

Working Paper n° 05-01

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# Health expenditures and the demographic rhetoric : reassessing the threat of ageing

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# 1 Introduction

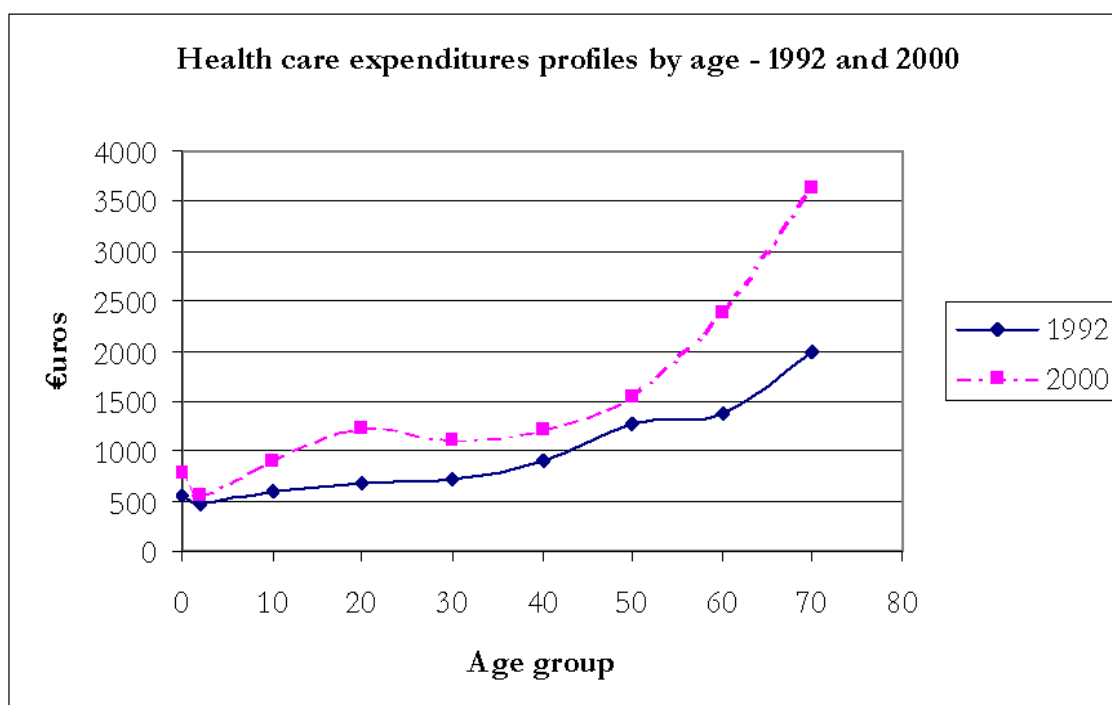
At any given point in time and for any given country, cross-section individual-level data show a clear age profile of medical expenditures, decreasing in the very first years of life, then increasing at an increasing rate from adult life to old and very old age. Holding such an age profile constant, it is obvious that an increase in the proportion of the elderly in the population will induce an increase in per capita medical expenditure. Using such a mechanical scenario, many have forecasted that ageing would lead to a financially unsustainable increase in health care expenditures from now on. For instance, the Certified General Accountants Association of Canada issued a warning in January, 2005, that health care expenditures are expected to increase by 80 % between 2000 and 2020 due to the ageing of population.

It seems that the function of this rhetoric is to present growth in health care needs as exogenous and inevitable. However, there are conflicting interpretations about the policy recommendations that such rhetoric can be used to support. According to Northcott (1994) [1], quoted by Barer et al. (1995) [2], the goal is to convince the public that cuts are necessary in public spending on programs for seniors. For example, the Accountants Association of Canada argues for seniors' health accounts, i.e. individual tax-sheltered health savings plans to complement public financing, on the basis of the idea that ageing will make public financing unsustainable. Similarly, the Geneva Association Information Newsletter of October 2004, on the theme "Health and Ageing" [3], published a paper on medical savings accounts, prefaced with the statement that ageing will place an unbearable burden on public health care financing. On the other hand, Zweifel et al. (1999) [4] think that the political purpose of such rhetoric is rather to convince the public that all cost containment efforts are in vain.

The aim of this paper is to show that ageing has a relatively small influence on health expenditure growth and that the determinants of this growth are mainly the outcome of decisions which can be within our control.

The effect of ageing on health care expenditures is usually thought as resulting from the combination of two phenomena : the ageing of population and the fact that health care expenditures are an increasing function of age.

Most projections of future health care expenditures available to date simulate the impact of



Graph 1 : Health care expenditures profiles by age groups in years 1992 and 2000

ageing simply by applying demographic previsions to the observed expenditure profile. Using this assumption of constant age profile of expenditure over time the OECD forecasts the share of health care expenditures in GDP to increase by 2 to 3 percentage points in most developed countries over the next 20 years (Casey et al. 2003 [5]). For France, the same method lead to forecast the share of health care expenditures in GDP to increase from 6.5 % in 1997 to 7.4 % in 2020 (Grignon, 2002 [6]).

However, the increase in total health care expenditures can be explained, not only by the purely demographic effect (namely, the increase in the proportion of elderly people, given that health expenditure is an increasing function of age), but also by a possible profile drift.

Graph 1<sup>1</sup> presents the expenditure profiles observed for France in 1992 and 2000. A sizeable drift can be observed between 1992 and 2000. For people aged 50 and over, it is strongly increasing with age. Notice that graph 1 is relative to average *individual* health care expenditure by age group. Therefore, the drift in the profile has nothing to do with changes in the age structure of the population. It can be linked to changes in patients' behavior, in physicians' practices, as well as to technological progress. As we will see later, it cannot be linked to changes in the health condition of

<sup>1</sup>This graph is computed on our sample for the years 1992 and 2000, see the definition of age groups in appendix A.

patients, since our data show that they are in better shape with time.

Our purpose is to study changes in health care expenditures in France between 1992 and 2000. We make use of micro data in order to evaluate the compared effects of demographic changes and profile drifts. As we will see in the results, the effect of the profile drifts is by far much larger than the effect of demographic changes.

As for the profile drift, we develop microsimulation techniques to identify its components, i.e. to evaluate the respective influences of changes in morbidity and changes in practices, for a given level of morbidity. Our results show that changes in morbidity induce a downward drift of the health care expenditures profile, whereas the drift due to changes in practices is upward and sizeable.

At the macroeconomic level, the results of the microsimulations can be used to evaluate for the French population the effects of demographic changes and profile drifts between 1992 and 2000. It turns out that the rise in health care expenditures due to demographic changes is very small, in comparison with the effects of the changes in practices. For total expenditures, we find that the impact of changes in practices is 6.8 times larger than the rise in health care expenditures due to changes in the age structure of the population. Considering a broader definition of changes in practices, their impact is even 14.7 times larger than the rise in health care expenditures due to changes in the age structure of the population. Moreover, we find that the impact of changes in morbidity is negative, indicating an improvement of the health status of individuals for a given age. This negative effect of changes in morbidity (-8.6 %) more than compensates the positive shock due to changes in the age structure of the population (+ 3.2 %). Drawing a rapid conclusion, one could ask whether the population is even ageing ?

In comparison with other studies on micro data, which pay a strong attention to proximity to death [4,7,8], our database presents the advantage of providing information not only about "vital risk", which is an indicator of death proximity, but also about numerous morbidity indicators. Performing exogeneity tests, we have selected 13 indicators, which turn out to be chronic diseases such as Hypertension, Ischemic heart disease, Diabetes, Arthritis & arthropathy and/or back pain, etc.

Furthermore, most articles focus only on hospital expenditures, like Seshamani et al. [7,8] or total

individual expenditures, like Zweifel et al. [4]. Our dataset allows us to study the different components of individual health care expenditures: home and office physician visits, pharmaceutical expenditures submitted to reimbursement, and hospital expenditures. Such a detailed analysis let us account for the very different nature of these various kinds of expenditures. For example, pharmaceutical and hospital costs are more influenced by supply-side changes, like technological progress, than are physician visits. Altogether, these two features of our data allow us (i) to highlight the sizeable effect of changes in practices and to show that they are mainly due to supply-side changes; (ii) to provide a better assessment of the influence of age on health care expenditures, controlling for several exogenous morbidity indicators.

The paper is organized as follows. In the next section, we make a short review of the literature devoted to the relation between age and health care consumption. Then, we present the French health care system, the sample and basic features of the data (section 3). Section 4 is devoted to the presentation of the morbidity indicators, their influence on the age-profile of health expenditures and their changes over time. The empirical approach is presented in section 5 and the results of the microsimulations in section 6. These results are used in section 7 to evaluate at the macro level the respective impacts of ageing, changes in morbidity and changes in practices. Section 8 concludes.

## 2 Ageing and health care consumption: a brief review

The consequences of ageing is an issue addressed by numerous macro and micro-economic papers. Surprisingly, the vast majority of macro-economic studies find out that the age composition of a country is not significant in a regression explaining the level of total health care expenditures, whereas factors like total *GDP* or level of education are highly significant [9–16].

An explanation of such a discrepancy between the increasing age profile and the non significant impact of age at the macro level might be that ageing *per se* is not the direct cause of expenditure, but is only highly correlated to such direct causes. In a controversial paper, Zweifel et al. [4] suggested that proximity to death was that direct cause of expenditure correlated to age. They showed that expenditure in the last years or even months of life increased dramatically<sup>2</sup>. Since proximity to death is increasing with age, they inferred that the age profile of expenditure could simply be an

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<sup>2</sup>For Medicare, payments per person-year for decedents are 7 times larger than for survivors ; in France, the corresponding coefficient is equal to 5.

artifact of the “true” relationship between expenditure and proximity to death. Other micro-economic studies [7, 8] have confirmed these findings: ageing (measured by the individual’s calendar age) has a negligible influence on individual health care expenditures, as long as proximity to death is taken into account.

These findings are likely to explain the lack of impact of ageing at the macro level. As stated by Stearns and Norton [17] on the basis of microsimulations, predictions failing to take proximity to death into account might even be misleading, resulting in upward-biased overall simulations.

After a substantial amount of controversy this dispute has now reached the following conclusion: proximity to death is indeed a crucial determinant of expenditure and explains much of the age profile. Simulations at the aggregate level indicate that controlling for proximity to death decreases the remaining age effect ( [17], [18]). However, there remains an age profile of expenditures even among the so-called survivors (those who still have more than two years to live).

