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The "Red Herring" after 20 Years: Ageing and Health Care Expenditures

Abstract

20 years ago, Zweifel, Felder and Meier (1999) established the by now famous "red-herring" hypothesis, according to which population ageing does not lead to an increase in per capita health care expenditures (HCE) because the observed positive correlation between age and health care expenditures (HCE) in cross-sectional data is exclusively due to the facts that mortality rises with age and a large share of HCE is caused by proximity to death. This hypothesis has spurned a large and still growing literature on the causes and consequences of growing HCE in OECD countries, but the results of empirical studies have been rather mixed. In light of the imminent population ageing in many of these countries it is still being discussed whether unfunded social health insurance systems will be sustainable, in particular as long as they promise to provide universal and unlimited access to medical care including the latest advances. In this paper, we present a critical survey of the empirical literature of the past 20 years on this topic and draw some preliminary conclusions regarding the policy question mentioned above. In doing so we distinguish four different versions of the red herring hypothesis and derive the logical connections between them. This will help to understand what empirical findings are suitable to derive predictions on the future sustainability of HCE.

JEL-Codes: H510, J110, I190.

Keywords: health care expenditures, ageing, red-herring hypothesis.

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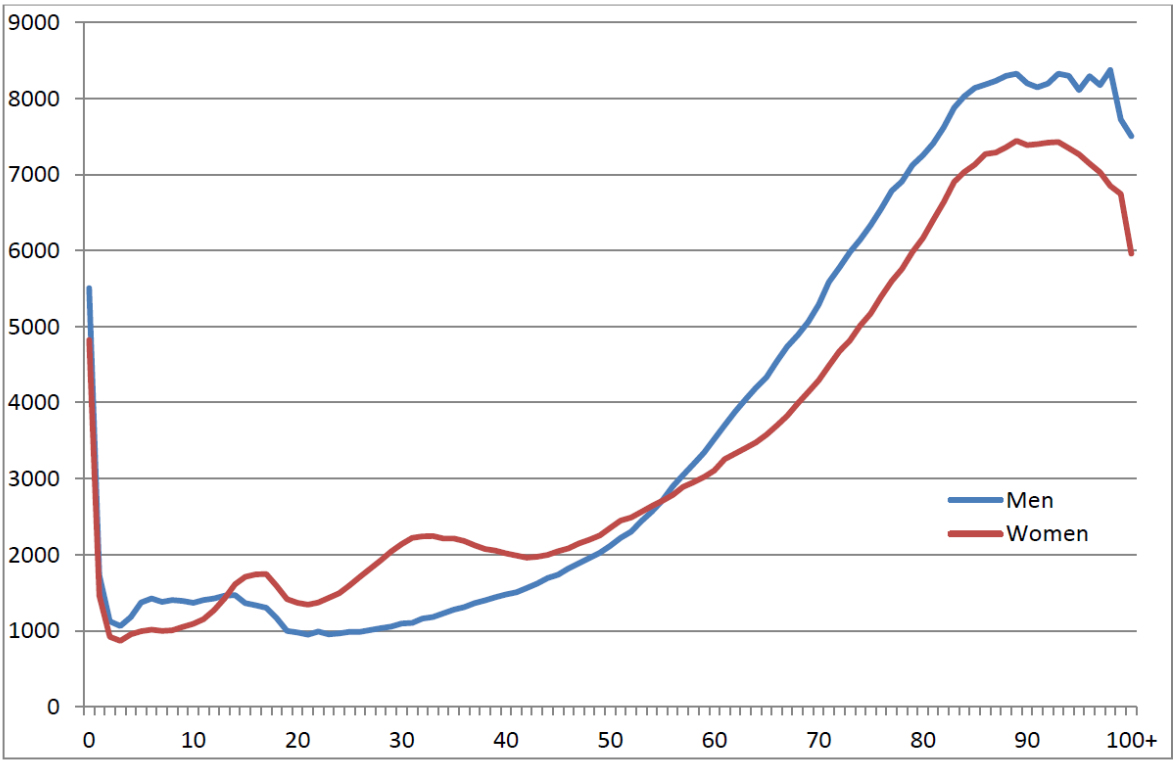
1. Introduction

One of the most important controversies in the health economics discourse of the last twenty years concerns the question whether the imminent ageing of the population in most OECD countries will place an additional burden on the tax-payers who finance public health care systems. These systems are usually pay-as-you-go financed with taxes or contributions depending on labor income and pensions. Population ageing due to rising longevity and below-replacement fertility in coming decades will lower the population share of working-age persons and raise the share of pensioners. Since labor income by far exceeds pensions, this will weaken the tax base so that tax or contribution rates will sharply rise.

Figure 1: Age-expenditure profiles for German sickness funds, 2017.



Horizontal axis: age in years; Vertical axis: average annual expenditures in Euro
Source: Bundesversicherungsamt (2018).

In addition and as suggested by cross-sectional data, if the elderly had higher health care expenditures (HCE) than the young, the trend of rising contribution rates would be reinforced. Figure 1 contains the age-expenditure profiles for men and women in German Social Health Insurance (SHI) in the year 2017. Considering that other branches of social insurance (notably pensions and long-term care) are also unfunded and involve growing transfers from working-age to retired people in the process of population ageing, the social insurance system as a whole may become unsustainable in the near future. This matter is of great policy relevance since in view of these developments, policy makers might soon have to make tough and highly unpopular decisions to curtail HCE growth, such as explicit rationing of health services.

