

Ageing and changes in medical practices : reassessing the influence of demography

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1 Introduction

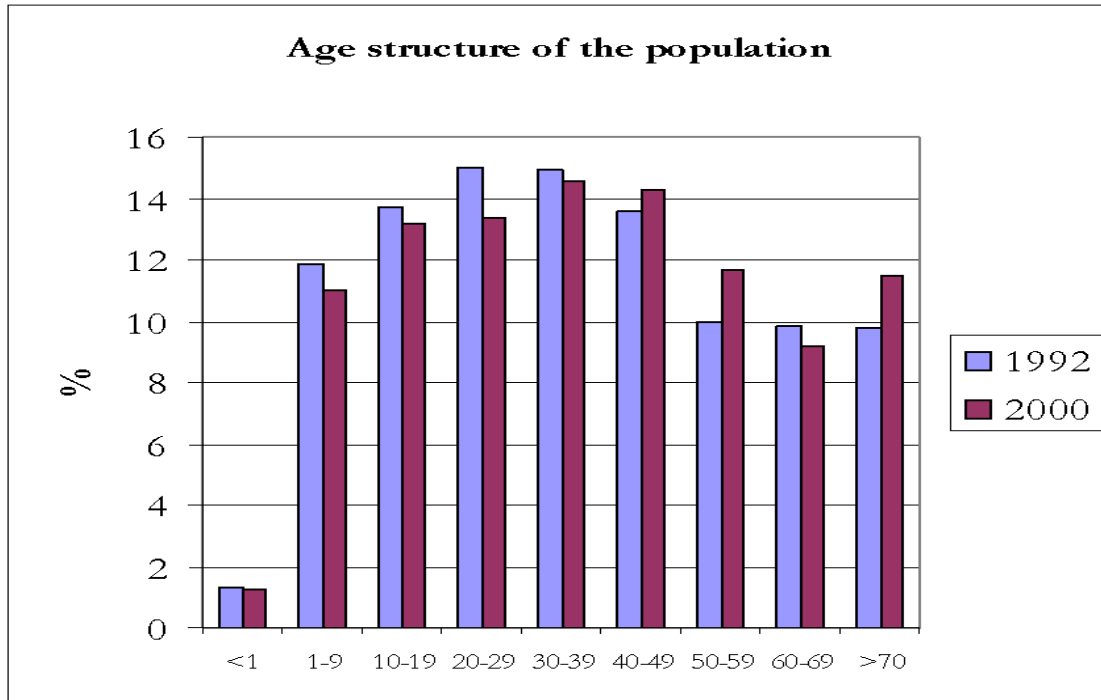
The ageing of population is often referred to as a major determinant of the future evolution of health care expenditures. Indeed, at the individual level, health care expenditures is an increasing function of age. As life expectancy keeps improving in developed countries, the likely growing proportion of elderly people should lead mechanically to an accelerated growth of total health care expenditures.

The consequences of ageing is an issue addressed by numerous macro and micro-economic papers. At the macro-economic level, the vast majority of studies find out that the age structure 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 [1 – 8]. At the individual level, micro-economic studies find out as well that ageing (represented 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 [1, 2, 3].

According to Zweifel et al. [1], the correlation observed between age and health care expenditures would be spurious. Actually, it would result from the fact that the probability of death increases with age, together with the high cost of dying (for Medicare, payments per person-year for decedents are 7 times larger than for survivors ; in France, the corresponding coefficient is equal to 5). Following this analysis, individual health care expenditures would in fact depend exclusively on proximity to death, and not on age.

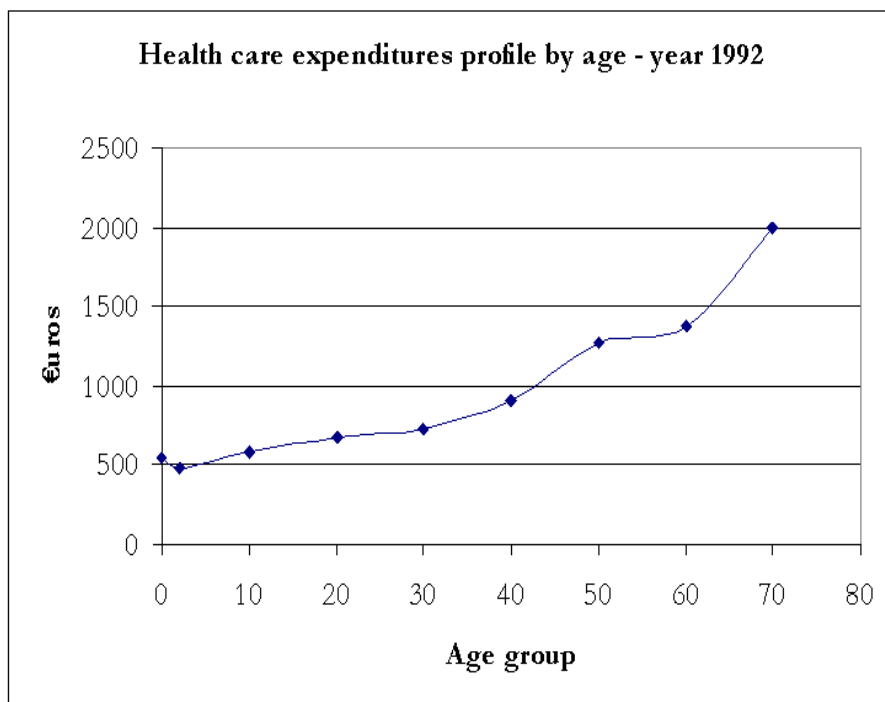
These findings are likely to explain the lack of impact of ageing at the macro level. As stated by Stearns and Norton [4] on the basis of microsimulations, predictions failing to take proximity to death into account might even be misleading, resulting in upward-biased overall simulations.

