of the model used to project health-care expenditures. The second section presents the results of the different simulated scenarios.

5.1 Econometric model

This section presents the results of the econometric models. Every model is estimated separately for Danes and immigrants. For each group the model is estimated additionally for men and women. Two models are considered. The first model ignores the effect of proximity to death and considers only the effect of age. The effect of age is modelled with the help of an orthogonal polynomial of the 5th degree. The second model including the effect of proximity to death uses an additional (orthogonal) polynomial of the 2nd degree and a dummy for survival status after 2010. The number of degrees of the polynomials included in the regression has been decided on the basis of the Aikaike information criterion, where additional terms were included until no improvements in the value of the criterion were observed.

Orthogonal polynomials are not different from traditional polynomials. They are just "easier" to interpret. The general problem of polynomial regressions is the multicollinearity between the different terms of the polynomial, which increases the risk of obtaining statistically insignificant estimates. Orthogonal polynomials are the polynomial terms removed from the effect of the terms of lower order. Therefore, each term can be interpreted as its additional effect compared to the effects of lower order. It can also be more easily tested whether an additional term adds statistically speaking predictive power to the model by performing usual t-tests on the coefficients of interest.

Table 5.1 presents the results of the econometric model used to estimate the effect of age on health-care expenditures.

Table 5.1 Estimates of the GLM model of health-care expenditures – age effects only

	Women		Men	
	Danes	Immigrants	Danes	Immigrants
Health-care expenditures				
Age	0.296***	0.249***	0.523***	0.411***
	(22.70)	(16.36)	(30.78)	(12.61)
Age ^2	0.0610***	-0.0141	0.0548**	-0.0489
	(4.25)	(-0.85)	(3.06)	(-1.66)
Age ^3	0.0272	0.0722***	-0.0722***	0.00577
	(1.76)	(4.86)	(-4.38)	(0.23)
Age ^4	-0.113***	-0.0883***	-0.0433**	0.00511
	(-7.71)	(-5.53)	(-2.61)	(0.18)
Age ^5	0.0358***	0.106***	-0.00424	0.0915*
	(3.35)	(6.64)	(-0.28)	(2.14)
Constant	9.108***	9.157***	8.824***	9.059***
	(704.26)	(602.27)	(460.04)	(244.35)
AIC	2.63256e+09	1.13076e+09	2.53082e+09	1.79930e+09
RMSE	32956.1	28721.5	36524.8	71298.1
MAPE	12191.7	10356.1	10743.3	10561.2
Observations	100744	51996	96323	52247

t statistics in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5.2 Estimates of the GLM model of health-care expenditures – age and proximity to death effects included

	Women		Men	
	Danes	Immigrants	Danes	Immigrants
Health-care expenditures				
Age	0.154***	0.117***	0.338***	0.248***
	(10.84)	(6.07)	(18.04)	(6.68)
Age^2	-0.0407**	-0.112***	-0.0638***	-0.160***
	(-2.66)	(-6.08)	(-3.46)	(-5.32)
Age^3	-0.00882	0.0345*	-0.104***	-0.0324
	(-0.57)	(2.28)	(-6.29)	(-1.26)
Age^4	-0.115***	-0.0937***	-0.0357*	-0.00433
	(-7.82)	(-5.89)	(-2.15)	(-0.15)
Age^5	0.0481***	0.108***	0.0131	0.0847
	(4.47)	(6.85)	(0.89)	(1.96)
Proximity to death (P.T.D.)	-0.105***	-0.130*	-0.0972***	-0.129*
	(-5.92)	(-2.49)	(-5.91)	(-2.29)
$P.T.D.^2$	0.0318***	0.0335	0.0480***	0.0356
	(3.62)	(1.34)	(5.67)	(1.21)
Survivor	-0.723***	-0.744***	-0.802***	-0.720**
	(-9.23)	(-3.31)	(-11.25)	(-3.09)
Constant	9.758***	9.843***	9.509***	9.689***
	(132.03)	(46.85)	(139.07)	(44.64)
AIC	2.48773e+09	1.10590e+09	2.37438e+09	1.76365e+09
RMSE	32541.2	28567.8	36111.8	71211.9
MAPE	11900.5	10275.7	10411.4	10454.9
Observations	100744	51996	96323	52247

t statistics in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In general, including proximity to death in the set of covariates decreases the effect of aging. This can be easily seen by comparing the coefficient on the first term of the polynomial in age in table 5.1 and 5.2. The coefficient is lower when proximity to death is taken into account. Note that both terms of the quadratic polynomial in proximity to death are statistically significant for Danes at the 0.1% level, whereas only the first degree of the polynomial for immigrants is significant at the 5% level. Figure 5.1 plots for each group the observed and the predicted age profile. In general, there is more variation in health-care expenditures along the life cycle for immigrants than for the native Danes. The difference is more visible for men. Persons at old age, i.e. after the age of 80, represent a lower share of the population of non-Western immigrants compared to Danes, which is reflected by the sharp increase in health-care expenditures around the age of 90. The estimates of the average around this point are probably statistically uncertain, as there are not so many observations. The polynomial tries to catch this non-linearity, but probably overestimates the effect on health-care expenditures at old age for male immigrants.

Figure 5.1 Age profile of health-care expenditures for Danes and non-Western immigrants – observed and predicted

Figure 5.2 provides a plot of the prediction of the health-care expenditures for different values of proximity to death against a non-parametric regression of HCE. It appears that the quadratic specification provides a good approximation for Danes, whereas for immigrants the non-parametric regression shows a lot of variation. As mentioned previously it could be due to the fact that immigrants are very probably a much more heterogeneous group, because of the different countries of origin they cover, which in turn can express different morbidity patterns or different lifestyles.