The view that per-capita HCE are rising because of population ageing has been questioned on methodological grounds in a path-breaking article by Zweifel, Felder and Meier (1999), who attacked the practice of relying on a cross-sectional correlation when forecasting future HCE. In fact, they dubbed the observed correlation between a person's age and his or her HCE a "red herring" (i.e., a false clue) because most of this correlation is due to the fact that HCE rise steeply before death and at higher ages more and more persons are in their last year of life. Thus, population ageing due to rising longevity would simply shift the high death-related costs to higher ages. While Zweifel et al. (1999) have coined the term "red herring" and are credited with advancing this hypothesis to a broader audience, they were not the first to detect the underlying relationship. 15 years earlier, Victor Fuchs (1984, pp.151ff.) concluded from his examination of Medicare data: "Health care spending among the elderly is not so much a function of time since birth as it is a function of time to death. The principal reason why expenditures rise with age in cross-section (among persons aged 65 and over) is that the proportion of persons near death increases with age. Expenditures are particularly large in the last year of life, and, to a lesser extent, in the next-to-last-year of life."

In the 20 years since the publication of the Zweifel et al. paper, a large literature has emerged in which the "red herring hypothesis" (RHH) has been tested using different datasets, different empirical approaches and more refined methods. Furthermore, the implications of these findings for the forecast of future HCE have been examined in a number of papers. The present paper critically reviews this literature and assesses to what extent population ageing is a threat to the sustainability of publicly financed health care systems. In doing so, we shall also consider medical progress, the other main driver of HCE growth.[1]

Despite the ink spilled on the topic, it is not even entirely clear what the RHH precisely means. Therefore, the present paper starts in Section 2 with the statement of four different versions of the RHH and the logical relationships among them. In Section 3, a critical review of the empirical tests of (the different versions of) the RHH is provided, in Section 4, we

[1] There has been a very comprehensive previous review by De Meijer et al. (2013), which, however, had a different focus and devoted less attention to the red herring hypothesis.

summarize the literature on the implications for HCE forecasts. Section 5 is devoted to a discussion of policy implications and Section 6 concludes.

2. The Red Herring Hypothesis: Theory

There is not a unique RHH, but in fact four different versions of it in the literature, which we shall call RHH-1 to RHH-4:

RHH-1: Population ageing per se (due to rising life expectancy) does not cause an increase in per-capita HCE (Zweifel et al. 1999).[2]

RHH-2: The increase in per-capita HCE with age in descriptive data is partly (or even predominantly) due to the fact that in older age groups more individuals are in their last year(s) of life in which HCE are particularly high (Fuchs 1984).

RHH-3: In a regression equation for individual HCE, the age variable(s) become(s) weak or insignificant, once time-to-death (TTD) is included (Zweifel et al 1999, Howdon and Rice 2018).

RHH-4: In a regression equation for individual HCE, the estimated age gradient becomes much smaller, when the analysis distinguishes between decedents (persons in their last *x* years of life, where *x* is a small number, often three or four) and survivors (all the others) (Zweifel et al. 2004, Howdon and Rice 2018).

The main difference between these four statements is that RHH-2 to RHH-4 refer to cross-sections of individual data, whereas RHH-1 is a claim about the behavior of aggregate HCE in a country over time. Thus it is necessary to examine the logical relations between them, and in particular to answer the question which of the last three hypotheses, if empirically confirmed, implies that RHH-1 is true. On this we can make the following statements:

1. On a general level, a claim on a dynamic development of HCE does not follow directly from any of the statements on cross-section data. First, the cross-sectional relationship between age and HCE does not have to be stable as time progresses and population ages. E.g., the age gradient of HCE may steepen over time (Buchner and Wasem 2006, Felder and Werblow 2008, Gregersen 2014). Secondly, the increase in life expectancy over time may have an independent impact on per-capita HCE, as proposed by Breyer et al. (2015)

[2] „…per capita HCE is not necessarily affected by the ageing of the population due to an increase in life expectancy. Rather, an increase in the elderly's share of population seems to shift the bulk of HCE to higher age, leaving per capita HCE unchanged" (p.493).

and dubbed "Eubie-Blake effect". [3] The reasoning is as follows. When physicians consider performing a complicated, expensive or risky treatment (such as hip replacement) on an elderly patient, they will deem it the more worthwhile the longer they the patient will – in their view - benefit from the treatment. Thus, the higher the (estimated) remaining life expectancy of the patient, the more of these expensive or risky treatments will be performed and thus the higher will be per-capita HCE.