The proximity to death factor points out that age is not a factor of expenditure *per se* but is rather correlated with other determinants. Health is an obvious one, and the absence of any link between the age composition and the aggregate level of expenditure might simply stem from a gradual change in the average health of the elderly population: such a betterment would flatten the age profile of expenditure therefore compensating for the increase in the proportion of elderly individuals with higher average expenditures.

As Getzen [19] points out this would still not explain that age composition is not a significant factor of cross national differences in expenditure. It indicates that studying the changes over time of the age profile of expenditure in one country or health care system can shed light on the relationship between age, health status and medical expenditure. For reasons of data limitations, the literature examining changes in the age profile of medical expenditure is rather limited and concerns mostly the Canadian and U.S. cases. It shows that the profile has changed over time, sometimes flattening, but more often steepening.

It is worthwhile to notice that the microeconomic studies mostly use data relative to hospital expenditures or strongly influenced by hospital expenditures. In that case, proximity to death can be interpreted as a morbidity indicator. It is even the best one, when no direct indicator is available. In our case, we use detailed information about several morbidity indicators. As showed below in section 4, age dummies do not influence the expenditure profile, once morbidity is taken into account. Therefore, we agree with Zweifel *et al.* [4] that age is not a factor of expenditure *per se*. Nevertheless,



population ageing is an indirect factor of expenditure growth, because morbidity is increasing with age.

However, given that our purpose is to study changes over time the appropriate questions are the following two : how does morbidity evolve over time, for each age group ? What is the size of the impact of ageing, in comparison with changes over time due to technological progress and, more broadly, changes in practices? This question of the relative size of the effects is the crucial one, the one that is likely to explain the macroeconometric results.

## 3 The data

### 3.1 The French health care system

Some features of the French health care system deserve attention. Indeed, the French public health insurance system is universal : about 99% of the population is covered, without age restriction, which means that coverage is *continuous* over the entire life span. It also grants unlimited access to care, without frequency restrictions. This system covers about 100 % of hospital care expenditures. As for ambulatory care, it reimburses 70% of individual expenditures, including pharmaceutical expenditures (while *Medicare* in the US does not cover medication when it is not prescribed in hospital). 80% of the population choose to add to this basic system an optional supplementary coverage, which covers the remaining 30% of the individual expenditures. Notice that in France, specialist consultations mostly take place in ambulatory care and not within hospital.

### 3.2 An original dataset on health care expenditures and morbidity

The available dataset was built by merging a random sample drawn from administrative data provided by the main French sickness funds (*EPAS*<sup>3</sup>) with a household survey collecting a wide array of information on health and socio-economic characteristics (*ESPS*<sup>4</sup>). The data set is called *Appariement EPAS-ESPS*, where *appariement* stands for "merging" in French.

*EPAS* is an ongoing extraction from the administrative files of reimbursement claims from the three major sickness funds in France, representing 90% of the French population (civil servants are excluded). These claims do not represent the whole scope of health care expenditures: outpatient

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<sup>3</sup>On-Going Sample of Insured Individuals called *EPAS* (*Echantillon Permanent d'Assurés Sociaux*).

<sup>4</sup>Survey on Health and Social Protection called *ESPS* (*Enquête Santé Protection Sociale*).

care in hospitals and home care services are not paid on an individual basis and are therefore absent from our individual-level file.

Therefore, the present work is concerned with what may be called "acute health care expenditures": ambulatory visits to physicians, prescription drugs <sup>5</sup>, hospital stays, and paramedical services (physiotherapists, nurses, etc.). Long-term care expenditures linked to dependence or rehabilitation are being put aside. The lack of knowledge on long term care facilities certainly restricted the scope of our analysis.

Eventually, the data cover approximately 90% of total health care expenditures. *EPAS* is a simple random sample from the overall administrative file, deemed satisfactorily representative. Total spending from *EPAS* underestimates the aggregate value by about 15%, due to the aforementioned absence of long term care expenditures, and underestimation in hospital stays costs.

While the *EPAS* sample is originally representative of the French population, the drawback of having led a general population survey (*ESPS*) on it was a slight loss of representativity. However, our data has the advantage of providing accurate individual-level expenditure recollection as well as extremely wide individual-level information. Indeed, the *EPAS* claims data are enriched with information from the *ESPS* survey, bringing information on health status, diseases, supplementary coverage, and various socio-demographic characteristics such as education and income. Information on health status and diseases is self-reported, but checked afterwards by the physicians who recode the survey, which adds reliability to the information collected. As will be developed further in section 4, these numerous indicators helped us to find instrumental variables, i.e. variables distinct from the regressors to test for the exogeneity of the morbidity indicators, which are crucial in our analysis.

The resulting file is composed of two cross-sectional individual-level data, one for the year 1992 (3441 individuals) and one for the year 2000 (4999 individuals), for whom we know socio-demographic characteristics, health status and health care expenditure. In 1992, data on wage earners <sup>6</sup> only were available : therefore, any comparison between the two files is based on this sub-population.

The household survey suffers from a non-response bias: for the year 2000, out of 20,000 individuals drawn from *EPAS*, 16,764 individuals had a known mail address. Of these individuals, 11,591 have been successfully contacted (69.1%) and 61.8% of these have agreed to answer *ESPS*. The sample follows a similar pattern for the year 1992, except that the number of individuals initially contacted

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<sup>5</sup>OTC accounts for a very small proportion of drugs expenditure in France

<sup>6</sup>80% of the total French population

was smaller. A rate of 30% non-response is common in non-compulsory household surveys. In France, these non-respondents are usually young (25-34 years old) or old (65 and over) and less educated. Since total expenditure is known for all individuals in *EPAS*, it is also possible to show that, among those with a positive expenditure, individuals with the highest expenditures are less likely to answer the survey.

These features are likely to affect the representativeness of our data. However, as can be seen below, these problems are rather limited. Nevertheless, this should be understood as the counterpart of the outstanding richness of the information provided by the *ESPS* survey.

### 3.3 Descriptive analysis

Table 1 presents the general characteristics of our sample. 3,441 individuals are observed in 1992 and 4,999 in 2000.

The survey provides detailed information about the structure of every individual's health care expenditures. We will focus on three subgroups of expenditures : physician home and office visits, pharmaceutical expenditures related to ambulatory care<sup>7</sup>, and hospital expenditures. In order to make health care expenditures comparable between the two years 1992 and 2000, we had to deflate the expenditures of the year 2000, and convert all values to Euros. The deflation coefficient is specific to the type of expenditure of interest and reflects the evolution of its price index. Between 1992 and 2000, the computed price index of physician home and office visits rose by 9.15%, reflecting the changes in fee levels, which are mostly regulated. The price index of ambulatory pharmaceutical expenditures rose by 2.04%, of course not reflecting changes in price due to innovation, which are not included in this index. The price index of hospital expenditures rose by 16.54%. As the pharmaceutical expenditures price index, it does not include technological progress. Indeed, it is computed on the basis of the costs of health services (combination of the index of civil servants' wages and the price index of regular goods).

Therefore, deflating the 2000 expenditures simply led to a compensation of the general inflation rate. The growth of deflated health care expenditures we want to analyse is still influenced by the pace of technological progress, which we are precisely interested in.

In table 1, the italics besides the percentages in the structure of health care expenditures studied

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<sup>7</sup>Notice that medication provided in hospital belong to the hospital expenditures. The pharmaceutical expenditure is relative to medication prescribed by physicians and not delivered in hospital.

refer to the corresponding proportions given for the whole population by the French Health Care Financing Administration. It can be seen that the overall proportion of each type of expenditure in our sample is relatively close to what is observed at the national level. Notice that we chose not to remove outliers from the data : indeed, removing the individuals who incurred the highest expenditures jeopardized the representativity of each aggregate, particularly hospital expenditures.

	1992	2000
N	3441	4999
% women	54,37%	50,89%
average HCE per capita (current euro )	874,1	1330,4
participation rate	86,60%	92,32%
<u>The structure of HCE</u>		
HCE studied (% of total HCE)	87,31%	77,80%
proportion of physician's expenditures in studied HCE	33,84%	26,45% (22,5)
proportion of pharmaceutical expenditures in studied HCE	23,23%	27,8% (22,1)
proportion of hospital expenditures in studied HCE	42,93%	45,74% (41,5)
<u>Growth rate in HCE studied</u>		
rise in physician expenditures (1992-2000)		6,02% (28,1)
rise in pharmaceutical expenditures (1992-2000)		62,3% (51,7)
rise in hospital expenditures (1992-2000)		44,5% (28,0)

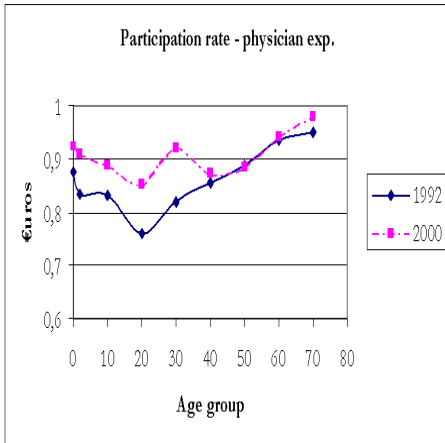
Table 1 : Characteristics of the sample

The particularity of health data such as ours is that the number of individuals who did not incur any cost during a particular year is non negligible. As concerns our data, we will focus on the predicted expenditure. This expenditure is explained by the *participation rate* as well as by the *conditional expenditure*, conditional on participation. The following graphs (graphs 2a to 2i) show,

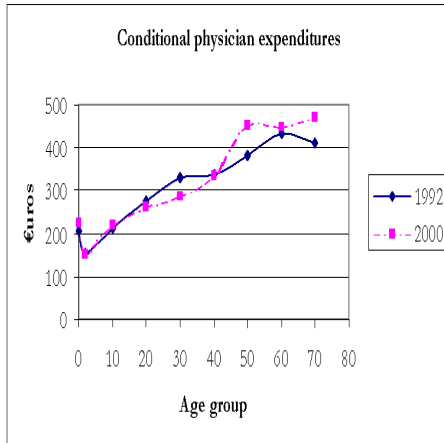
for each type of expenditure under study (physician visits, medication and hospital expenditures) the age profile of participation rate, conditional expenditure and unconditional expenditure. The participation rates of physician visits and pharmaceutical expenditures are quite high (around 90%). The observed change in the participation profile therefore has a small impact on the unconditional expenditure. For these expenditures, the conditional and unconditional expenditures profiles are very similar (see graphs 2e and 2f). This is not the same for hospital expenditures, for which the participation rate is quite low (between 10% and 20%): changes in the participation profile have a greater impact on the final profile, which shows a sizeable drift between 1992 and 2000 for people aged 50 and over. These features show that ambulatory care and hospital care need separate analyses.