Figure 5.2 Proximity to death profile of health-care expenditures for Danes and non-Western immigrants (decedents only) – observed and predicted

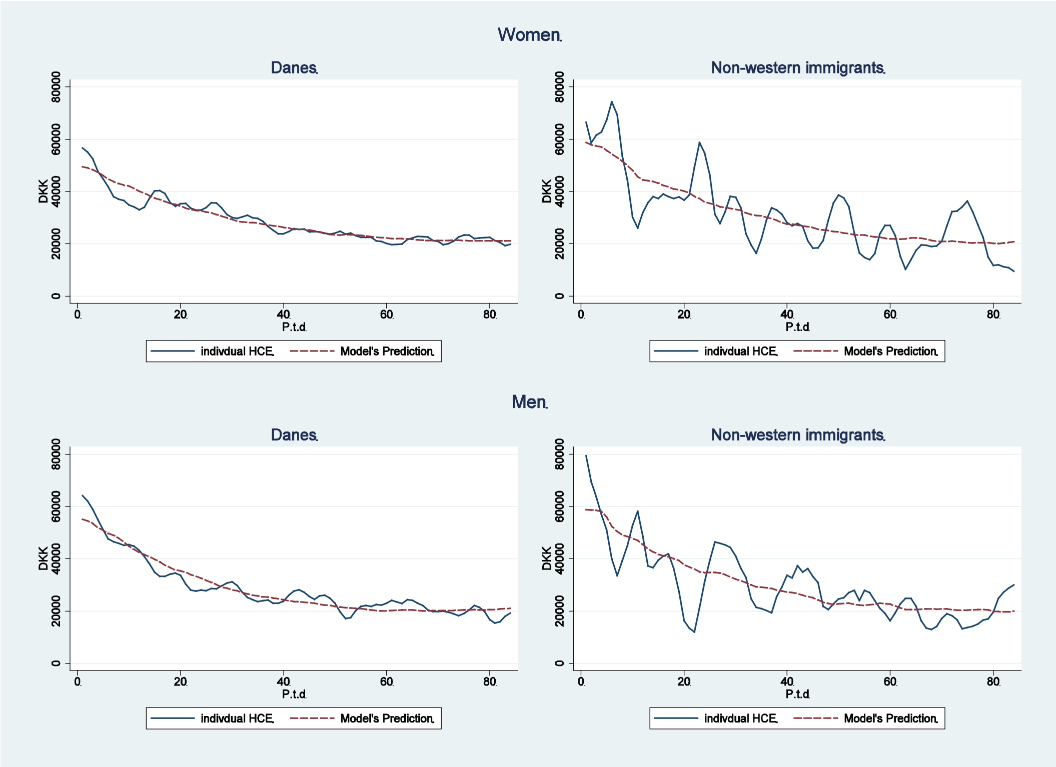

Table 5.3 illustrates the differences in the predicted health-care expenditures between non-Western immigrants and Danes. This table differentiates predictions by survival status and it has been chosen to look at a survival period of four years. Differences are positive and larger for men compared to women for each age group. For each gender group health expenditures are higher for the groups of decedents for most of the age groups except between 70 and 80 for women and past 70 for men. For both male and female survivors differences are on average positive and for most of the age groups except past the age of 70. Differences are substantial but particularly for people aged between 20 and 60. The difference for males aged between 30 and 40 is around 43%, where it is around 14% for the age group 70 to 80 years old.

Table 5.3 Differences in per cent by age, gender and survival status for the predictions of HCE between non-Western immigrants and Danes

	Women		
	Survival status		
Age	Dies within 4 years	Survive after 4 years	Total
age<20	6,1%	-8,6%	-8,6%
20<age<=30	31,4%	11,5%	11,6%
30<age<=40	28,0%	12,1%	12,2%
40<age<=50	28,7%	11,2%	11,8%
50<age<=60	28,2%	11,4%	12,8%
60<age<=70	15,0%	1,7%	4,2%
70<age<=80	-5,8%	-16,4%	-12,4%
age>80	10,1%	-15,3%	0,9%
Total	7,8%	4,6%	5,2%

	Men		
	Survival status		
Age	Dies within 4 years	Survive after 4 years	Total
age<20	15,7%	9,5%	9,5%
20<age<=30	53,4%	42,3%	42,4%
30<age<=40	51,7%	43,5%	43,7%
40<age<=50	47,3%	38,6%	39,2%
50<age<=60	40,1%	32,2%	33,1%
60<age<=70	18,1%	12,7%	14,1%
70<age<=80	-10,2%	-13,8%	-12,1%
age>80	-1,9%	-16,5%	-6,1%
Total	7,1%	24,9%	21,0%

5.2 Simulation results

In this section the results of the simulation model are presented. Several scenarios have been performed with two different models. The first model considers a naïve approach, where proximity to death plays no role. In this case the estimates of the model where proximity to death is excluded are used to predict health-care expenditures. As claimed by Breyer & Felder (2006) this scenario constitutes the lower bound of a scenario under the assumption of an expansion of morbidity. Under this assumption as the population becomes older an expansion of morbidity will be observed leading to an increase in health expenditures and in an increase in the age profiles of health-care expenditures. The second model considers explicitly the role of proximity to death. In order to be consistent with the econometric model proximity to death is discretised in this simulation model. The same approach as Breyer & Felder (2006) is used. Projected mortality rates are computed yearly whereas in the individual data proximity to death is measured in months. More specifically, for each age group the proportion of decedents within year intervals is computed and an average value of proximity to death is attributed. For example, for those dying within the next year a value of six months is attributed to proximity to death, and 18 months for those dying in two years' time, and so on[9]. Proximity to death is measured up to seven years. In order to evaluate the effect of introducing proximity to death, a third model is used where the estimates from the model

[9] The values for proximity to death are 6, 18, 30, 42, 54, 66, 78 for the decedents and 84 months for the survivors.

which takes proximity to death explicitly into account are used, but the effect of proximity to death is set to zero.

For the two models, four scenarios are simulated. In the first scenario all the effects are taken into account and future health-care expenditures are simulated on the basis of the official projected demographic evolution. The next scenarios can be considered as thought experiments or counterfactual analyses. The second scenario maintains constant the parameters of the econometric model for the two populations, such that immigrants are given the parameters of the econometric model estimated on the population of native Danes. The third scenario considers a situation where the immigrants have the same age distribution as the native Danes. Finally, in order to evaluate the impact of the flows of migrations the fourth scenario considers a situation where there is no migration flows over the whole period.