But even apart from this general problem of mixing static and dynamic properties, RHH-1 does not follow from any of the other three hypotheses, even if they were confirmed:

2. RHH-4 implies RHH-2, but neither of the two implies RHH-1: If the age gradient decreases when determined separately for survivors and decedents, part of the "raw" age gradient is due to the "high costs of dying", so RHH-2 is confirmed. However, this does not mean that ageing does not raise HCE as long as the age gradient for decedents is still positive. Even if the age gradient for decedents is negative, but the one for survivors is large enough, an increase in the share of the elderly may suffice to raise per-capita HCE because it has been shown in many recent studies from various countries (e.g. the papers in French, ed. (2016)) that a much higher share of total HCE is spent on survivors than on decedents.[4]

3. Finally, existing empirical confirmations of RHH-3 do not imply RHH-1, either. Quite to the contrary, they even contradict RHH-1. To see this, notice first that in descriptive individual data, the relationship between age and HCE for decedents is negative beyond a certain age (usually about 50 years),[5] and positive in this age group for survivors. Now for reasons of data availability, TTD can be observed mainly for persons for which this variable is relatively small (2 to 5 years in Zweifel et al. 1999, up to 7 years in Howdon & Rice 2018), i.e., for decedents, and these two papers exclusively deal with decedents. Thus, had these authors found a significant negative age effect on HCE among decedents, this could be the countervailing force necessary to offset the positive effect of aging on the average HCE due to the positive age gradient of survivors. However, if this countervailing effect is missing, i.e., if RHH-3 is true and the age gradient of decedents is zero, then

[3] It is here assumed that life expectancy rises exogenously, not as a result of increasing HCE. On this see Section 3.1.1.
[4] On this see Section 5 below.
[5] See, e.g., Levinsky et al. (2001) for the U.S., Brockmann (2002) for Germany or Häkkinen et al. (2008) for Finland.

RHH-1 cannot hold. Thus, the key argument brought forward in the famous “red herring” paper by Zweifel et al. (1999) is a non-sequitur.

3. Empirical Tests of the Red Herring Hypothesis

There are three different types of data sets on which the impact of population ageing (and medical progress) on HCE has been tested:

1) Individual data: In large data sets on individuals (insured persons), the impact of age and TTD on HCE has been examined where data contain age, HCE and the date of death of those persons who have died (decedents). In many cases, cross-sectional data for a limited time period are used (usually one or a few years) so that the impact of medical progress is not a subject of the analysis.

2) Country Data: Here data refer to average HCE in a country in a specific year. The age structure of the population is only captured by crude measures such as average age or the share of people over 65 years. The influence of medical progress is usually inferred from the time trend, but the latter also captures other time-varying factors such as GDP growth.

3) Group data: Here the individual unit of observation is a subgroup of the population of a country, defined by age (either 1-year or 5-year age brackets) and sex, and the HCE measure is again the average within the group. In contrast to individual data (but similar to country data), TTD is not observable in these data, but instead the share of group members who have died within the period of observation, usually one year. Furthermore, from the annual death rates group-specific life expectancies can be calculated.

Finally, empirical studies can be distinguished by the type of HCE which constitute the endogenous variable, total HCE or expenditures for specific types of services (e.g. outpatient, hospital or long-term care).

3.1 Individual Data

3.1.1 Total HCE

The seminal paper by Zweifel et al. (1999) is based on the analysis of HCE of approximately 1000 members of two Swiss sickness funds who died between 1983 and 1992, most of them at the age above 65 years. The expenditure data are quarterly total HCE and are available for the last eight quarters before death. The authors found that HCE were significantly and steeply rising towards the individual’s death, while the patient’s age turned out to be insignificant, even when the time period before death was extended to 20 quarters. They concluded: "Exclusive emphasis on population ageing as a cause of growth in per capita health care expenditure runs the risk of creating a red herring by distracting from the choices that ought to be made …" (p. 494) and immediately above this sentence: "attention is diverted from the real causes of growth of the health care sector, which are failures in insurance markets, technical progress in providing health care services, and wrong incentives for patients, doctors and hospitals caused by government regulation of the health care sector."

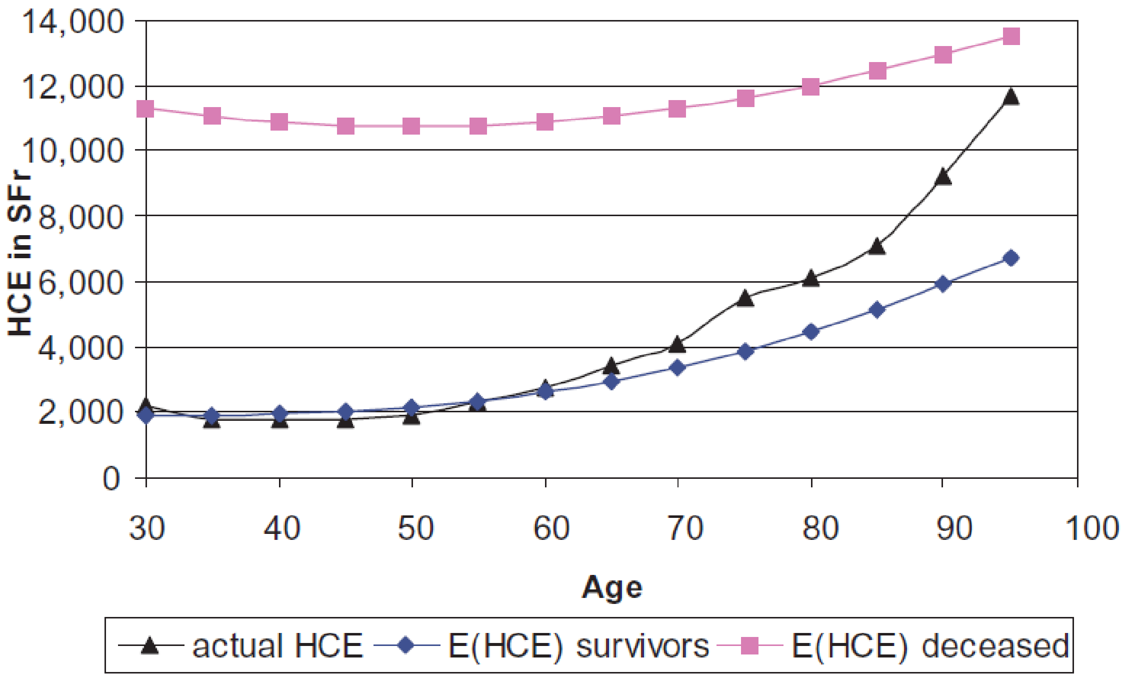
The paper not only convincingly confirms the TTD hypothesis advanced by Victor Fuchs (1984), but also marks the birth of the famous red-herring claim which gave its name to a whole branch of the health economics literature.[6] The quotation shows that the authors suggest that the apparent relationship between population ageing and HCE was created by politicians and health care officials who wanted to distract public attention from the real reasons for the observed increase in HCE: inefficiency and overprovision of health care services. However, as their empirical analysis confirms RHH-3 (which in turn contradicts RHH-1, see Section 2), this conclusion cannot be drawn. In a companion paper using the same data set but a slightly different specification, Felder et al. (2000) found that within the age group 65+, HCE in the last quarters before death were a declining function of the patient's age, which refutes RHH-3 and thus is compatible with RHH-1.