For ambulatory care (physician and pharmaceutical expenditures), the expenditure profile (conditional and unconditional on participation) is clearly increasing with age. A noticeable upwards drift of this profile between the years 1992 and 2000 is noticeable for people aged 40 and over. While both are increasing with age, this drift is much larger for drugs than for physician visits. While the participation rate of the less than 50-year-old has visibly increased for both physician and pharmaceutical expenditures, the impact of this rise is negligible on the unconditional expenditures.

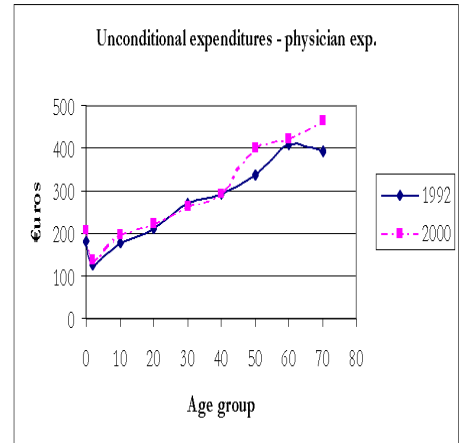
As for hospital conditional expenditures, there is a clear increase with age of the expenditure profile for people aged 60 and over, but no general upward drift is clearly noticeable. What is clear however is that participation rate of hospital expenditures has dramatically increased between 1992 and 2000, for all age groups, and that this rise explains the shape of the unconditional expenditures profiles. The unconditional hospital expenditure graph eventually puts emphasis on what Zweifel et al. [4] have kept saying, namely that proximity to death is the main driver of (hospital) costs. Indeed, the expenditure profile is relatively flat until the 50-59 age group, then becomes an increasing function of age. Moreover, the upward profile drift seems to concern mainly the more than 59 year-olds.



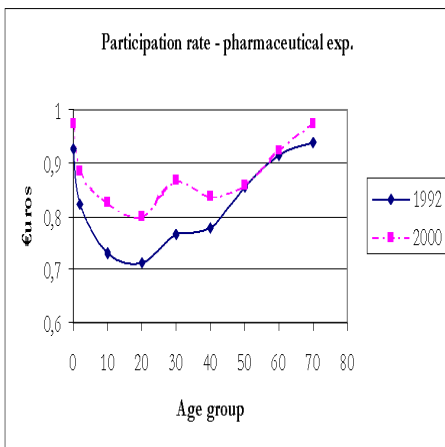
Graph 2a



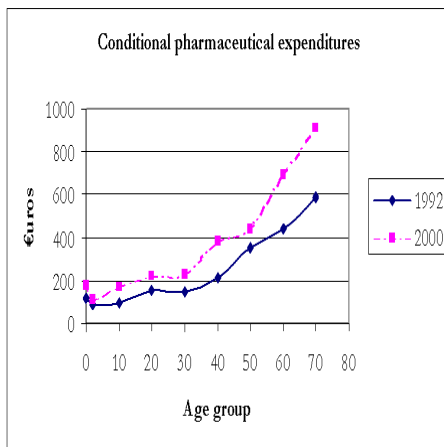
Graph 2b



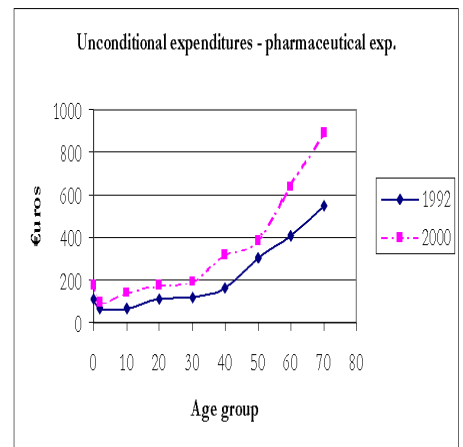
Graph2c



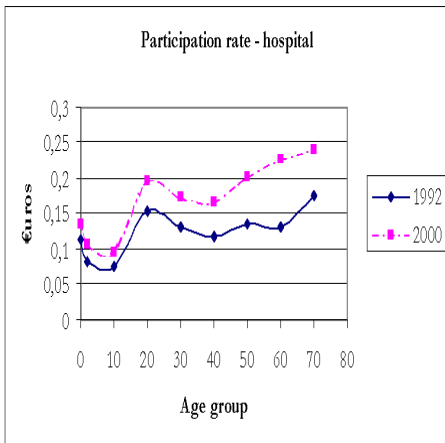
Graph 2d



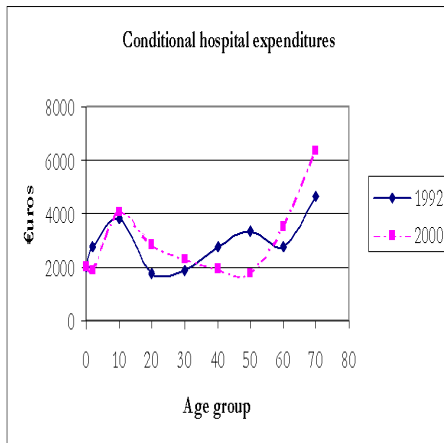
Graph 2e



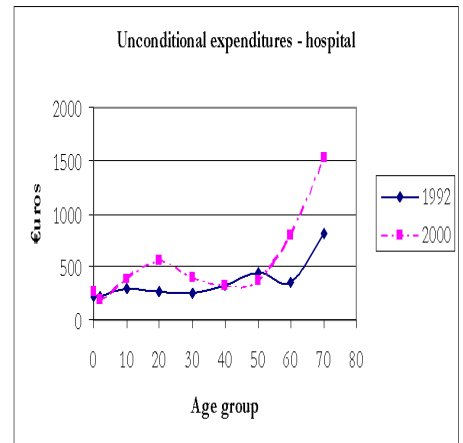
Graph2f



Graph 2g



Graph 2h



Graph2i

## 4 Morbidity and age

We have paid a strong attention to the building and testing of relevant morbidity indicators. Indeed, the level of morbidity by age group, as well as changes over time of morbidity, play a central role in our empirical evaluation. As stated above, our dataset gives us an access to detailed information about the individual's health status and the illnesses he/she might suffer from. In addition, an information is recorded about the individual characteristics and habits, such as his/her size, his/her body mass index (BMI), whether he/she is a regular smoker and/or alcoholic, and about socioeconomic variables such as the education level, the employment status (employed-unemployed-retired), whether or not he/she receives allowances from the public assistance. All these variables are not used as regressors in our equations of participation and health care consumption (see section 5 below). Therefore, we can use them as instrumental variables to test for the exogeneity of our morbidity indicators.

The information at our disposal result from answers of the individual to the survey. Physicians check the survey and correct for discrepancies between objective information (e.g., type of medication taken) and declaration. From this information, synthetic indicators have been built, such as the number of pathologies, level of disability (8 levels) and level of death risk. This latter variable is a grade given by the physicians who recode the survey, relative to the probability of death within the following five years. It has six levels, from 0 (zero death risk) to 5 (surely negative prognosis). In addition, we have built indicators for specific illnesses, mainly chronic diseases such as Hypertension, Ischemic heart disease, Diabetes, Arthritis & arthropathy and/or back pain, etc (altogether 13 illnesses). All indicators are detailed in appendix B.

### 4.1 Selecting exogenous morbidity indicators

We have chosen to select exogenous morbidity indicators in order to avoid adding methodological difficulties to an already rather sophisticated empirical approach (see section 5).

That health status can be endogenous in an equation of medical expenditure goes without saying: if health care is effective on the measure of health status used as a regressor, we are confronted with a case of simultaneity<sup>8</sup>. Studies of the impact of health status on expenditures should therefore define

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<sup>8</sup>Cutler (2003) [20] documents the impact of medical care on the reduction of disability, therefore indicating a possible endogeneity bias in the relationship between disability and expenditures. His article focus on the impact of surgical operations (open heart surgery, hip replacement) performed within hospital.

the former as health states not susceptible of being altered by medical care.

Standard wisdom is that morbidity is a reasonable choice of an exogenous measure of health care in relation to expenditure, except disability which may be endogenous: medical care cannot remove the cause (the underlying chronic disease which is to remain) but delay or prevent the consequences of the disease (either a more severe stage or consequences in terms of functioning and deficiencies). Of course, a few cancers or mental diseases can be cured for good. But most of the most prevalent chronic diseases (diabetes, hypertension, or heart diseases) can never be cured and their onset is independent from the amount of medical care provided to the individual.

Most of previous analyses of the impact of aging on expenditures have included health status as a control in the relationship, but without any way of testing whether the variable used to measure health (very often disability) was exogenous. Thanks to the richness of our data, we were able to perform Hausman tests, in order to select a set of exogenous morbidity indicators for each of the three health care consumption equations (consultations, pharmaceutical, hospital). Notice, however, that it was possible to perform such tests for year 2000 only. Not enough instruments were available for 1992, where the survey did not record enough information about socioeconomic variables nor about individual characteristics and habits. Nevertheless, it seems to us legitimate to assume that exogeneity checked for 2000 holds for 1992.