The effect of ageing on health care expenditures is usually thought as resulting from the combination of two phenomena : the ageing of population (graph 1) and the fact that health care expenditures increase with age (graph 2A¹).



Graph 1 : The age structure of the French population, years 1992 and 2000 - *Source : Eco-Sante*

¹This graph is computed on our sample for the year 1992, see the definition of age groups in appendix A.



Graph 2A : The health care expenditures profile by age, year 1992

Most projections of future health care expenditures available to date simulate the impact of ageing simply by applying demographic previsions to the observed expenditure profile. However, changes in health care expenditure level also depend on changes over time in the profile by age group. Graph 2B presents these profiles computed for the years 1992 and 2000. A sizeable drift can be observed for people aged 40 and over. It is strongly increasing with age. This drift 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 patients, since our data show that they are in better shape with time.

Consequently, the increase in total health care expenditures in France can be explained by three distinct factors : (i) the purely demographic effect (namely, the increase in the proportion of elderly people, given that health expenditure is an increasing function of age) ; (ii) the changes in morbidity at a given age ; (iii) the changes in practices, for a given age and morbidity level (e.g. technological

progress). The aim of this paper is basically to disentangle, evaluate and interpret the respective effects of these three factors. If the technological progress hypothesis were to explain most of the rise in health care costs, it would reflect a collective choice towards allocating more health care to the elderly, coupled with improved technical feasibility.

We make use of micro data in order to evaluate the compared effects of these 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.

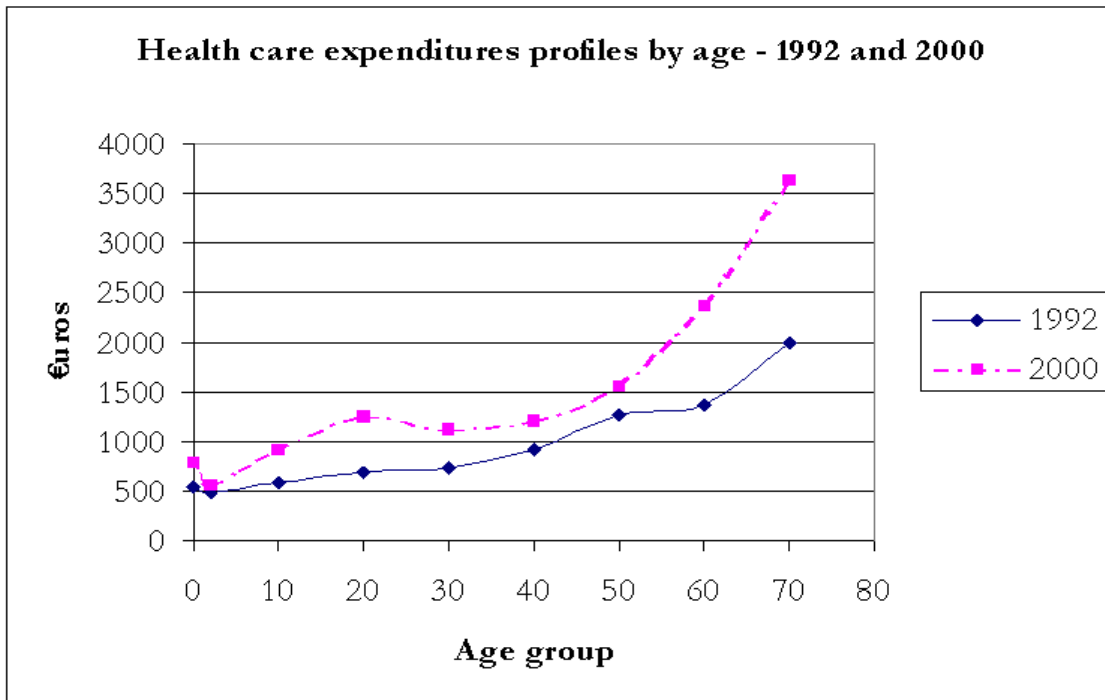
As for the profile drift, we use microsimulation techniques in order to identify its components over the period 1992-2000. More precisely, we evaluate the respective influences of changes in morbidity and changes in practices, for a given level of morbidity. Our results show that changes in morbidity induce a downward drift of the health care expenditures profile, whereas the drift due to changes in practices is upward and sizeable.