The results of the scenario for the model where only age effects are taken into account are summarised in table 5.4. For each group the average health-care expenditures, the average age and the share of group in the whole population are reported. The immigrants' share of the population is increasing over time which reflects the projections that the population of immigrants is going to increase. At the same time the two populations are getting older, where the ageing is fastest for immigrants and quite moderate for Danes. This also reflects the fact that demographic projections expect an increase in longevity. In 2011 the immigrant population is around ten years younger on average compared to Danes, where by the year 2050 the average age of the population will be almost the same. Table 5.4 considers the results from the model with only age effects, i.e. it neglects the effect of proximity to death. Under this scenario health-care expenditures will increase from 9,200 DKK to 10,300 DKK until the year 2040, this is a little more than 1,100 DKK for Danes which represents an increase of around 11%. For immigrants HCE increase linearly until the year 2050. The total increase is about 2,500 DKK and represents, compared to the year 2011, an increase of around 35%. Under this scenario the increase in health-care expenditures for the immigrants is more than twice as much as the increase for Danes. HCE for immigrants continue to increase moderately until 2080 and is above the level of HCE for Danes by the year 2060. At the same time the increase of the immigrants' share of the population gives more weight across time to the impact of the ageing of immigrants on health-care expenditures. Comparing the year 2090 and 2011, the increase for Danes is about 11% and 50% for immigrants.

Table 5.4 Evolution of the average health-care expenditures per capita, average age of the population and the share in the total population for Danes and non-Western immigrants 2011-2090 – Scenario with age effects only

	Danes			Immigrants			All	
	HCE	Age	Share	HCE	Age	Share	HCE	Age
2011	9176.92	48.1	0.93	7185.60	37.7	0.07	9045.70	47.4
2020	9711.54	49.3	0.92	7730.92	40.2	0.08	9552.75	48.6
2030	10206.42	50.5	0.91	8468.99	43.4	0.09	10042.36	49.8
2040	10311.25	50.6	0.89	9133.13	46.6	0.11	10184.86	50.1
2050	10207.13	50.2	0.88	9743.70	49.2	0.12	10153.45	50.1
2060	10002.90	49.7	0.88	10265.56	51.2	0.12	10034.85	49.9
2070	10024.76	49.7	0.88	10603.96	52.7	0.12	10096.19	50.1
2080	10163.77	50.2	0.88	10716.83	53.7	0.12	10230.56	50.6
2090	10184.48	50.3	0.88	10701.04	53.8	0.12	10245.27	50.7

Table 5.5 reports a summary of the results obtained with the model with the effect of proximity to death. With this model the effect of ageing is less dramatic than with the model where the effect of proximity to death is omitted. The increase in ageing of the immigrant population will make the level of HCE for the two groups very similar. The level of HCE for Danes does not change very much between 2011 and 2050, and starts to decrease afterwards. The impact for immigrants between 2011 and 2050 is more important since the average HCE for this group increases by approximately 1,700 DKK and represents an increase of around 25%. It then continues to increase until 2070 where it decreases afterwards. The question is to what extent this effect is due to an increase in ageing or in differences of use of health-care services. Note that both the average age and the average level of HCE are very similar for the two groups, suggesting that the effect of ageing is predominant. Comparing the year 2011 and 2090, HCE for Danes experience a decrease of 5% where immigrants experience an increase of 26%.

Table 5.5 Evolution of the average health-care expenditures per capita, average age of the population and the share in the total population for Danes and non-Western immigrants 2011-2090 – Scenario with age and proximity to death effects

	Danes			Immigrants			All	
	HCE	Age	Share	HCE	Age	Share	HCE	Age
2011	8671.65	48.1	0.93	7271.05	37.7	0.07	8579.36	47.4
2020	8914.59	49.3	0.92	7708.00	40.2	0.08	8817.86	48.6
2030	9088.23	50.5	0.91	8259.51	43.4	0.09	9009.98	49.8
2040	8948.07	50.6	0.89	8685.62	46.6	0.11	8919.91	50.1
2050	8707.35	50.2	0.88	9038.31	49.2	0.12	8745.69	50.1
2060	8449.79	49.7	0.88	9288.48	51.2	0.12	8551.82	49.9
2070	8325.37	49.7	0.88	9363.70	52.7	0.12	8453.43	50.1
2080	8304.32	50.2	0.88	9288.63	53.7	0.12	8423.19	50.6
2090	8230.71	50.3	0.88	9168.78	53.8	0.12	8341.10	50.7

Figure 5.3 shows, that including proximity to death in the simulation model affects the conditional mean function for health-care expenditures given age over time. Because of the increase in life expectancy or the improvement in survival rates, the age profile becomes flatter over time. Therefore, including proximity to death moderates the effect of ageing.

Figure 5.3 Evolution over time of health expenditures' age profile for Danes and non-Western immigrants 2011-2090 – model with age and proximity to death