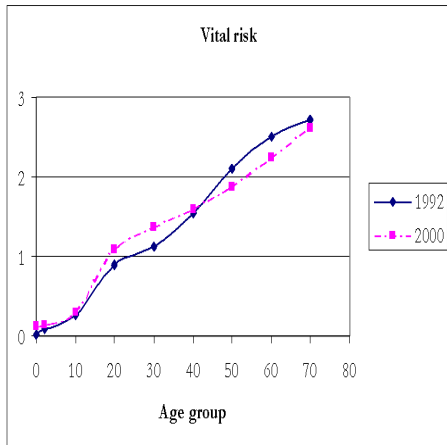
To test for exogeneity of our morbidity indicators we used instrumental variables to build a Hausman's specification test for each of the three health care consumption equations. A Sargan test was used to check the validity of the instruments used. In addition, we examined whether this test could be subject to the weak instrument problem (Staiger and Stock, 1997 [21]). For this purpose, we tested for global significance of the instruments in a system equation model (*SURE*) comprising several equations, where each instrumented variable (i.e. each morbidity indicator) is explained by the instruments and the exogenous regressors. Several iterations led us to select a set of exogenous morbidity indicators for each of the three health care consumption equations. In each case, we found a large significance of the partial correlation between instruments and morbidity indicators, with high statistics and levels of significance lower than  $10^{-3}$ . In addition, Sargan tests validated the exogeneity of the instruments. Detailed results are provided in appendix B. For example, considering the first equation, relative to consultations, we have selected 9 morbidity indicators: Diabetes, Ischemic heart disease, Hypertension, Circulatory disease, Conditions associated with lipid metabolism, Depression,



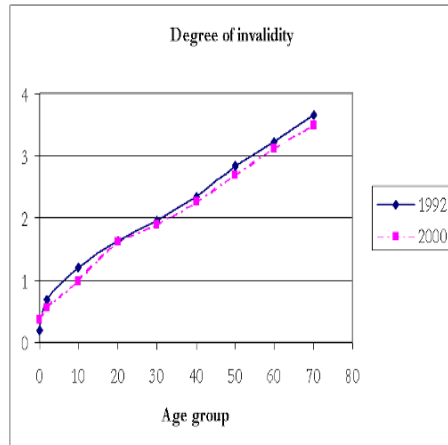
Sleeping disorder, Arthritis & arthropathy and/or back pain, Number of diseases. 11 instrumental variables were used: Individual size, BMI (4 levels, one reference), employment status (3 levels, one reference), an indicator that the individual receives allowances from public assistance, education level (5 levels, one reference). The p-value for the Sargan test is 0.938. The p-value for the Hausman test is 0.079.

## **4.2 Morbidity and health expenditures profile**

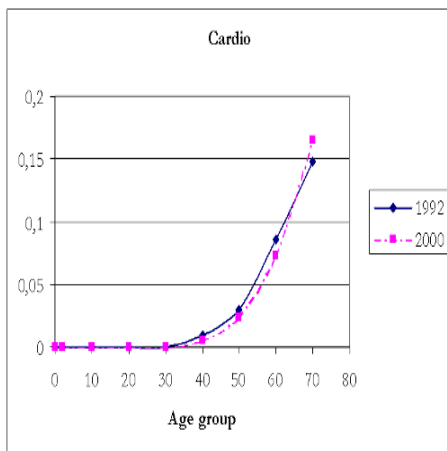
It is well known that morbidity is increasing with age. This appears clearly in graphs 3, where we have represented the average level of some of our morbidity indicators for each age group.



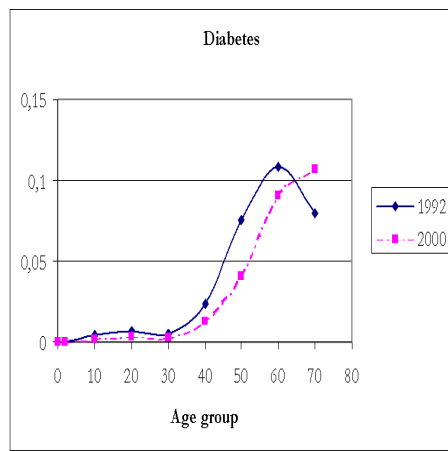
Graph 3a



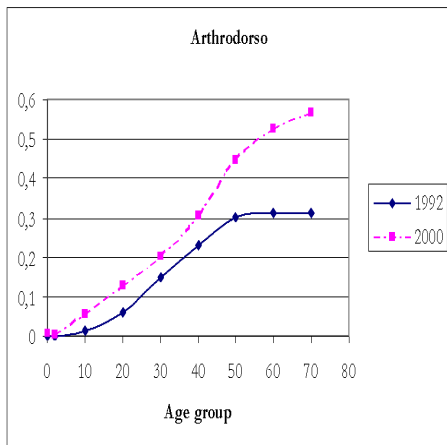
Graph 3b



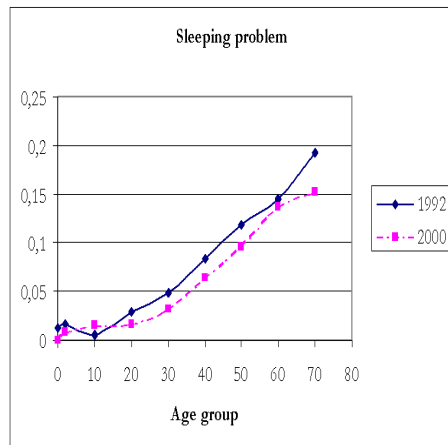
Graph 3c



Graph 3d

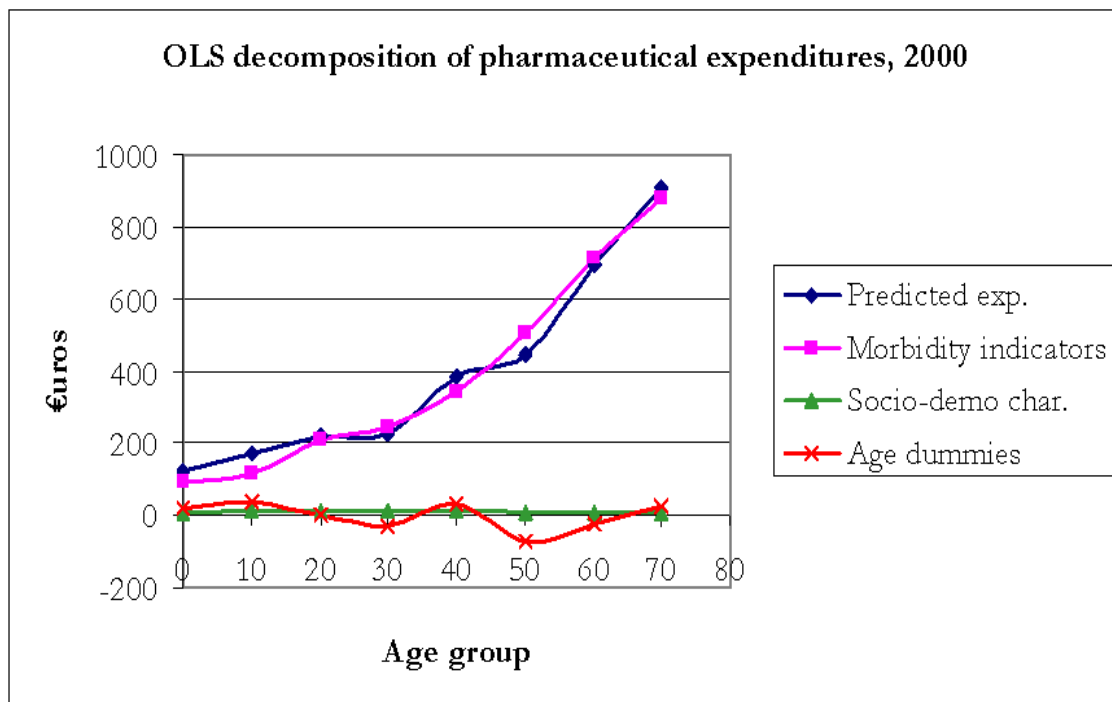


Graph 3e



Graph 3f

Graphs 3



Graph 4 : Additive effects explaining pharmaceutical expenditures in an OLS model

Actually, a simple OLS analysis performed on untransformed data shows us that the increase in morbidity with age explains entirely the expenditures profile by age. Graph 4 presents the contribution of each one of 3 sets of variables explaining the level of conditional pharmaceutical expenditures in a basic untransformed linear model : age dummies, morbidity indicators and socio-economic characteristics (gender, income, coverage, social and occupational group)<sup>9</sup>. The graph shows clearly that age *per se* is not a factor of expenditure: age dummies do not influence the expenditure profile, once morbidity is taken into account.

### 4.3 Changes in morbidity over time

Graphs 3 make it possible to study changes in the age profiles of the morbidity indicators between 1992 and 2000. These graphs are representative of what is found for our various indicators. For most of them, there is a decrease in the level of morbidity over time, i.e. a health improvement. However, this is not systematic and not homogenous along age groups. For instance, the frequency of diabetes

<sup>9</sup>This was obtained for the year 2000. Comparable graphs can be obtained for the year 1992 and other types of expenditures. The same kind of results has been obtained as regards participation rate : the increasing profile of the use of health care services with age is mainly explained by the evolution of morbidity with age.

is decreasing for all age groups between 1992 and 2000, but increases for individuals aged 70 and over (graph 3d). The same kind of changes is observed for ischemic heart disease (graph 3c). The frequency of arthritis and back pain is increasing for each age groups (graph 3e).

These graphs do not allow to draw any conclusion about a health improvement hypothesis. However, our estimates will allow us to evaluate, for each age group, the aggregate effect of all these various changes on the level of health care expenditure. In other words, it is possible to assess the impact of changes in morbidity, all other things being equal. Anticipating on our results, we find that this impact is negative, indicating that the health status of individuals is improving, indeed.

## 5 Empirical approach

Our purpose is to implement simulation techniques in order to examine the influence of various effects on the shifts in the profile of health expenditures by age group. Our empirical approach entails three steps: firstly, the specification and estimation of a two-equations model explaining the decision to consume and the level of expenditure, conditional on participation; secondly, the use of the estimates to simulate counterfactual average levels of participation and expenditure by age group. This second step makes it possible to identify the components of the drift observed between 1992 and 2000 in the profile by age of health expenditures. More precisely, we evaluate the impacts of changes in morbidity between 1992 and 2000 and the effects of changes in practices between 1992 and 2000, for a given level of morbidity. In the third step, we use the microsimulation results to identify, at the macroeconomic level for the period 1992-2000, the relative effects of demographic changes and profile drifts.

This approach is implemented for each of the three components of health care expenditures we focus on. In this section, we present the econometric specifications and the principles of our predictions and microsimulations.

### 5.1 Econometric specifications

A typical feature of health expenditure data is that many individuals incur no health costs within the period of observation. The descriptive analysis has shown the high proportion of non-users of hospital. As regards consultations and drugs, the proportion of non-users is smaller, but not negligible. Such a configuration requires specific estimation techniques. Many papers addressed the

issue of the choice between the sample-selection model (Heckit [22]) and the two-part model [23–25]. Monte Carlo studies implemented by Manning, Duan and Rogers [25] show that the two-part model performs better than the sample selection model even when the latter is the true model. However, Leung and Yu [24] have shown that the performances of the sample selection model depend crucially on the degree of collinearity between the inverse Mill’s ratio and the explanatory variables of the second step equation. When there are no collinearity problems, a t-test of the coefficient of the inverse Mill’s ratio can be used to choose between the two specifications.

As stated below, our data do not lead to serious collinearity between the inverse Mill’s ratio and the explanatory variables of the second step equation. Therefore, we chose to allow for the possibility of selection and used the Heckit model whenever the inverse Mill’s ratio appeared to be significant.