One problem of these studies, which was addressed by Salas and Raftery (2001) and Seshamani und Gray (2004a), was that the variable TTD is not necessarily exogenous since survival may depend on medical care consumption and thus HCE.

In subsequent papers, the Zweifel group addressed the two objections mentioned above. Zweifel et al. (2004) again examined Swiss health insurance data referring to the year 1999, but this time for both groups, decedents and survivors. Estimating a two-part model, they find that the increase of predicted HCE with age beyond age 50 in each of these groups is considerably smaller than the one in the descriptive data of the whole group (see Figure 2). This confirms RHH-4 (but not RHH-3).

Figure 2: Predicted age profiles of HCE for survivors and decedents, Switzerland 1999.

[6] Readers of criminal stories know that a „red herring" is a false clue that has been deliberately laid by the culprit (or the author) to lead the detective (or the reader) astray.



Source: Zweifel et al. (2004), p. 663.

However, the specification of the regression equation can be criticized on two accounts: first, the age of the patient is measured only by age and age-squared, forcing a parabolic relationship between age and HCE. One of the problems of this approach, which the authors acknowledge, is that it does not consider more complicated functional relationships, in particular, the convex shape of HCE between ages 40 and 70 and the decrease with age at very high ages, can not both be captured by a parabola. Secondly, the estimation was not performed separately for survivors and decedents, but in a single regression equation in which the suvival status was accounted for only by a binary variable, and interacted with the linear age variable, but not with age-squared. As decedents account for only about 4 per cent of all individuals in the data set, this implies that the shape of the parabola is mainly determined by the U-shaped age-expenditure profile of survivors. Thus, it appears that HCE in the last year(s) of life are lowest at about age 50 and increase more than proportionally with age thereafter – which is exactly the opposite shape to the one observed in descriptive data and in other studies (see Footnote 5)..

The endogenous nature of TTD was taken into account by Felder et al. (2010) who applied an instrumental variable approach to first predict TTD based on monthly HCE for the last 36 months and then to estimate the HCE equation using age, predicted TTD and other determinants. As a result, while the test for exogeneity of TTD failed – in that past HCE siginificantly increased survival –, the impact of age and TTD on HCE on the second stage turned out to be similar to the previous findings.

Shang and Goldman (2008) also used a 2SLS procedure to first explain TTD (which they call „life expectancy“) and then HCE. They confirm the original Zweifel et al. result that "age has little additional predictive power on health care expenditures after controlling for life expectancy" (p.487), but then add that "the predictive power of life expectancy itself diminishes as health status measures are introduced into the model" (ibid.). In a way, this amounts to throwing the baby out with the bath water since, first, it is trivial that HCE depend on the health of the patient and, secondly, when one wants to predict the future course of HCE in a country, while information on the age structure of the population is often available, forecasts of the prevalence of specific diseases such as diabetes, cancer or stroke are typically not. This begs the question how this particular finding can be used.

3.1.2 Expenditures in Specific Areas of Health Care

Several studies have focussed on expenditures for specific types of services such as hospital care, outpatient care or long-term care (LTC). Although such an approach is of limited value when one is interested in the validity of RHH-1 (the question whether population ageing constitutes a threat to the financial sustainability of public health care systems), in some cases this choice is inevitable for reasons of data availability. In particular in the British NHS, where no market for health care services exist, only hospital services are systematically „priced“ at average costs and the resulting values summed up at the individual level. Using such data ,containing a large number of patients who were at least 65 years old in 1970 and could be observed until 1999 (or their death if it occurred earlier), Seshamani and Gray (2004b) could show that hospital costs in Britain started rising as early as 15 years before a patient's death (and increased by a factor of ten from 5 years before death until the last year), whereas the increase of the costs of the final year with age between 65 and the peak at 80 amounted to only about 30 per cent.[7]

Wong et al. (2011) examined disease-specific hospital expenditures in the Netherlands for 94 different conditions and found that there was a clear effect of proximity of death on HCE, which was present for most diseases and was strongest for most cancers. However, even for some less fatal diseases, TTD was found to be an important predictor of expenditures.