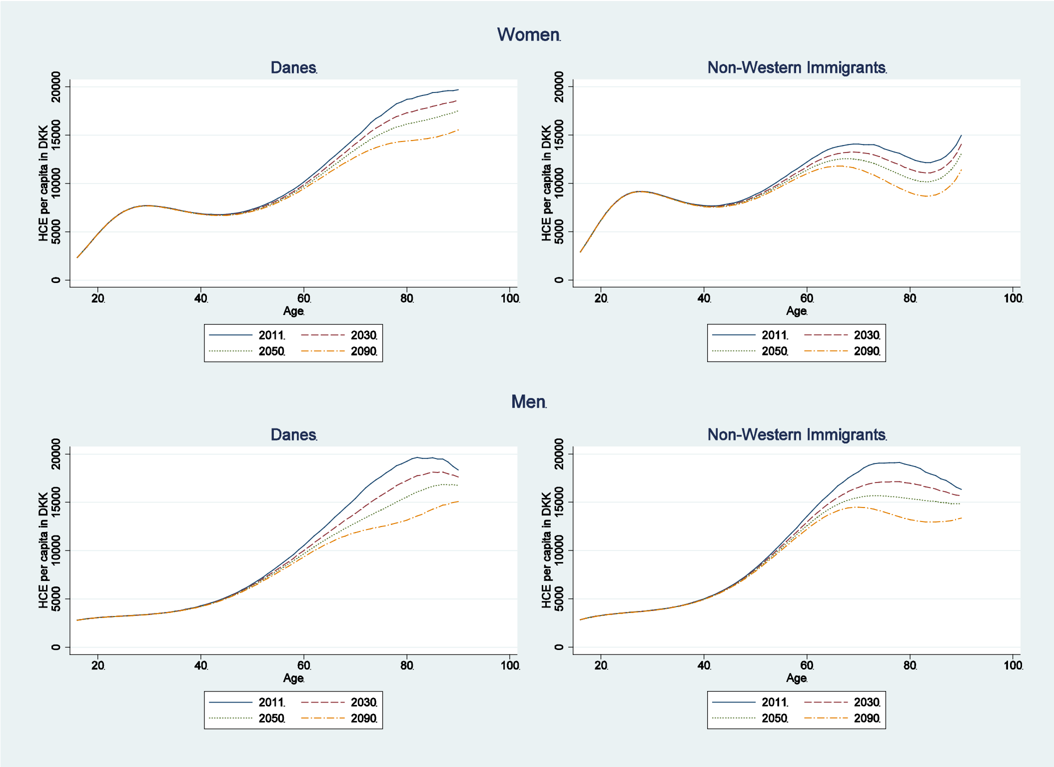

Figure 5.4 plots the evolution of the HCE for the two different scenarios. Compared to the model considering only the age effects, the model including the effect of proximity to death gives a different picture of the evolution of the health-care expenditures. The average level of expenditures is lower for the model which includes proximity to death and shows flatter evolution for Danes and the overall population. Both models show an increase over time of the average level of expenditures for non-Western immigrants. The proximity to death model exhibits, however, a flatter increase of health-care expenditures. Looking at the model with proximity to death, HCE for Danes increase over the period 2011-2030 and then decreases, whereas in the naïve approach HCE decrease from 2030 to 2060 and then stabilise (with a light increase though). For immigrants the model with proximity to death predicts an increase in HCE until 2065, where it decreases afterwards. The naïve approach predicts an increase until 2070 where afterwards HCE tend to stay constant. The naïve approach predicts that the average of HCE starts to increase because of the ageing of the immigrants' population after 2055 where the other model predicts a similar effect in HCE around ten years earlier. But at the same time the model predicts a decrease in HCE due to a delay in mortality. The decrease is lower because of the ageing of the immigrants' population.

Figure 5.4 **Evolution of HCE over time for Danes, non-Western immigrants and the total population model with age vs. model with age and proximity to death, year 2011-2093**

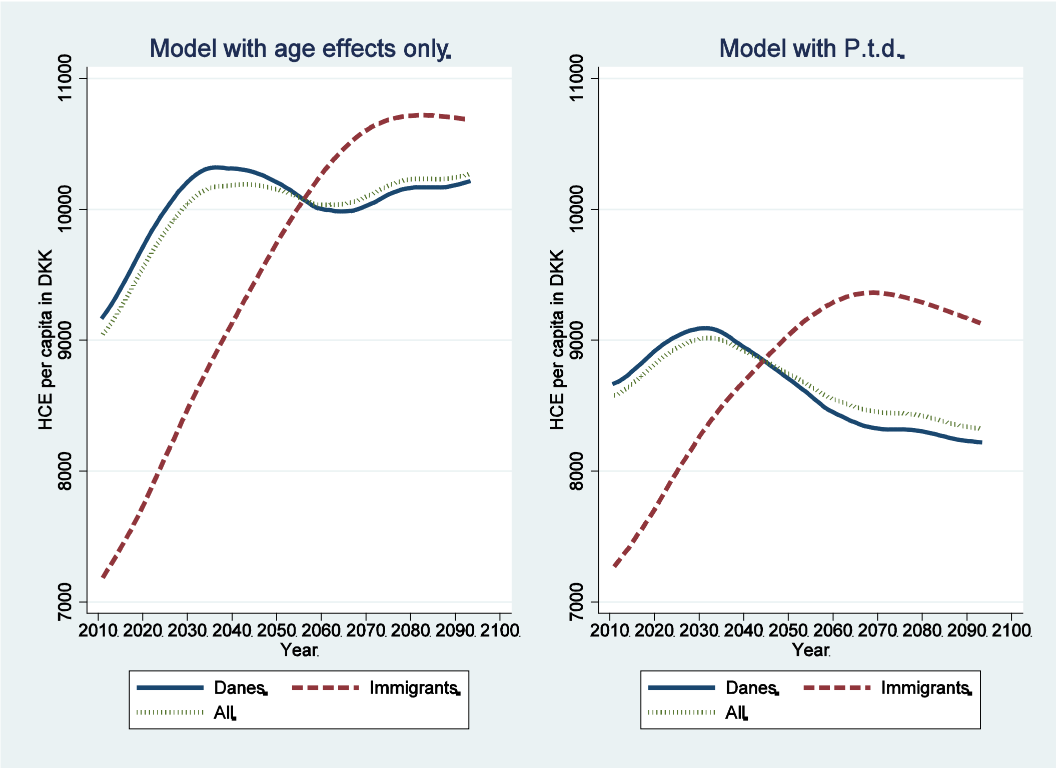

Table 5.6 reports the results of a scenario where the parameters of the age effects of the model with proximity to death have been used, but the effect of proximity to death is set to zero. It allows us to compare the effect of proximity to death, or the impact of the cost of dying, to the effect of ageing. Compared to table 5.5 the cost of dying within a period of seven years represents in 2011 for Danes 7,5% (=8672/8020-1) of the average forecasted cost, where it only represents 4.2% in 2090. For immigrants the cost of dying represents 5.3% and 7.7% of the average health cost, respectively, in 2011 and 2090. So the cost of dying is expected to decrease for Danes and increase for immigrants. For the Danes it is the result of a delay in mortality, whereas for immigrants it is the result of an increase of the share of decedents.