For the individual  $i$  belonging to the age group  $j$ , we denote  $P_{ij}$  the dichotomic variable representing participation and  $C_{ij}$  the health care consumption, and consider the following model:

$$P_{ij} = \mathbf{I}_{P_{ij}^* > 0} \quad \text{with} \quad P_{ij}^* = W'_{ij}c + M'_{ij}b + a_j + u_{1,ij} = X'_{1,ij}d + u_{1,ij} \quad (1)$$

$$\begin{cases} \text{Log}(C_{ij}) = \mathbf{I}_{(P_{ij}=1)} \cdot [\text{Log}(C_{ij}^*)] \\ \text{with } \text{Log}(C_{ij}^*) = Z'_{ij}\gamma + M'_{ij}\beta + \alpha_j + u_{2,ij} = X'_{2,ij}\delta + u_{2,ij} \end{cases} \quad (2)$$

$$\text{where } (u_{1,ij} \quad u_{2,ij}) \sim N \left( \begin{pmatrix} 0 \\ 0 \end{pmatrix}; \begin{pmatrix} \sigma_1^2 & \rho \sigma_1 \sigma_2 \\ \rho \sigma_1 \sigma_2 & \sigma_2^2 \end{pmatrix} \right).$$

Equation (1) describes the decision to use health care services and equation (2) explains the level of consumption. If  $\rho = 0$ , the participation decision is independent of the level of consumption and the two equations can be estimated separately (two-part model). If, on the contrary,  $\rho \neq 0$ , we must take the sample selection process into account, in order to obtain a consistent estimate of (2) [22].

$X'_{1,ij}$  and  $X'_{2,ij}$  are the explanatory variables of the participation and consumption equations (1) and (2). These explanatory variables entail  $M'_{ij}$ , which are related to the morbidity indicators. Equations (1) and (2) include dummies  $a_j$  and  $\alpha_j$  related to the age groups. In addition, equation (1) includes explanatory variables such as family size, education level, coverage by a supplementary insurance, gender and matrimonial status (variables  $W'_{ij}$ ). Equation (2) also includes explanatory variables in addition to the morbidity indicators and age group dummies : level of earnings, coverage by a supplementary insurance, social and occupational group and gender (variables  $Z'_{ij}$ ). For identification purposes, some explanatory variables of equation (2) are not included in equation (1) [26].

The sample selection model can be estimated by the maximum likelihood estimator. However, we are interested in studying and performing simulations on the participation behaviour as well as on the conditional consumption. Therefore, we preferred to use Heckman's two-step estimation procedure, which is based on the fact that:

$$E(\text{Log}(C_{ij}) | P_{ij} = 1) = X'_{2,ij}\delta + \mu\lambda_{ij}$$

where  $\mu = \rho\sigma_2$  and  $\lambda_{ij} = \varphi(\frac{X'_{1,ij}d}{\sigma_1})/\Phi(\frac{X'_{1,ij}d}{\sigma_1})$ , with  $\varphi(\cdot)$  and  $\Phi(\cdot)$  standing for the pdf and cdf of the standard normal distribution.

## 5.2 Predicted expenditures with the sample selection model

The decision to use health care services can be easily predicted. From the estimation of (1) by a Probit estimator, one has:

$$\hat{E}(P_{ij} | X_{1,ij}) = \Phi(X'_{1,ij}\hat{d}) \quad (3)$$

The prediction of the conditional expenditures is not so easy to derive, since we have to deal with the retransformation problem. Indeed, among the positive expenditure observations  $C_{ij}$ , there is a large skew and we have to specify (2) in terms of  $\text{Log}(C_{ij})$ . However, we need to predict expenditures on the untransformed scale because decision makers do not work with log Euros. Therefore, we have to deal with the problem of retransforming back to raw-scale expenditure predictions.

Consider first that  $\rho = 0$  (this is the case for hospital expenditures). Then a consistent estimate of (2) is obtained by running OLS, for non-zero observations, on the following specification:

$$\text{Log}(C_{ij}) = X'_{2,ij}\delta + u_{2,ij} \quad (4)$$

In this case, one has :

$$E(C_{ij} | P_{ij} = 1; X_{2,ij}) = \exp\{X'_{2,ij}\delta\} \int \exp\{u_{2,ij}\} dF(u_{2,ij})$$

Assuming a normality distribution for  $u_{2,ij}$  leads to a simple analytical expression of  $\int \exp\{u_{2,ij}\} dF(u_{2,ij})$ , which is then equal to  $\exp\{\frac{1}{2}\sigma_2^2\}$ . More generally, Duan [27] suggested to use a non parametric "smearing estimator", where  $\int \exp\{u_{2,ij}\} dF(u_{2,ij})$  is estimated by [28]:  $\hat{\psi} = \frac{1}{N} \sum_{i=1}^N \exp\{\hat{u}_{2,ij}\}$ . Following this definition, we can estimate:

$$\hat{E}(C_{ij} | P_{ij} = 1; X_{2,ij}) = \exp\left\{X'_{2,ij}\hat{\delta}\right\} \cdot \hat{\psi} \quad (5)$$

The smearing estimator is likely to produce biased estimates when the log-scale errors are heteroscedastic in some function of the explanatory variables. Instead of using Duan's estimator [27], Manning and Mullahy [29] and Mullahy [30] suggest to use alternative procedures.

When  $\rho \neq 0$ , equation (2) can be consistently estimated by applying OLS for non-zero observations to the specification:

$$\text{Log}(C_{ij}) = X'_{2,ij}\delta + \mu\hat{\lambda}_{ij} + w_{ij} \quad (6)$$

where  $\hat{\lambda}_{ij} = \varphi\left(\frac{X'_{1,ij}\hat{d}}{\hat{\sigma}_1}\right)/\Phi\left(\frac{X'_{1,ij}\hat{d}}{\hat{\sigma}_1}\right)$  is computed from the estimation of (1) in the first step.

Since heteroscedasticity is likely to be introduced by the taking into account of the inverse Mill's ratio [31], we performed a Breusch-Pagan test to check whether the disturbances  $w_{ij}$  of (6) were homoscedastic or not. For consultations and pharmaceutical expenditures, most of the tests rejected the global homoscedasticity hypothesis, but did not reject homoscedasticity within each age group. In these cases, we assumed a normality distribution for  $w_{i,j}$ , which leads to the simple retransformation formula  $\exp\left\{\frac{1}{2}\hat{\sigma}_{w,j}^2\right\}$ , where  $\hat{\sigma}_{w,j}^2$  is a straightforward estimator built for each age group using the sum of squares of the first step estimated residuals<sup>10</sup>.

On the whole, in the case of heteroscedasticity<sup>11</sup>, we predicted the expenditures following the expression:

$$\hat{E}(C_{ij} | P_{ij} = 1; X_{2,ij}) = \exp\left\{X'_{2,ij}\hat{\delta} + \hat{\mu}\hat{\lambda}_{ij}\right\} \cdot \hat{\psi}'' \quad (7)$$

with  $\hat{\psi}'' = \exp\left\{\frac{1}{2}\hat{\sigma}_{w,j}^2\right\}$  when there is homoscedasticity within the age group and with  $\hat{\psi}'' = \exp\left\{\frac{1}{2}\hat{\sigma}_{w,i}^2\right\}$  with  $\hat{\sigma}_{w,i}^2 = V'_{ij}\hat{\theta}$  when there is heteroscedasticity within the age group.

As concerns hospital expenditures, the selection effect was not significant, allowing us to consider a two part model. In this case, it was possible to avoid the retransformation difficulties by considering a GLM estimate, where the conditional expectancy of expenditures on the raw scale is directly specified

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<sup>10</sup>In a few cases, homoscedasticity was rejected within one age group. In this case, we used an estimator  $\hat{\sigma}_{w,i}^2$  obtained by the identification of the variance function of the error  $w_{ij}$ , and estimated for that purpose the specification  $\hat{w}_{i,j}^2 = V'_{ij}\theta + \xi_{ij}$ , where  $\hat{w}_{i,j}$  are the estimated residuals of (6) and where  $V'_{ij}$  entails  $X'_{2,ij}$ . The estimator  $\hat{\sigma}_{w,i}^2$  was then defined by:  $\hat{\sigma}_{w,i}^2 = V'_{ij}\hat{\theta}$ . To check whether we had correctly identified the variance function of  $w_{ij}$ , we applied the weighted least squares to (6) and performed a Breusch-Pagan test on the transformed model. Notice, however, that we used expression (6) and not the weighted specification to compute the predicted expenditures.

<sup>11</sup>In that case, we used asymptotic standard errors estimators robust to heteroscedasticity (White (1980) [32]) to perform the significance tests of the coefficients of (6).

and estimated:

$$\hat{E}(C_{ij} | P_{ij} = 1; X_{2,ij}) = \exp \left\{ X'_{2,ij} \hat{\delta} \right\}. \quad (8)$$

### 5.3 Principles of simulations

The model is estimated separately for the years 1992 and 2000, leading to the estimated coefficients  $\hat{d}_{92}$ ,  $\hat{d}_{00}$ ,  $\hat{\delta}_{92}$ ,  $\hat{\delta}_{00}$ ,  $\hat{\mu}_{92}$  and  $\hat{\mu}_{00}$ .

Since the computation of predictors (3) and (5), (7) or (8) involve several non-linear functions, we cannot exhibit additive effects. Instead, we use an incremental approach.

As concerns participation (decision to use health care services), we compute or simulate the predicted probability for the average patient of each age group  $j$ . This is done for each expenditure component, i.e. physicians visits, drugs and hospital.

For the population observed in 1992 and behavior of 1992, the predicted probability of using health care services is the following:

$$\hat{\pi}_{ij}^{92.92} = \Phi \left( X_{1,ij}^{92} \hat{d}_{92} \right) = \Phi \left( W_{1,ij}^{92} \hat{c}_{92} + M_{ij}^{92} \hat{b}_{92} + \hat{a}_{j,92} \right)$$

This probability is evaluated at the average point of each age group:

$$\hat{\pi}_{.j}^{92.92} = \Phi \left( X_{1,j}^{92} \hat{d}_{92} \right) = \Phi \left( W_{1,j}^{92} \hat{c}_{92} + M_j^{92} \hat{b}_{92} + \hat{a}_{j,92} \right) \quad (9)$$

We have chosen this approach instead of computing the average by age group of individual predicted probabilities. This empirical strategy allows us to simulate the effects of changes in morbidity, while we hold constant the other explanatory variables.