[7] Interestingly, as this is a group of decedents, it is remarkable that costs rise and do not fall with age within this age bracket, as one would expect from the studies cited in footnote 5.

Controlling for TTD, age was found to be a significant predictor of expenditures for most diseases. However, its impact was modest when compared to proximity to death.

The most recent contribution to this literature has been by Howdon and Rice (2018) who analyze the relation between age, TTD and inpatient expenditures in the British NHS and claim that their results are "in line with those in the red herring strand of existing research" (p.69). Strikingly, their empirical analysis shows that the age gradient is not lowered by the inclusion of the TTD variable,[8] contradicting their statement of the RHH-3, which says that "once TTD is included in models of HCE, age per se does not explain changes in HCE" (p.63). Moreover, their sample is highly selective in several respects: By exclusively using data on persons in their last 5-8 years of life for their econometric analysis, they try to make inferences from the subset of decedents on the entire age-HCE relationship. This has been the main critique already put forward by Seshamani and Gray (2004a) with respect to the Zweifel et al. (1999) paper. Furthermore, they do report descriptively on expenditure data of a panel of "survivors" and show that in this group the age gradient is rather low (their Figure 4), but this sample is extremely selective as well because the inclusion criterion is having had a hospital admission in the age bracket 50-55.[9] Thus, it comprises those individuals who have already been relatively sick (and therefore high-cost) in their middle age so that the potential for a steep age-gradient was limited.

In contrast to the results on hospital expenditures, Atella und Conti (2014), who examined a large sample of 750,000 adult persons in Italy in the time period 2006-2009, found for primary care expenditures (pharmaceuticals, diagnostic tests and specialist visits) that age is a much better predictor than TTD: while expenditures increased fivefold between age 40 and 80, the increase in the last year of life amounted to only 30 per cent compared to an average year.

A significant impact of age could also be established for long-term care (LTC) expenditures in the study by De Meijer et al. (2011) for the Netherlands, whereas TTD served only as a proxy for the degree of LTC need and became insignificant when the latter could be measured directly. A similar finding for Switzerland is due to Werblow et al. (2007), who could show that age plays a role only for LTC expenditures, whereas all other types of expenditures were

[8] The age gradient can be calculated from their Tables 5 and 6.
[9] Using data from the NHS, only about 12 per cent of all persons in the age bracket 50-54 in the UK had a hospital episode in 2005/06 (NHS Digital, 2016).

rather falling with age. Finally, Karlsson and Klohn (2014) showed for Sweden that LTC expenditures were significantly determined by age and to a much lesser extent by TTD.

3.2 Country Data

An important weakness of most of the empirical analyses discussed so far is their dependence on cross-sectional data so that the impact of population ageing due to rising longevity, which is a development over time, could not be measured directly.[10] To deal with this problem, it is necessary to analyze time series or panel data in which the units of observation are not individuals, but groups of people or populations of whole countries.

In an early study for Germany, Breyer and Ulrich (2000) analyzed a time series (1975 to 1995) of per-capita HCE data for German sickness funds to isolate the impacts of ageing, economic growth and medical progress on HCE. Although the age structure could be proxied only by the share of sickness fund members in the age group 65+, this variable turned out to be a significant determinant of HCE, as was GDP per capita, but the death rate was not. Finally, the time trend indicated an annual growth rate of HCE that exceeded GDP growth by 1 percentage point. In contrast, studies for other countries did not reveal a significant effect of the share of the elderly on per capita HCE of a country. Examples are Getzen (1992) for a panel of 20 OECD countries over 28 years (1960-88) and Barros (1998) for a panel of 24 OECD countries over three decades (1960-90).

In contrast, Zweifel et al. (2005), who examined the mutual dependence of longevity and HCE, found for a panel of 30 OECD countries over three decades (1970-2000) that the variable which measures both life expectancy and the share of citizens of age 65+ was a significant positive determinant of per-capita HCE.

In a very recent study for Switzerland, Colombier (2018) showed that real per-capita GDP, the old-age dependency ratio and R&D expenditures in the US health care sector (as a proxy for medical innovation) significantly increased per-capita HCE, whereas a positive and significant impact of the mortality rate could not be identified.

3.3 Group Data

An intermediate strategy between the use of individual and country data is the use of group data. This has pros and cons. Unlike individual data, group data allow one to calculate life

[10] Exceptions are Seshamani and Gray (2004b) and Felder et al. (2010).

expectancy, but TTD does not make sense and has to be replaced by aggegate measures such as the (annual) mortality rate.

In a study of hospital expenditures for Norway, Godager and Gregersen (2014) looked at a panel of 101 (one-year) age groups for men and women in 430 communities over 12 years (1998 bis 2009) and found that both age and the mortality rate had a significant impact on average expenditures, while expenditures in the last year of life were a decreasing function of age. Using the same data set, Gregersen (2014) showed that the age gradient of per-capita expenditures was not only positive, but steepening over time.