Table 5.6 Evolution of average health-care expenditures per capita, average age of the population and the share in the total population for Danes and immigrants – Scenario with age effects from the proximity to death model and with the assumption that everyone is a survivor

	Danes			Immigrants			All	
	HCE	Age	Share	HCE	Age	Share	HCE	Age
2011	8019.77	48.1	0.93	6888.54	37.7	0.07	7945.23	47.4
2020	8261.57	49.3	0.92	7276.49	40.2	0.08	8182.60	48.6
2030	8407.10	50.5	0.91	7741.70	43.4	0.09	8344.27	49.8
2040	8317.62	50.6	0.89	8065.06	46.6	0.11	8290.52	50.1
2050	8126.30	50.2	0.88	8338.14	49.2	0.12	8150.84	50.1
2060	7968.10	49.7	0.88	8559.29	51.2	0.12	8040.02	49.9
2070	7922.90	49.7	0.88	8611.92	52.7	0.12	8007.88	50.1
2080	7909.20	50.2	0.88	8528.77	53.7	0.12	7984.02	50.6
2090	7881.08	50.3	0.88	8462.09	53.8	0.12	7949.45	50.7

Figure 5.5 is a plot of the projection of health-care expenditures over time with the model which includes age only. The first plot is the projection of HCE considering both the evolution of the two different populations and the differences in use of these two populations. The second plot considers the evolution of the HCE given that the two populations have the same age effects. By maintaining the age distribution equal across the two groups it is possible to see which part of the evolution of the HCE is due to the differences in use of health-care services. This scenario allows evaluating the impact of the ageing of the two types of population. The first diagram of figure 5.5 shows the simulated evolution of the average health-care expenditures. The second diagram shows the evolution of HCE where immigrants and Danes have the same age parameters. Ageing of the immigrants' population causes a linear increase of the average HCE from about 6,500 DKK in 2011 to around 10,000 DKK in 2060 which represents an increase of 53%. The third diagram shows the effect of the differences in use between the two populations since the age distribution is maintained to be the same and equal to that of the Danes. The results actually give a profile over time where the difference in HCE between immigrants and Danes is positive at the beginning of the period of simulation, but decreasing over time. Despite the increase in HCE for immigrants the average HCE of the total population closely follow those of the Danes. The last diagram simulates the effect on HCE if there were no migration flow over the period 2011 to 2043. This diagram shows that the impact of the projected migration flows is marginal in the evolution of the HCE for immigrants.

Figure 5.5 Evolution of HCE over time for Danes, non-Western immigrants and the total population – Counterfactual analysis for the years 2011-2093 – model with age effects only

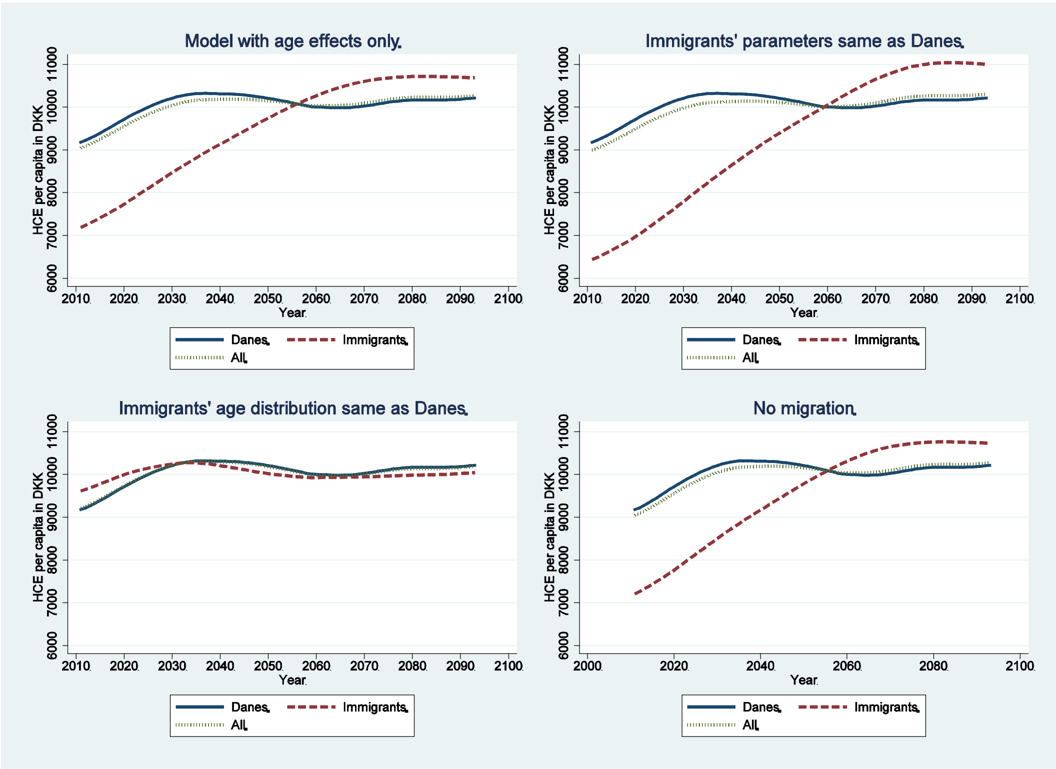

Figure 5.6 shows the results of a similar counterfactual analysis as shown on figure 5.5, but this time the simulation model uses the results of the econometric model including proximity to death. The results show a similar pattern compared to those obtained with the model with age effects only, but the increase in HCE over time for immigrants is flatter. The effect due to ageing is also important but flattens over time and it is due to the increase in longevity. Interestingly, the level of HCE for immigrants, if their age distribution was the same as the native Danes, would be about 1,000 DKK above the level of HCE of the Danes in the first years. This difference diminishes over time though remains constant from 2040. However, the impact on the average expenditures for the total population is marginal. According to these simulations average health-care expenditures will be almost equal to those of the native Danes by the year 2043. Finally, the last diagram shows like for figure 5.5 that the flows of migration are not responsible for the increase over time in HCE for immigrants.