Given the role of morbidity on the expenditure profile, we focus on changes in morbidity and changes in practices, for a given morbidity.

The effect on participation of changes in practices for a given morbidity can be evaluated by replacing  $\hat{b}_{92}$  by  $\hat{b}_{00}$  in expression (9):

$$\hat{\pi}_{.j}^{m92.b00} = \Phi \left( W_{1,j}^{92} \hat{c}_{92} + M_j^{92} \hat{b}_{00} + \hat{a}_{j,92} \right) \quad (10)$$

The *incremental* effect of changes in morbidity between 1992 and 2000 can be evaluated by replacing, for each age group, the average level of morbidity observed in 1992,  $M_j^{92}$  by the average



level of morbidity observed in 2000,  $M_j^{'00}$  :

$$\hat{\pi}_j^{m00.b00} = \Phi \left( W_{1,j}^{'92} \hat{c}_{92} + M_j^{'00} \hat{b}_{00} + \hat{a}_{j,92} \right) \quad (11)$$

Finally, the incremental effects of other changes in behavior and individual characteristics lead to the predicted probability for the year 2000:

$$\hat{\pi}_j^{00.00} = \Phi \left( X_{1,j}^{'00} \hat{d}_{00} \right) = \Phi \left( W_{1,j}^{'00} \hat{c}_{00} + M_j^{'00} \hat{b}_{00} + \hat{a}_{j,00} \right) \quad (12)$$

We follow the same principles to compute the predictions  $(C|P)_{.j}$  of the levels of expenditures by age group, conditional on participation. We use the expressions derived above to compute  $(C|P)_{.j}^{92.92}$ ,  $(C|P)_{.j}^{m92.b00}$ ,  $(C|P)_{.j}^{m00.b00}$  and  $(C|P)_{.j}^{00.00}$ . More precisely, the means by age group of the explanatory variables are computed only on the subsamples of participants, when simulating the *conditional* expenditures. As concerns physician visits and pharmaceutical expenditures our estimates gave empirical evidence of a significant Mill's ratio and heteroscedasticity (see below). In these cases, we used expressions (7) to compute  $(C|P)_{.j}^{92.92}$ ,  $(C|P)_{.j}^{m92.b00}$ ,  $(C|P)_{.j}^{m00.b00}$  and  $(C|P)_{.j}^{00.00}$ . On the contrary, we performed GLM estimates for hospital and thus used expression (8) to compute the simulations.

To sum up :

- The transition from  $(C|P)_{.j}^{92.92}$  to  $(C|P)_{.j}^{m92.b00}$  gives the effect of changes in practices for a given morbidity.
- The transition from  $(C|P)_{.j}^{m92.b00}$  to  $(C|P)_{.j}^{m00.b00}$  gives the incremental effect of changes in morbidity (among the participants) between 1992 and 2000.
- Finally, the transition from  $(C|P)_{.j}^{m00.b00}$  to  $(C|P)_{.j}^{00.00}$  gives the incremental effect of other changes of behavior and individual characteristics between 1992 and 2000.

Broadly understood, changes in practices are changes in the estimated parameters of (1) or (2) between 1992 and 2000. These changes can be linked to changes in patients' behavior or in physicians' behavior. They can result from technological progress, which induces the use of innovative procedures or innovative drugs which can be more costly. This technological progress may concern treatment of diseases specific to the elderly. Changes in practices are also linked to the extension of prevention

protocols to old ages. For example, medical recommendations for preventing hypercholesterolaemia have been recently extended to very old ages in France. In the same way, the use of surgical treatment of cataract changed dramatically for people aged 75-84 in France: the proportion of surgical treatment rose from 40 % to 55 % between 1993 and 1998 [33].

More precisely, changes in practices for a given morbidity is linked to changes in the estimated coefficients  $\hat{b}$  and  $\hat{\beta}$ , which measure the influence of morbidity on the participation rate and expenditures. What we call "other changes in behavior and individual characteristics between 1992 and 2000" can also be interpreted as changes in practices. Actually, these "other changes" depend on changes in the variables  $W$  and  $Z$ , as well as changes in the parameters  $\hat{c}$ ,  $\hat{\gamma}$ ,  $\hat{a}_j$  and  $\hat{\alpha}_j$ . However, our econometric results reveal that they are mainly due to changes in the age-specific constants  $\hat{a}_j$  and  $\hat{\alpha}_j$ . To make the presentation of our micro simulations readable, we did not present separately the effects of changes in the age-specific constants. However, this is done for the recapitulative table, presented in section 7, where we make the evaluations at the macroeconomic level. These changes in age-specific constants can be linked to changes in unobservable morbidity as well as changes in practices for a given level of morbidity. In this paper, we will interpret changes in age-specific constants as changes in practices for a given observable level of morbidity.

## 6 Microeconomic results

### 6.1 Results of the estimates

The estimation of expressions (1) and (2) reveal a strong influence of the morbidity indicators on participation and on the level of conditional consumption, given participation<sup>12</sup>. The number of diseases, as well as the invalidity and vital risk levels, have large positive impacts on the use of health care services. To take an example, in 1992, an invalidity level of 3 raises the conditional pharmaceutical consumption of 27 %. When the invalidity level is 4 or 5, the rise in the conditional pharmaceutical consumption amounts to 57 % and 78 %. Having an Ischemic heart disease raises the conditional pharmaceutical consumption by 42% and suffering from Hypertension raises the conditional pharmaceutical consumption by 46%. Otherwise, we find that the fact of belonging to a low-income category has a negative influence on the level of conditional consumption of ambulatory care. The lack of supplementary coverage has a negative influence on the participation and the conditional expenditure

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<sup>12</sup>Detailed results are available on request.

for each of the three components of health care services<sup>13</sup>. In general, gender is not significant for participation, but women incur significantly higher levels of conditional consumption. To sum up, the effect of ageing on health expenditures is captured in our specification by morbidity indicators. Our estimations show that these factors have strong significant impacts on participation and consumption of ambulatory and hospital care.

To check for the potential collinearity problem addressed by Leung and Yu [24], we computed, for each year and health expenditure component, the  $R^2$  of the regression of the inverse Mill's ratios  $\lambda_{ij}$  on  $X'_{2,ij}$  the regressors of (2). The results obtained validate our approach in terms of sample selection model: we find, in 1992 for instance, 0.63 for consultations, 0.74 for drugs and 0.67 for hospital<sup>14</sup>.

We find that the inverse Mill's ratio is significantly negative for the expenditures associated with physician visits and drugs, but not significant for hospital care services. From a theoretical point of view, the coefficient of the inverse Mill's ratio is equal to  $\rho\sigma_2$ , where  $\rho$  is the correlation coefficient between the disturbances of equations (1) and (2). Our results suggest that the unobservable heterogeneity explaining participation is negatively correlated to the unobservable heterogeneity explaining conditional consumption. This makes sense when thinking, for instance, to risk aversion in connection to the risk of illness. This risk aversion is likely to be a component of both disturbances  $u_1$  and  $u_2$ . Our results then suggest the following interpretation: more risk aversion induces more participation with more preventive care. This results in less severe diseases with a smaller level of conditional expenditures. This reasoning should not be appropriate as concerns hospital, where participation is connected to the diagnosis of a disease. This is confirmed by our estimates, which lead to reject the significance of the inverse Mill's ratio.

From a methodological point of view, notice that many papers devoted to health expenditures in connection to age defend the principle of rejecting the sample-selection model in favour of the use of the two-part model. This is partly due to practical reasons, since it is easier to avoid the retransformation problem by simply considering a GLM estimation within the two-part model framework. Another explanation is that these papers focus on hospital care services. On our data, we do not find any empirical evidence of a significant selection process as regards the use of hospital services. On the contrary, we find a correlation between unobserved determinants of the participation and conditional

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<sup>13</sup>Its impact is not significant only for participation to hospital care services.

<sup>14</sup>These values are much smaller than the  $R^2$  equal to 0.9997 obtained by Seshamani and Gray [8] running on their data the approach of Zweifel et al. [4]

consumption of physician visits and drugs. Our results show that one should be cautious about a general rejection of the sample selection model.

## 6.2 Results of the microsimulations

The implementation of the estimation and simulation methods described above allow us to compute  $(C|P)_{.j}^{92.92}$ ,  $(C|P)_{.j}^{m92.b00}$ ,  $(C|P)_{.j}^{m00.b00}$  and  $(C|P)_{.j}^{00.00}$  for the conditional consumption and  $\hat{\pi}_{.j}^{92.92}$ ,  $\hat{\pi}_{.j}^{m92.b00}$ ,  $\hat{\pi}_{.j}^{m00.b00}$  and  $\hat{\pi}_{.j}^{00.00}$  for the participation.

The results are displayed in graphs 5. For each graph, (i) the transition from profile 1 to profile 2 gives the effect of changes in practices for a given morbidity; (ii) the transition from profile 2 to profile 3 gives the incremental effect of changes in morbidity between 1992 and 2000; (iii) the transition from profile 3 to profile 4 gives the incremental effect of other changes of behavior and individual characteristics between 1992 and 2000.