Breyer et.al. (2015) tested the hypothesis of the prevalence of a Eubie-Blake effect using data from the German risk adjustment system, which contains for each age-gender group and for each year (in this case for the period 1997-2009) per-capita expenditures for all medical services, excluding long-term care. For each group, the annual mortality rate was used as a proxy for TTD, and life expectancy was measured by the predicted 5-year survival rate obtained from a regression of past survival rates on a time trend. Both variables turned out to be significantly positive, confirming both the time-to-death hypothesis and the Eubie Blake effect. However, when holding both variables constant, there was still a significant and large age gradient of HCE and a positive time trend.

4. Implications for Future Expenditure Increases

The authors of the studies discussed above aimed at uncovering the relationship between calendar age or population ageing and HCE in the past. However, the main target of this literature is to make empirically well-founded predictions on future development of expenditures for health care and LTC. Such endeavors are to some degree problematic, as they can not take political decisions into account which might be taken in view of the scarcity of public funds. Simulation exercises in this field can only be interpreted as estimates of the future demand for HCE and to assess potential gaps between demand and available public funds at present contribution rates and thus make inferences on the sustainability of the existing system of health care financing.

The most important conclusion from studies in this branch of the literature is that simulations on the basis of empirical estimates predict a less dramatic increase in future expenditures when the variable TTD is included among the regressors than otherwise. This was first shown by Miller (2001) and Stearns and Norton (2004) for the US. The latter authors compared forecasts of Medicare expenditures in the year 2020 based on expenditure data of the period

1992 to 1998 and found that ignoring the TTD effect leads to an overestimate of total HCE of a Medicare recipient (starting from age 65) by up to 15 per cent (namely to 117,000 instead of 102,000 USD).

To relate this forecast error to the true expenditure growth over this period, it is necessary to take the level of expenditures in the 1990s into account. According to Lubitz et al. (1995) they amounted to about 53,000 USD in the year 1990. Hence the „correctly“ estimated HCE growth over the 30-year period 1990 to 2020 was 92 per cent, while the „overestimated“ one was 121 per cent, and the extent of overestimation amounted to almost one-third of the „true“ growth. Other studies for various countries found different values for the forecast error. On the low end, Van Baal and Wong (2012) for the Netherlands and Colombier and Weber (2011) for Switzerland found no effect of death-related costs on long-run projections of HCE in their countries, Polder et al. (2006) calculated for the Netherlands an overestimate of the HCE growth rate due to the „wrong” model of 10 per cent, and Geue et al. (2014) found an overestimate of about 17 per cent for hospital expenditures in Scotland. A considerably stronger overestimation effect of about 50 per cent was found by Bjørner and Arnberg (2012) for Denmark. .

Breyer and Felder (2006) used the regression equation which was estimated by Zweifel et al. (2004) with Swiss data for a simulation of the development of HCE in Germany for the period 2002 to 2050 by inserting population forecasts of the German Statistical Office. Compared to a status-quo projection based on the age-expenditure profile of 2002, which resulted in a purely demographic increase of per-capita HCE until 2050 by 24 per cent, this growth was reduced to 19.5 per cent when expenditures for decedents and survivors were explicitly distinguished, and to 14 per cent by assuming that Fries’ (1980) “compression of morbidity” hypothesis is valid and the rising part of the age-expenditure curve is shifted to the right by the increase in longevity. The surprising conclusion from these simulations therefore is that even taking all mitigating factors into account, there is still a positive effect of demographic ageing on HCE, which was confirmed by Steinmann et al. (2007) for Switzerland.

On the other hand, in Breyer and Felder (2006), the size of this demographic effect is dwarfed by the impact of medical progress on HCE: when the latter effect is fixed at an annual growth rate of one per cent in excess of GDP growth (as was estimated by Breyer and Ulrich 2000), then real per-capita HCE in Germany was calculated to rise between 2002 and 2050 by a total of 101 per cent, of which the above mentioned demographic component of 14 per cent is only a small part. Similarly, Dormont et al. (2006) estimated for France that the impact of medical progress on HCE growth exceeds the impact of population ageing by the factor 3.8.

Finally, Breyer et al. (2015) performed a simulation of per-capita HCE of German sickness fund members for the period 2009 to 2060 on the basis of population projections by the German Statistical Office. Depending on the specific estimation model used the resulting purely demographic effect on HCE amounted to an annual growth rate of 0.5 to 1 per cent, to which an autonomous time trend of annually 1-1.5 per cent for women or 2 per cent for men must be added. Again the bottom line is that the demographic effect on the expenditure growth is definitely not zero, although it is considerably smaller than the time trend.

5. Discussion and Policy Implications

This review shows that the findings on the relationship between ageing and HCE are contradictory and therefore inconclusive. This is partly due to the use of different empirical strategies. In particular, while there is solid support for hypotheses RHH-2 (the TTD hypothesis) and RHH-4 (the importance of distinguishing between "survivors" and "decedents"), before any definite conclusion on the policy relevant hypothesis RHH-1 can be drawn, a number of methodological issues have to be resolved:

1. As the functional relationship between age and individual HCE is not simply parabolic, finer measures than age and age squared such as 5-year age brackets or semiparametric methods are recommended. The latter are used in a new study by Breyer and Lorenz (2019) with data from German SHI.
2. When distinguishing between survivors and decedents a decision has to be made for how many years before death a person is regarded a decedent. Ideally, this dividing line should be drawn according to the criterion how long before its occurrence imminent death has an influence on HCE and thus should depend upon the cause of a person's death. For people dying from cancer, e.g., the time span between onset of the disease and death varies greatly by the type of cancer. In contrast, victims of fatal accidents never reach the status of a decedent for a time span worth mentioning. Thus the decision will typically be made for practical reasons: each additional year before death that is shifted into the decedent category implies the loss of one year of data in the survivor category. In existing studies with this distinction the time span before death is usually defined between 3 and 4 years.
3. A related issue concerns the question whether studies with "pure" decedent data such as Zweifel et al. (1999) and Howdon and Rice (2018) yield reliable insights on the overall

problem of ageing and HCE. After all, the bulk of HCE is not incurred in the last 3 to 4 years before death, as has been shown recently by Bakx (2016), Karlsson et al. (2016) and other contributions to the special issue of Fiscal Studies (French, ed. 2016). According to these studies, only between 12 and 16 per cent of all HCE are spent on people in this time span before death.

4. An extremely important question is how the observed expenditure data have to be interpreted: Do they constitute demand or even medical "need" or are they the result of rationing?[11] Whenever it is the purpose of the studies to assess the future sustainability of health care financing systems, it seems desirable to forecast future "need" however this is defined. On this account, cross-sectional studies based on individual data appear to be most appropriate because differences in individual expenditures within a specific health system at a point in time most likely reflect differences in medical necessity (at least in systems with universal access and without important patient cost-sharing). In contrast, results from aggregate data tend to depend most heavily on rationing rules prevailing in the corresponding countries. It is therefore not surprising that these studies failed to uncover any effect of the age structure of the population on per-capita HCE. Assuming that the rationing rule is based on some kind of national health care budget, this fixes the expenditures and their growth rate, no matter how the share of the elderly population changes from one year to the next.
5. A related question with respect to RHH-1 is through which channel population ageing should lead to rising per-capita HCE. The bulk of the literature seems to take it for granted that the channel is medical need: as morbidity rises with age (and ignoring a TTD effect), a larger share of older people should lead to higher HCE. But the channel can also be political pressure of the electorate: with a higher share of elderly voters, there is more political demand for public HCE, and more public HCE in turn will result in increased longevity and therefore a higher share of the elderly in the electorate, who will vote for higher public HCE, and so on. Thus, there may be a vicious circle or, as the originators of this hypothesis, Zweifel and Ferrari (1992), called it, a "Sisyphus Syndrome" in health care. The authors did not find empirical evidence for their claim in their original study, but a confirmation was provided in a subsequent study (Zweifel et al., 2005). Taking this result for granted, it is no longer the question whether ageing raises HCE, but only how this comes about.

[11] On the normative and empirical aspects of health care rationing see, e.g., Callahan (1987) and Strech et al. (2008).

6. Furthermore, it seems to matter what type of expenditures are included in the analysis: those for medical services in the narrower sense or also those for LTC. It appears that a positive association between ageing and HCE is more prevalent for LTC than for other health expenditures. From the perspective of the compression of morbidity hypothesis, this is surprising: if the total increase in longevity consists in “healthy” years and if LTC need is always caused by illness, then LTC expenditures should only depend on TTD and not at all on age. As a consequence, age-specific LTC shares should fall when life expectancy rises. But exactly this cannot be observed in German LTC insurance data (see Table 1).

Table 1: Age-specific LTC shares in Germany (in per cent), 1999-2017

	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017
below 75	0,9	0,9	0,9	0,9	1,0	1,0	1,1	1,1	1,1	1,4
75 - 85 years	13,9	13,7	14,3	14,0	14,2	14,2	14,3	13,9	14,1	16,3
85 - 90 years	38,4	39,5	39,9	36,3	37,2	38,0	38,8	38,2	39,7	44,5
90 and over	60,2	59,7	59,4	60,2	61,6	59,1	64,9	63,9	66,1	70,7

Source: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Pflege/_inhalt.html

7. When comparing the size of the ageing effect with other causes of HCE growth, it is important to properly identify the “time trend”, which plays a large role in many time-series studies. It is obvious that it captures all time-varying factors which are not explicitly accounted for in the regression. Some authors interpret it as the effect of technological change (Chernew and Newhouse 2012, p.6) or medical progress, but part of it can also be due to other time-varying factors such as GDP. When income grows, people might be willing to spend more on health, and they can do so without any changes in the tax or contribution rate as long as expenditures grow in line with GDP. Thus it is the difference between the growth rates of GDP and HCE that needs an explanation. Part of it may be given by medical progress, another part by “Baumol’s cost disease” (Hartwig 2008), which states that unit costs increase in labor-intensive sectors, in which the productivity growth falls short of the general growth of wages.

Table 2: Old-Age Dependency Ratios (65+/20-64) in Selected Countries (in per cent), 1970-2050.