Figure 5.6 Evolution of HCE over time for Danes, non-Western immigrants and the total population – Counterfactual analysis for the years 2011-2093 – model with age and proximity to death

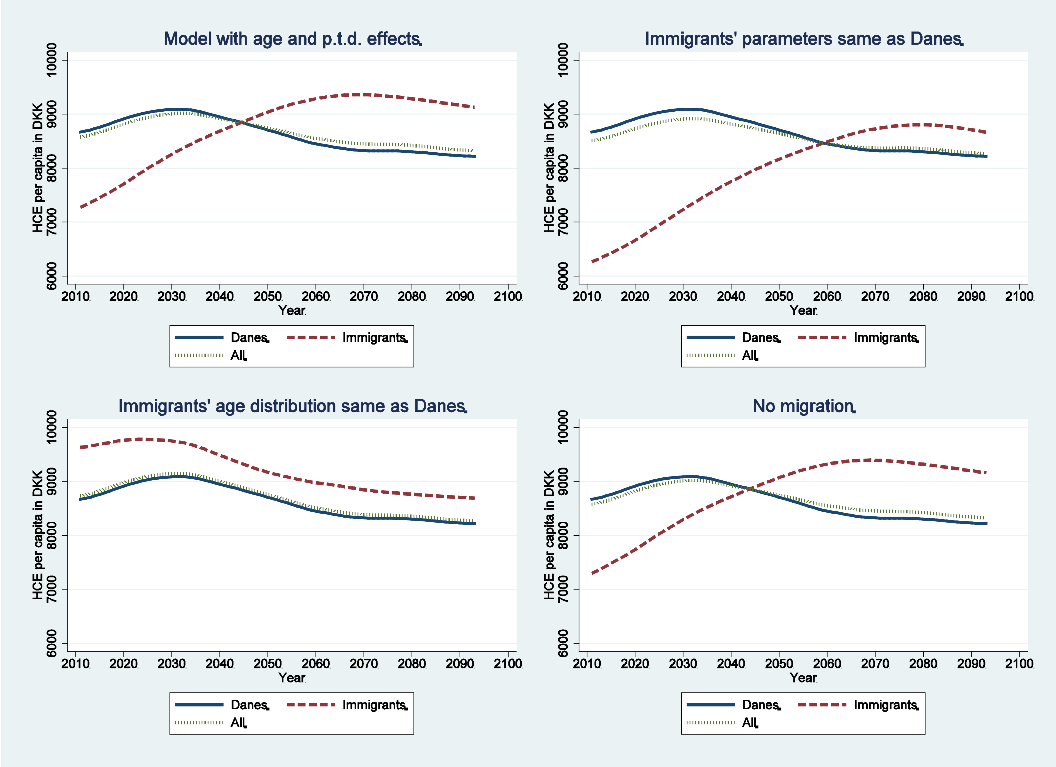

Figure 5.7 illustrates the projected ageing of the populations of Danes and non-Western immigrants. It plots the share of individuals aged 65 and over among the population of Danes and non-Western immigrants, respectively, over the period 2011 to 2100. This quantity can be considered as a measure of the ageing of the two populations. This share is projected to increase for Danes until 2040 and then decrease to attain a roughly constant level over the rest of the period. It is projected as if it has attained its steady-state. For non-Western immigrants it will increase until 2080. Therefore, this population is projected to age dramatically in the future.

Figure 5.7 Projected number of Danes and non-Western immigrants aged 65 and over as a share of their own population, 2011-2100

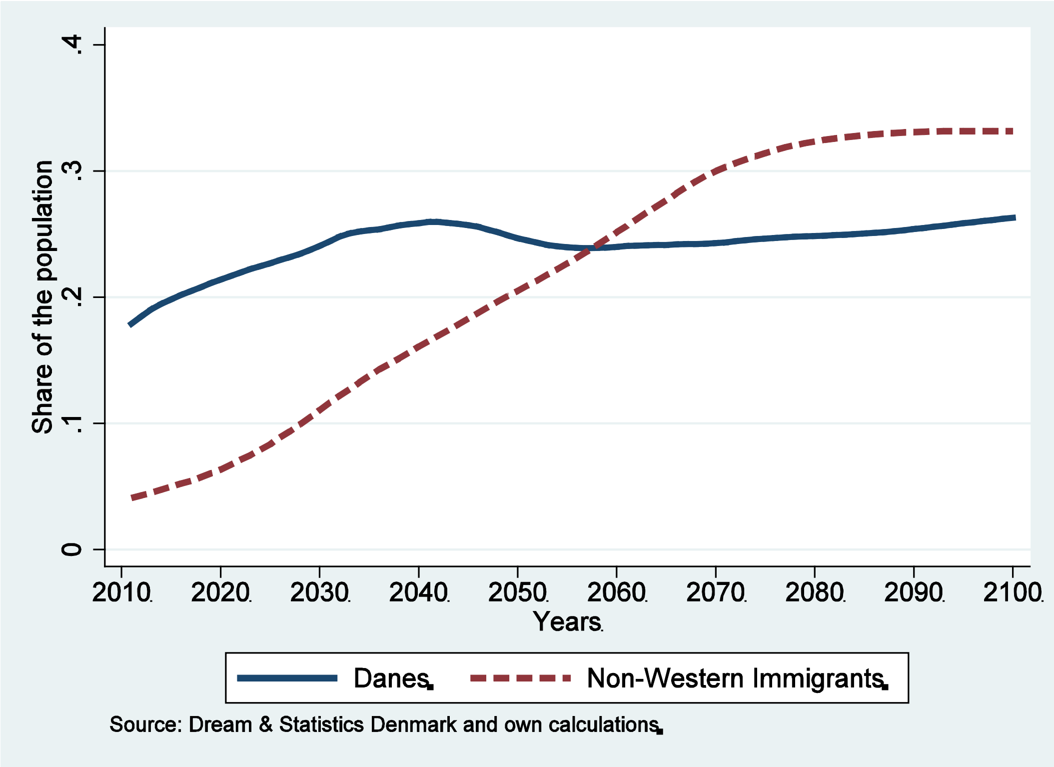

Figure 5.8 illustrates graphically a scenario where the age distribution of the population of non-Western immigrants has been maintained constant as well as the share of non-Western immigrants in the total population. In a way it shows a scenario where both populations are stationary. It shows that in the simulation model the fact that this population is projected to become older in the future is the main factor which causes health expenditures of non-Western immigrants to increase over time. Maintaining the age distribution of the immigrants is one way to contain the health-care expenditures per capita since it is lower compared to the projections which assume that non-Western immigrants are going to age in the future[10].