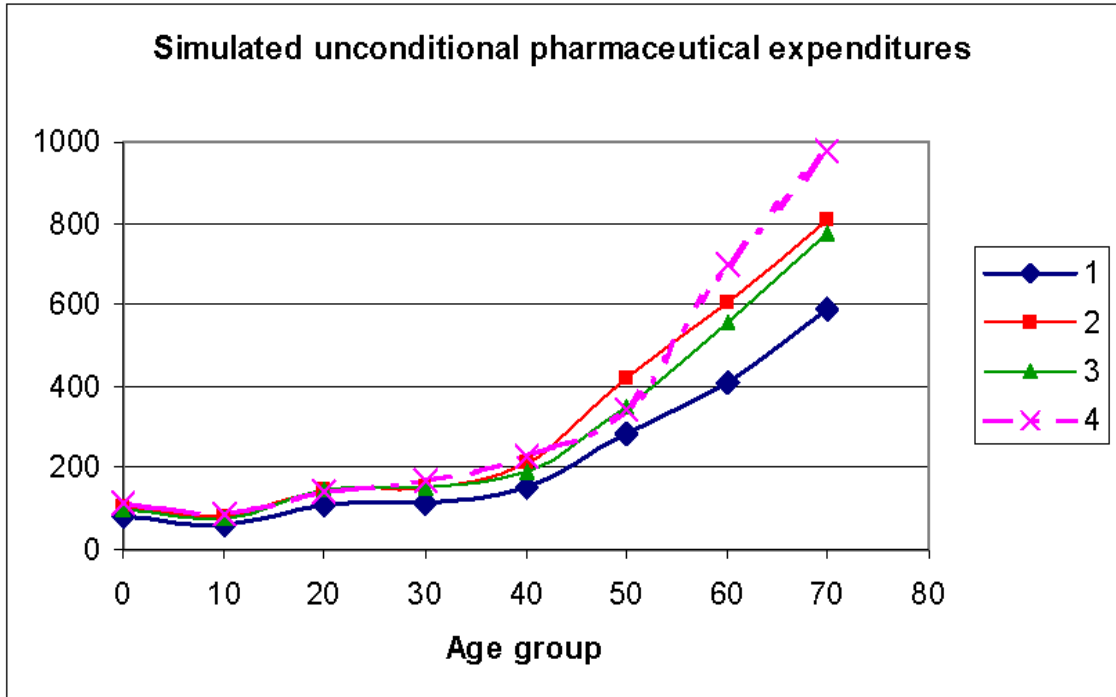
For ambulatory care, the bulk of changes are essentially due to changes in expenditures conditional on participation and not to changes in participation. The changes observed for pharmaceutical expenditures are clearly observable in the zoomed graph 5f. The pharmaceutical expenditures rise tremendously. Our simulations show that this growth is due to a large upward drift of the profile in relation to changes in practices and "other changes". Remind that these "other changes" are mainly due to changes in the age-specific constants, that we interpret as changes in practices for a given observable level of morbidity. It is noticeable that the sum of these two upward drifts is much more important than what is observed for physician expenditures. This can be observed by comparing graphs 5c and 5f, keeping in mind that scales differ. The changes in morbidity induce a downward drift which compensates only partly this total upward drift.

To sum up, the drift due to changes in practices is much more spectacular for pharmaceutical expenditures than for physician visits (which result mainly from patients' decision). There is thus a large innovation component in this observed drift. These results concern pharmaceutical expenditures, which are responsible for the bulk of the growth in total health care expenditures. They show that the drifts are not due to changes in the behaviours of the elderly, but are rather linked to the supply of new products on the health care market.

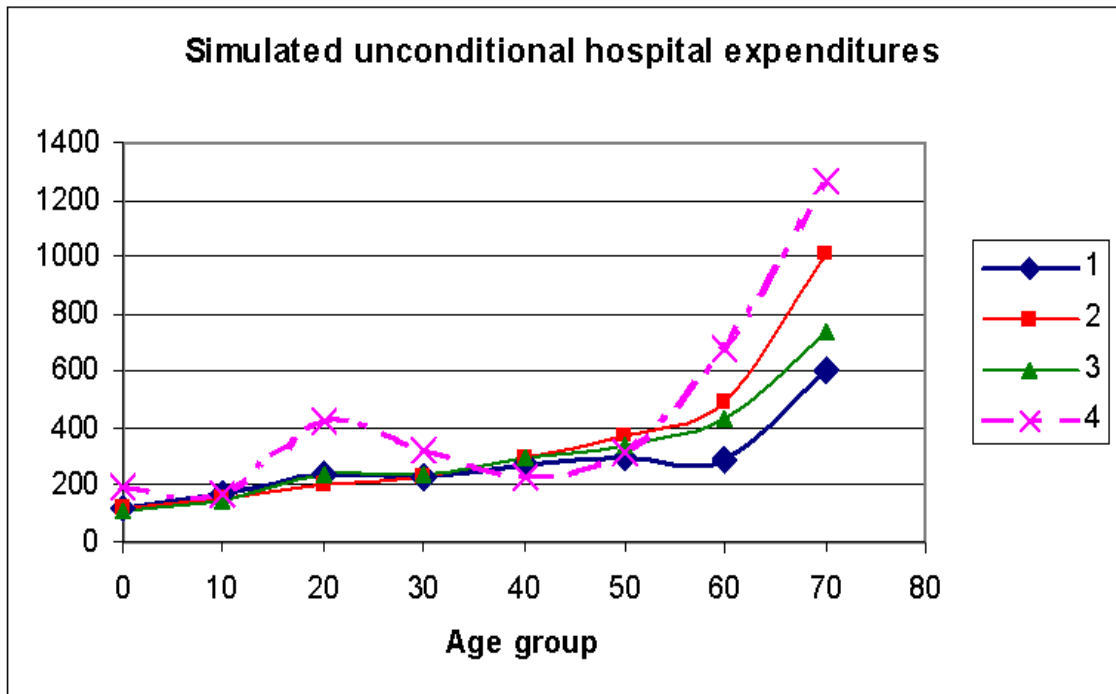
What is observed for hospital care contrasts strongly with ambulatory care. Indeed, the changes

are mainly due to a drift in the participation profile by age (see graph 5g ). The drift in participation rates is observed for every age group, but appears to be increasing with age. Our simulation shows that this upward drift is entirely due to changes in practices for a given level of morbidity.

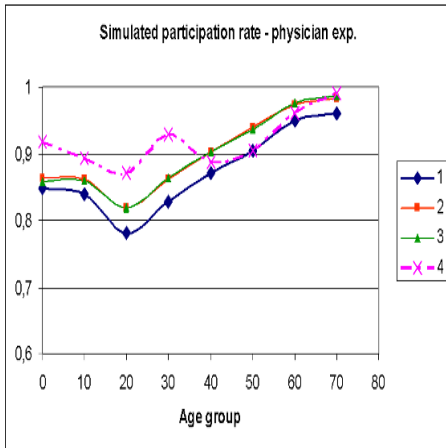
As for hospital unconditional expenditures, we find again the negative effect of changes in morbidity for people aged 40 and over, as well as the positive effect of changes in practices for a given morbidity. One observes for the last age group a tremendous change in practices for a given morbidity. This jump is only visible on graph 5i (unconditional expenditures), since it is only due to the change in participation behaviour, which is entirely due to changes in practices for a given level of morbidity. To sum up, there is not much of a profile as regards hospital expenditures, but rather a jump for the last age group, which is only due to changes in practices (more participation) for a given level of morbidity. This result seems to be close to results of studies which focus on the influence of time to death on health care expenditures [4, 7, 8]. Indeed, the dependent variables of these studies is reduced to hospital care as concerns Seshamani & Gray [7, 8] or mainly influenced by hospital expenditures as concerns Zweifel, Felder & Meiers [4]. However, the jump we observe is mainly due to changes in participation, and less linked to changes in morbidity level when people are close to death, leading to a rather different interpretation.



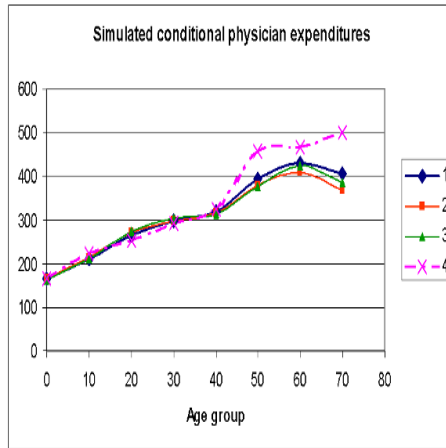
Graph 5f (zoomed) - Simulated unconditional pharmaceutical expenditures



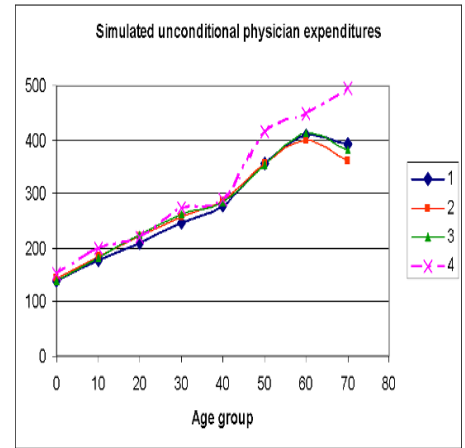
Graph 5i (zoomed) - Simulated unconditional hospital expenditures