	1970	1980	1990	2000	2010	2020	2030	2040	2050	2000 -1970	2050 -2020
Bulgaria	16,2	20,1	22,2	27,2	28,7	36,2	40,6	46,0	54,6	11,0	18,4
Czechia	20,9	24,0	22,0	21,9	23,9	33,8	38,5	45,3	55,9	1,0	22,1
Hungary	19,8	23,3	22,9	24,5	25,6	33,4	37,3	44,1	52,6	4,7	19,2
Poland	15,2	17,6	17,3	20,1	20,8	30,5	40,2	45,5	60,3	4,9	29,8
Slovakia	17,3	19,0	18,2	18,6	19,0	26,5	35,6	42,0	54,6	1,3	28,1
Ukraine	16,1	20,1	20,1	22,5	24,5	27,1	33,3	36,2	45,9	6,4	18,8
Denmark	21,6	25,3	25,9	24,2	28,2	34,9	40,5	45,9	44,6	2,6	9,7
Finland	16,1	20,1	22,0	24,8	28,7	40,1	47,5	48,5	51,4	8,7	11,3
Ireland	22,9	21,7	21,6	17,9	17,8	25,0	31,1	39,2	50,6	-5,0	25,6
Norway	23,4	26,6	28,5	25,9	25,0	29,6	35,0	41,2	43,4	2,5	13,8
Sweden	23,4	28,5	30,9	29,5	31,2	35,9	40,2	44,5	45,5	6,1	9,6
United Kingdom	23,3	26,9	26,9	27,0	27,8	32,0	38,5	43,5	47,1	3,7	15,1
Greece	18,2	22,2	22,9	26,7	31,6	37,8	46,0	59,8	75,0	8,5	37,2
Italy	19,6	23,6	24,3	29,5	33,7	39,5	49,5	65,5	74,4	9,9	34,9
Portugal	18,3	21,4	23,9	26,7	30,6	38,6	47,8	61,0	71,4	8,4	32,8
Slovenia	17,3	19,8	17,3	22,4	26,0	34,7	45,9	54,6	65,0	5,1	30,3
Spain	17,7	20,4	23,1	26,8	27,0	32,8	43,2	60,3	78,4	9,1	45,6
Austria	25,4	27,2	24,3	24,9	28,9	31,3	41,7	51,6	56,0	-0,5	24,7
Belgium	24,2	25,2	24,8	28,3	29,0	33,1	41,5	47,9	51,3	4,1	18,2
France	23,7	25,0	24,0	27,5	28,7	37,3	44,9	51,9	54,5	3,8	17,2
Germany	24,2	27,3	23,5	26,5	33,9	36,5	47,7	55,7	58,1	2,3	21,6
Netherlands	18,7	19,8	20,6	21,9	25,3	34,3	44,6	53,1	53,3	3,2	19,0
Switzerland	19,5	23,8	23,6	24,8	27,2	31,3	41,2	50,0	54,4	5,3	23,1
Canada	15,4	16,3	18,4	20,4	22,5	29,8	40,0	42,9	44,9	5,0	15,1
USA	19,1	20,4	21,6	20,9	21,8	28,4	36,0	39,0	40,4	1,8	12,0
Australia	15,3	17,1	18,8	20,6	22,0	27,7	34,5	38,5	41,6	5,3	13,9
New Zealand	16,8	18,4	19,5	20,3	22,1	28,3	37,0	42,9	43,8	3,5	15,5
mean increase										4,5	21,6

Source: United Nations, Department of Economic and Social Affairs, World Population Prospects 2019.

8. Finally, even if it were true that population ageing had a positive, but small effect on HCE in the past, this would not necessarily imply that this effect must remain small in the future. For whether an exogenous variable *x* has a large impact on an endogenous variable *y* depends on the extent to which *x* varies, and the speed at which populations are ageing will increase considerably in the coming decades. This is demonstrated by Table 2, which shows the development of the old-age dependency ratio (OADR, number of persons over 65 as a percentage of the population between 20 and 64) in selected countries. In the last

30 years of the 20th century, this ratio increased only by a few percentage points so that at the time of writing, Zweifel et al. (1999) were safe in stating that population ageing could not have been a major cause of HCE growth until that time. In contrast, the coming decades will see much bigger increases in the OADR, which amount to 20 or more percentage points in many countries and to over 30 percentage points in Southern Europe. Therefore, even if the effect of a one-percentage-point increase of the OADR on average HCE is a small number, multiplying this number by 30 may yield a sizeable overall effect.

Although no final verdict on the validity of RHH-1 is possible at this point, it is an independent question whether the ageing-HCE relationship is truly a “red herring” in political debates on health care reforms – in the sense that it “detracts from the choices that ought to be made”. Ironically, this assertion can easily be turned around: if politicians know that the public health insurance system is unsustainable, they might – one would hope – take measures to prevent the most negative consequences of a breakdown of the system, e.g. by curtailing less cost-effective services from its benefit package. Now, the publication and dissemination of the early red herring literature, in particular of the claim RHH-1 may lead journalists and politicians to believe that the imminent ageing of the population – which will be far more severe than in the past (see item 8) – will not cause any problems for the financial viability of social health insurance. Thus it is the red herring hypothesis itself that carries with it the danger to “detract from the choices that ought to be made”.

6. Concluding Remarks

A tentative conclusion that can be drawn from this survey is that future population ageing will have a positive impact on HCE, but the size of this impact depends on the type of service, with a larger one for LTC than for acute care. Moreover, it can be argued that the growth rate that is caused by population ageing is small compared to the one which is due to other time-varying factors such as medical progress and ever rising GDP. On the other hand, as long as the growth rate does not exceed GDP growth, it does not jeopardize the financial viability of publicly financed health care systems. Thus, when GDP growth is deducted from the time trend, then it is no longer clear that the impact of population ageing is “small” relative to this difference.

In any case, there is still room for improvement in the methodology of measuring the impact of population ageing on HCE. As data availability and quality improves, more precise measures will hopefully be possible.

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