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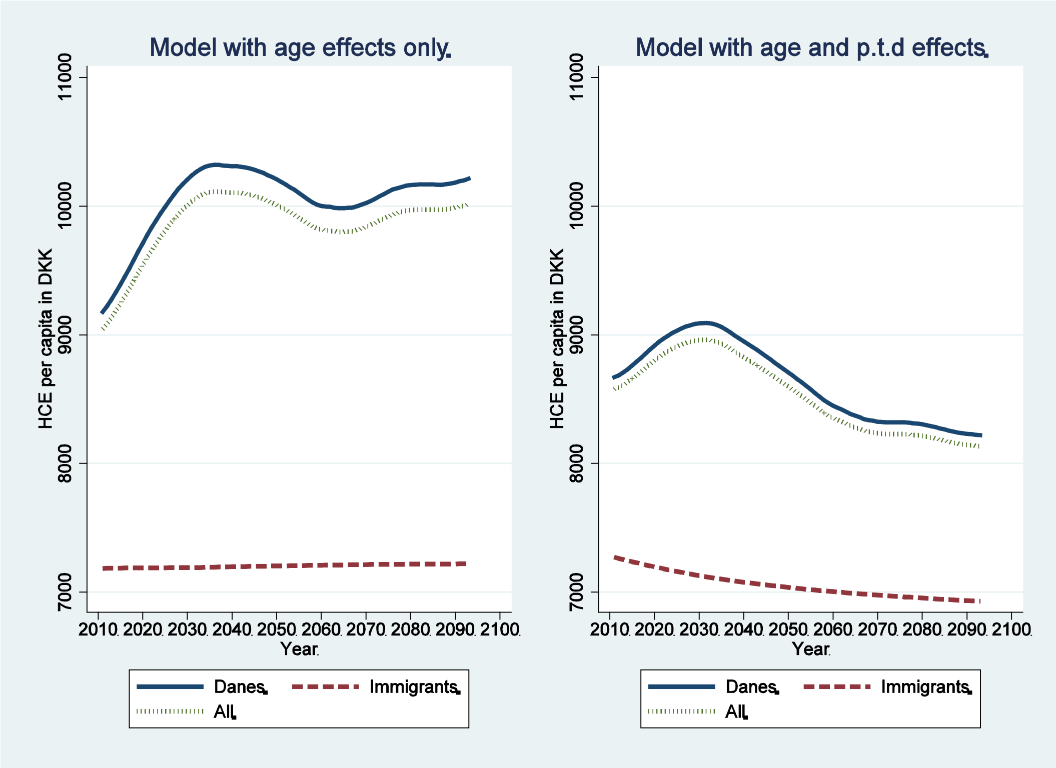
10 In another scenario the evolution of HCE over time has been simulated with a stationary age distribution for the non-Western immigrants, but at the same time the share of non-Western immigrants in the total population was the same as the share given by the projections from Statistics Denmark/DREAM. There were fundamentally no differences with the present scenario.

Figure 5.8 Evolution of HCE over time for Danes, non-Western immigrants and the total population – Counterfactual analysis where the age distribution of immigrants is maintained constant over time for the years 2011-2093



6 Discussion

An increase in the share of immigrants coming from non-Western countries in the total population of Denmark according to the current demographic projections will lead to a modest increase in health-care expenditures in the future. The scenario where only age effects are taken into account represents a lower bound of the evolution of health expenditures under the hypothesis of an expansion of morbidity. A simulation model where proximity to death is taken into account represents an upper bound for a scenario which assumes the hypothesis of compression of morbidity. The two models give quite different forecasts for health-care expenditures, especially for immigrants. Health expenditures increase less under the scenario where the role of proximity to death is modelled. So excluding proximity to death can give misleading conclusions.

The increase in the average health expenditures for immigrants over time is mostly due to the projections of the ageing of the two populations and not the difference in use of health care. Said differently, it seems that immigrants overall pull down the average health expenditures because of a younger population and that this effect will decrease over time because of the ageing of this population. This growth in the average age of this population is partly due to an increase in longevity, but also because more immigrants are expected to stay and age in the country. This latter effect seems to predominate. Some of the differences over time in health-care expenditure between native Danes and non-Western immigrants are due to differences in use of the health-care expenditures, but these differences are pretty much constant over time. If the immigrants had the same age distribution as the Danes, their average level of health-care expenditures would be above those of the Danes, where the difference is roughly constant over time and would actually decrease a little bit because of an increase in longevity. In a sense this model predicts that immigrants will look more like the Danes in the future. The difference in use of the health-care system can be partly explained by the fact that the non-Western immigrants' population includes refugees who are likely to have a higher level of health expenditures because they have been exposed to traumatic situations. But it is unlikely that it will explain much of the whole difference, as refugees represent a small share of the immigrants' population. Overall, the impact is moderate because the higher level of HCE for immigrants is mitigated by the still low immigrants' share in the population.

The model has not taken into account that there may be differences in mortality rates between the two populations and has rather assumed that the evolution of the mortality in the future will be the same for the two groups. Summary statistics have shown that the survival rate for the immigrants lies above that of the Danes, but it covers populations with different origins. The issues related to the financing of the increase of the average health expenditures of non-Western immigrants have not been discussed. The answer to this question will depend on the net contribution of immigrants in the future, but it is beyond the scope of this paper. Another limitation is that this study uses data from 2003. Since that year the level of health-care expenditures has increased and it may be that immigrants have started to increase their use of health-care services. The increase is mainly due to technological factors and is independent of the ageing of the population. However, this study is concerned with the potential changes of health-care expenditures due to the ageing of the non-Western immigrant population and the increase in longevity. The link between income and the use of health-care services has also been discarded from the analysis. This would require modelling the future evolution of income for both populations, which is beyond the scope of this study. But it is worth mentioning that the income distribution of native Danes and non-Western immigrants is different, where non-Western immigrants have lower incomes on average and it will probably be a source of discrepancy. There are some differences between the impact of ageing and proximity to death on health-care expenditure obtained in this study and the one obtained in the models proposed by the OECD (Oliveira Martins & De la Maisonneuve 2006) and the Danish model DREAM (Hansen & Pedersen 2010). First, the purpose of these studies is to project the growth of health-care expenditures and investigate the sustainability of health-care expenditures. Hence it requires taking into account other factors which might affect health-care expenditures. The present study's focus is to investigate the impact of ageing of two different populations. Second, the results of the econometric model for the individual health expenditures show that there are significant differences in the effects between the two populations. Third, the magnitude of the impact of the net immigration on health-care expenditure is dependent on the DREAM model's prediction of how the population of non-Western immigrants is going to age in the next 90 years.