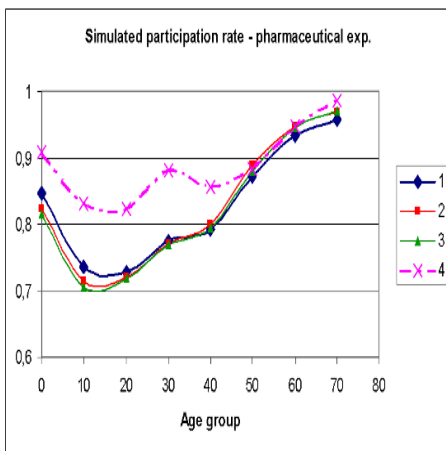
Graph 5a



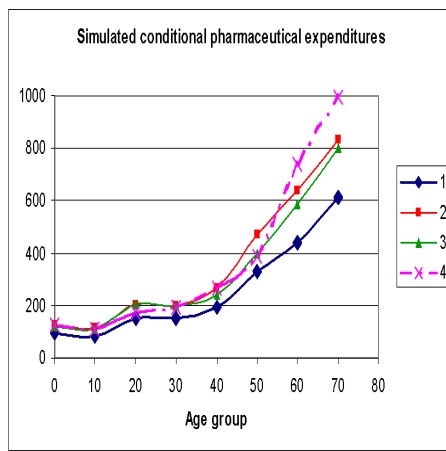
Graph 5b



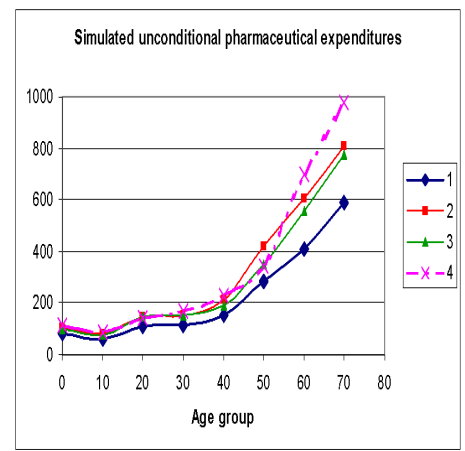
Graph5c



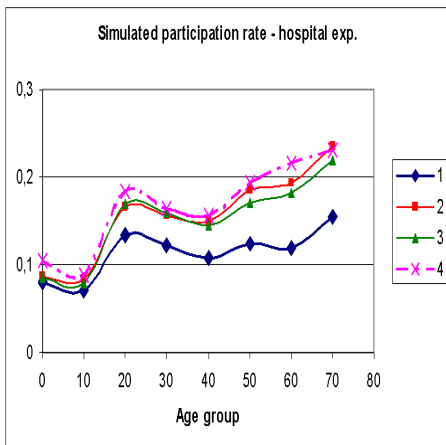
Graph 5d



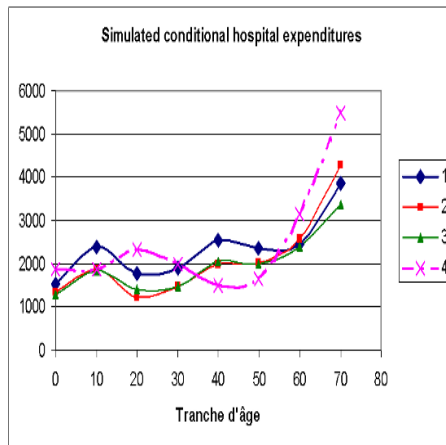
Graph 5e



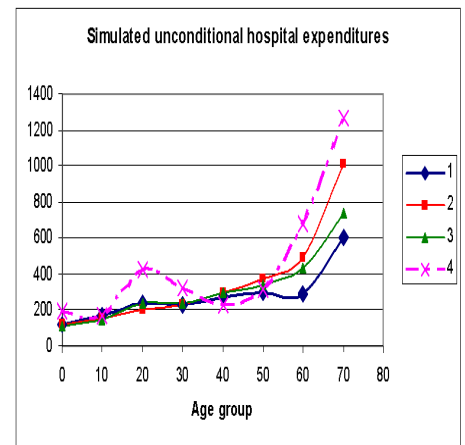
Graph5f



Graph 5g



Graph 5h



Graph5i

## 7 Comparing demographic effects, changes in practices and changes in morbidity at the macro level

On table 2, we applied the predictions and simulations derived above to the structure by age of the French population. This allows us to evaluate, for the past period 1992-2000, the relative effects of demographic changes and profile drifts. In addition, we can evaluate the components of changes in profile drifts. Table 3 in appendix C show the results of Bootstrap replications ( $N=500$ ) performed to assess the significancy of these results.

We find again the negative effect of changes in morbidity. The rise in health care expenditures due to demographic changes appears to be very small, in comparison with the effects of changes in practices. For total expenditures, we find that the impact of changes in practices is equal to +22.1%, and thus 6.8 times larger than the rise in health care expenditures due to changes in the age structure of the population (+3.2%). Considering a broader definition of changes in practices, their impact is even 14.7 times larger than the rise in health care expenditures due to changes in the age structure of the population. Moreover, we find that the impact of changes in morbidity is negative, indicating an improvement of the health status of individuals for a given age. This negative effect of changes in morbidity (-8.6 %) more than compensates the positive shock due to changes in the age structure of the population (+ 3.2 %). Drawing a rapid conclusion, one could ask whether the population is even ageing.



Variation 1992-2000 (%)	Physicians	Pharmac.	Hospital	Aggregate
Total demographic change	5,04	8,00	6,18	<b>6,22</b>
of which :				
part of structural change	2,09	4,97	3,20	3,24
part of growing size of population	2,95	3,03	2,98	2,98
Changes in practices for a given morbidity	0,75	42,80	27,79	22,13
Changes in morbidity	1,06	-10,75	-15,04	<b>-8,60</b>
Changes in age dummies	56,99	70,98	-24,14	25,41
Other changes	-45,60	-46,98	72,41	4,74
Total variation 1992-2000 (%)	18,25	64,05	67,20	49,90

Table 2 : Relative size of effects at the macroeconomic level

## 8 Conclusion

Our results show that ageing is likely to explain only partially the rise in health care expenditures. The main explanation is linked to technological progress and better access to innovations for the elderly, through extended recommendations. This explanation has not to do with ageing per se, but with changes in the taking into account of the well-being of the elderly. For ambulatory care, changes in practices for the elderly are not linked to changes in participation behaviour but to changes in conditional consumption. The drift due to changes in practices is much more spectacular for pharmaceutical expenditures than for physician visits, suggesting a large innovation component. These results reveal that the drifts we observe are not due to changes in the behaviours of the elderly, but can rather be linked to the introduction of new products on the health care market.

Our data allow us to split the health care expenditures into 3 components. Therefore, our study is not restricted to hospital expenditures, but also considers ambulatory care. The taking into account of participation in our model allows us to isolate changes that can be due to patients' initiative. Furthermore, the possibility we had to consider separately pharmaceutical expenditures makes it

possible to identify that the upward drift in drug consumption is mainly due to the supply of new products, i.e. to technological progress.

In comparison with studies concentrated on time to death, another advantage of our database is that it provides information about morbidity indicators as well as about vital risk, which is an indicator of probability of death. This allows us : (i) to give evidence of the fact that the health of the elderly is improving, which leads to savings in health care spending, (ii) to evaluate the savings due to changes in morbidity. The negative impact of changes in morbidity is sizeable. It more than compensates the positive shock due to changes in the age structure of the population.

The availability of morbidity indicators for every observed individual allows us to estimate expenditure profiles for all age groups. This makes it possible to provide evidence of the fact that the upward drift linked to changes in practices, which is mainly due to technological progress is increasing with age. A main driver of the rise in health care expenditures has been identified and is mainly under control: changes in practices for a given morbidity.

## 9 Appendix

### Appendix A : the age groups

- 0 : 0-1 years old
- 2 : 2-9 years old
- 10 : 10-19 years old
- 20 : 20-29 years old
- 30 : 30-39 years old
- 40 : 40-49 years old
- 50 : 50-59 years old
- 60 : 60-69 years old
- 70 : 70 years old and older

### Appendix B-1 :the synthetic indicators of morbidity

The level of invalidity :

- 0 : no difficulty
- 1 : very small level of difficulty
- 2 : small level of difficulty
- 3 : experiences difficulties but lives normally
- 4 : must diminish his/her domestic or professional activity
- 5 : diminished activity
- 6 : no domestic autonomy
- 7 : confined to bed

The vital risk :

- 0 : level zero of vital risk
- 1 : very low negative prognosis
- 2 : low negative prognosis
- 3 : possible risk
- 4 : probably negative prognosis
- 5 : surely negative prognosis

The level of vital risk (probability of death within the following 5 years) is elaborated by the IRDES physicians who recode the survey.

The number of pathologies is calculated from the list of pathologies declared by the respondent, coupled with the ones found out by the physicians recoding the survey, on the basis of objective information they have.

## Appendix B-2

### Variables used in the estimations

Participation equation : variables  $X_1$  :

- Age group
- Gender
- Marital status
- Size of household
- Level of education
- Absence of complementary coverage
- Morbidity indicators

Conditional expenditure equation : variables  $X_2$  :

- Age group
- Gender
- Social and occupational group
- Household net income
- Absence of complementary coverage
- Morbidity indicators

## Appendix B-3

**Morbidity indicators used for each type of expenditure, along with the instruments used to test for their exogeneity**

### **Physician expenditures :**

Morbidity indicators : Diabetes, Ischemic heart disease, Hypertension, Circulatory disease, Conditions associated with lipid metabolism, Depression, Sleeping disorder, Arthritis & arthropathy and/or back pain, Number of diseases

Instruments : Individual size, BMI (4 levels, one reference), employment status (3 levels, one reference), an indicator that the individual receives allowances from public assistance, education level (5 levels, one reference)

Sargan test :  $t = 0.129$  ;  $p\text{-value} = 0.9377$

Hausman test :  $t = 15.46$  ;  $p\text{-value} = 0.0790$

### **Pharmaceutical expenditures :**

Morbidity indicators : Chronic obstructive pulmonary disease and related diseases, Ischemic heart disease, Hypertension, Circulatory disease, Arthritis & arthropathy and/or back pain, Number of diseases, Degree of invalidity, Self-assessed health

Instruments : Individual size, BMI (4 levels, one reference), employment status (3 levels, one reference), an indicator that the individual receives allowances from public assistance, education level (5 levels, one reference), Smoking, Alcoholic

Sargan test :  $t = 7.948$  ;  $p\text{-value} = 0.1591$

Hausman test :  $t = 13.90$  ;  $p\text{-value} = 0.0845$

### **Hospital expenditures :**

Morbidity indicators : Ischemic heart disease, Circulatory disease, Conditions associated with lipid metabolism, Depression, Sleeping disorder, Arthritis & arthropathy and/or back pain, Number

of diseases, Death risk, Degree of invalidity

Instruments : Individual size, BMI (4 levels, one reference), employment status (3 levels, one reference), an indicator that the individual receives allowances from public assistance, education level (5 levels, one reference), Smoking, Alcoholic

Sargan test :  $t = 0.812$  ;  $p\text{-value} = 0.6662$

Hausman test :  $t = 12.71$  ;  $p\text{-value} = 0.1762$

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**Appendix C - Table 3 : Bootstrap estimates of the relative size of effects at the macroeconomic level**

Variation 1992-2000	Physicians		Pharmacy		Hospital	
	Mean [Median]	[C. I 95%]	Mean [Median]	[C.I 95%]	Mean [Median]	[C.I 95%]
Total demographic change	5,03 [5,03]	[4,54 ; 5,58]	7,99 [7,97]	[6,87 ; 8,94]	6,16 [6,16]	[4,34 ; 7,98]
<i>Of which</i>						
<i>Structural change</i>	2,08 [2,08]	[1,60 ; 2,62]	4,96 [4,94]	[3,87 ; 5,88]	3,18 [3,18]	[1,41 ; 4,95]
Changes in pract. for a given morb.	2,14 [1,63]	[-10,26 ; 17,20]	45,09 [42,08]	[-4,26 ; 106,86]	22,85 [13,91]	[-34,73 ; 103,10]
Changes in morbidity	1,16 [1,12]	[-0,81 ; 3,20]	-10,63 [-9,88]	[-20,21 ; -3,08]	-14,24 [-12,26]	[-34,45 ; 1,20]
Changes in alphaj	49,69 [49,35]	[3,34 ; 98,19]	67,39 [69,77]	[-7,43 ; 136,01]	-11,68 [-11,53]	[-100,05 ; 84,84]
Other changes	-39,59 [-39,72]	[-83,29 ; -1,25]	-40,19 [-38,68]	[-101,39 ; 11,24]	63,83 [66,75]	[-19,05 ; 123,74]
total	18,42 [18,37]	[11,29 ; 25,67]	69,65 [67,44]	[50,94 ; 92,45]	66,92 [65,75]	[34,78 ; 108,01 ]

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