According to the results of this analysis taking into account the impact of ageing and mortality of the non-Western immigrant population is probably a second-order effect, compared to technological progress which is actually the main driver of health-care expenditure. Indeed technology, income, new treatments and changes in practices will probably make health expenditures continue to grow (Oliveira Martins & De la Maisonneuve 2006; Dormont, Oliveira et al. 2008). But at the same time these results have also shown that the assumption underlying the evolution of the age distribution of the population of non-Western immigrants has a non-negligible impact on the projection of health-care expenditures. Including proximity to death tends to reduce the impact of ageing.

The ageing of the non-Western immigrant population could put the health-care system under pressure, not because non-Western immigrants generally incur higher levels of expenditures, but because of the age distribution of this population has not attained its stationary level. Today, non-Western immigrants are lowering the health-care expenditures per capita, but it is expected to increase in the future. At the same time this scenario is dependent on the prediction of the future size of this population. Although the differences in use of the health-care system do not weight much in the level of health-care expenditure per capita it is probably worth investigating the reasons for these differences and investing in policies which will reduce these differences.

Dormont, Oliveira et al. (2008) discuss the role of technical progress for the growth of HCE. According to these authors medical technological change has mainly two components. The first component consists in the substitution of old treatments by new ones, whereas the second component consists in extending new treatments. The first component will have a negative impact on health-care expenditures since it will result in a gain of productivity by lowering the unit costs. The second component has a positive impact since treatments are provided to other patients which treatment would have been too costly before the innovation. Dormont, Grignon et al. (2006) show that the increase in health expenditures is also explained by changes in medical practices and that age plays a minor role. Their study is based on French data for 1992 and 2000 and they apply micro-simulation techniques to disentangle the role of age, morbidity and changes in medical practices on health-care expenditure.

However, the view that ageing and technological progress are two separate issues has been challenged by Breyer, Costa-Font et al. (2010). These authors link the increase in longevity and the statistical value of a life with the evolution of health-care expenditure. As longevity increases, so will the statistical value of a life in the future. Age profiles will therefore probably change over time, because of growth in income and longevity. It is a common weakness of the previous studies, since they could not disentangle age, time and cohort effects.

7 Conclusion

This paper has investigated the likely impact of an increase of the net immigration of individuals coming from non-Western countries on health-care expenditures in Denmark, as well as the role of ageing and proximity to death. The analysis is based on a simulation model which takes into account official projections of the evolution of the population of Denmark. First, the conditional expectation function for health-care expenditures is modelled with the help of a micro-econometric model and is estimated on individual data emanating from administrative registers separately for Danes and non-Western immigrants. The analysis distinguishes between men and women. Two types of models are considered. The first model ignores the impact of proximity to death, whereas the second model includes information on the time of death of each individual. Then the estimates of the conditional expectation for health-care expenditures are used to project future health-care expenditures according to official demographic projections. Counterfactual analyses are performed to investigate the role of ageing and the role of the differences in use of health-care services between the two kinds of populations.

The results show first that the increase in the immigrants' share of the population from non-Western countries in the Danish population will have a very moderate impact on the aggregate health expenditures. Depending on the scenario the increase in the average health expenditure for immigrants will be of around 50% for the years 2011 and 2090 in the case of a scenario where proximity to death is ignored and 26% if proximity to death is taken into account. For Danes the choice of the model matters more since the increase is about 11% in case of the naïve model and a decrease of 5% in case of the model with proximity to death. Second, health-care expenditures for Immigrants will increase in the future mostly because of the ageing of this population and not because they have used health-care services differently from the natives. Third, the impact of proximity to death combined with the increase in longevity will moderate the impact of the ageing of the immigrant population on health-care expenditures. The evolution of the size of non-Western immigrant population depends on a number of factors, which are the flows of migration (immigration and emigration), mortality and fertility. The flows of migration do not seem to have a strong impact on the evolution of health-care expenditures.

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Dansk sammenfatning

Christophe Kolodziejczyk

Effekten på sundhedsudgifter af en stigning i antallet af ikke-vestlige indvandrere i den danske befolkning

Betydning af alder og dødelighed

Dette papir undersøger den mulige effekt af en stigning i ikke-vestlige indvandreres befolkning på sundhedsudgifter i Danmark for årene 2011-2100. Sundhedsudgifter er fremskrevet på baggrund af en økonometrisk model for sundhedsudgifter sammen med officielle fremskrivninger af den danske befolkning. Den økonometriske model er estimeret med individuelle data og modellerer den forventede værdi af sundhedsudgifter som en funktion af alder og nærhed til død. Ændringer i teknologi og økonomiske betingelser er udeladt. Modellen er simuleret for at forudsige den sandsynlige effekt af den forventede stigning af befolkningen af ikke-vestlige indvandrere ved at overveje to scenarier. Det første scenario inddrager aldring, men ignorerer nærhed til død, hvor det andet scenario inddrager de to variabler. Kontrafaktiske analyser bliver udført for at evaluere delen, som skyldes aldringen af de to populationer og den del, der skyldes forskellen i brug af sundhedsvæsnet. Under scenariet, der ser bort fra nærhed til død, viser resultaterne en stigning i sundhedsudgifter på 50 procent for ikke-vestlige indvandrere mod en stigning på 11 procent for etniske danskere. Under det andet scenario oplever danskere et fald på 5 procent i deres sundhedsudgifter, hvor ikke-vestlige indvandrere oplever en stigning på 26 procent. Stigningen for ikke-vestlige indvandrere er resultat af udviklingen af alderssammensætningen for denne population. Forskelle i brug af sundhedsvæsnet sammen med indvandring spiller en mindre rolle.

The Impact of an Increase in the Non-Western Immigrant Population of Denmark on Health-Care Expenditures

The purpose is to make projections of health-care expenditures for non-Western immigrants and the effect on the health expenditures as a result of an increase of the share of non-Western immigrants in the Danish population. Health-care expenditures for non-Western immigrants will grow over time mainly because of the predicted ageing of this population. Differences in use of health-care services and migration play a minor role. The analysis also shows that including proximity to death gives a lower projection of health-care expenditures for non-Western immigrants. A simulation model combined with projections for the population from Statistics Denmark and DREAM over the period 2011-2100 is used to project health-care expenditures. The model is based on an econometric model for health-care expenditures at the individual level which includes age and proximity to death as explanatory variables.

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