Once having disentangled these various effects, we apply our microsimulations to the age structure of the French population in order to finally evaluate, for the period 1992-2000, the effects of demographic changes and profile drifts. At this macroeconomic level, 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 4.6 times larger than the rise in health care expenditures due to demographic changes. Considering a broader definition of changes in practices (including other changes), we find that their impact is even 6.4 times larger than the rise in health care expenditures due to demographic changes.

In comparison with studies concentrated on time to death [2, 3, 1], our database presents the advantage of providing information not only about "vital risk", which

is an indicator of death proximity, but also about several other morbidity indicators. Furthermore, rather than studying only hospital expenditures, like Seshamani et al. [2, 3] or aggregate individual expenditures, like Zweifel et al. [1], 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 very much influenced by technological progress, unlike physician visits.

The paper is organized as follows. In the next section, we present the French health care system and discuss the access to care of the elderly. Then, we present the sample and variables (section 3) and the basic features of the data (section 4). The empirical approach is presented in section 5 and the results in section 6. In section 7, we use microsimulations in order to evaluate the respective impact of ageing and changes in practices at the macro level. Section 8 concludes.



Graph 2B : health care expenditures profiles by age groups in years 1992 and 2000

2 The French health care system: the access to care of the elderly

2.1 The public health insurance

In France, about 99% of the population is covered by the universal public health insurance system, which covers about 70% of individual health care expenditures. The remaining 30% (co-payment) can be covered, partially or totally, by private supplementary coverage, subscribed on a voluntary basis or offered by the employer. Over the 1992-2000 period, 80% of the population was covered by such a supplementary coverage.

In France, ambulatory care is mainly provided by private (self-employed) physicians. Hospital care is provided by public hospitals (2/3 of stays) or private hospitals (not-for-profit as well as for-profit) [5]. Self-employed physicians receive fee-for-service

payments for ambulatory care and services provided in private hospitals. Physicians are salaried when working in public hospitals, which are financed by a global budget.

French insured citizens have free access to care ; indeed, the cost of home and office visits is covered without frequency restriction. Not only are visits and hospitalization covered, but also prescriptions, including drugs. This contrasts strongly with Medicare. Indeed, this insurance scheme, which concerns retired people aged 65 and over in the US, does not cover prescribed drugs for ambulatory care.

In France, the same public health insurance system covers both retired and active people, making no difference between them. This is another difference with the US health care system, where universal public health care insurance is available only for people aged 65 and over and for low-income disabled individuals.

The French elderly are well covered. Therefore, they do not face financial constraints which could limit their access to health care. In addition, since they have been well covered their whole life before turning 65, there is no reason why health care expenditures should rise at this age (this rise can indeed be observed in the US, where people can delay care until they become eligible for Medicare). On the whole, coverage is continuous over the lifetime. It is thus unlikely to influence the profile of health expenditures by age group².

2.2 The pharmaceutical prescriptions

As for drugs, any innovation is submitted first to authorization and then to possible coverage by the public health insurance. There is a bargaining between pharmaceutical firms and the health insurance administration in order to determine the level of coverage and set the price of the new medicine. In France, the levels of drug prices

²A small effect of coverage can be seen because the coverage by supplementary insurance has extended recently and is not equal to 80% for the oldest individuals of the population. Therefore, together with the future ageing of population, a rise will be observed in the average coverage, which could explain a rise in HCE (Grignon, 2003).

are slightly lower than in comparable developed countries. In addition, since the fixed price is in general not adjusted afterwards, the price index for drugs is decreasing. However, at the global level, the overall value of drug prescriptions is growing rapidly because of the rising prices of innovations newly allowed on the market. On the whole, whereas the total number of physicians' visits increased by 18% between 1992 and 2000, the total pharmaceutical expenditures increased by 59% in volume [6].

2.3 The case of the elderly

As stated above, elderly people are covered just like everyone else. As everyone has free access to care, at low financial cost, behaviors can be subject to what is called "moral hazard". A characteristic of the period we are interested in is the modification of the medical practices and recommendations, notably concerning the aged. We think particularly of the development of cholesterolemia medication recommendations for the oldest old, or of the prodigious development of cataract surgery, now occurring at very early stages of the illness : between 1993 and 1999, the number of cataract surgeries increased by 44% [7]. These procedures might indeed lead to higher costs, but to considerably better well-being for the elderly.

3 Sample and variables

3.1 The survey

We make use of a micro-economic data set concerning 3265 insured French citizens for the year 1992 and 4804 for the year 2000. This data set results from a survey (*SPS*, i.e. *Santé Protection Sociale*) conducted by IRDES ³ on a subsample drawn

³Formerly CREDES, Research and Information Center for Health Economics, 10, rue Vauve-nargues, 75018 Paris, France

from administrative data⁴ provided by the French public health insurance, which records every health expenditure submitted to reimbursement.

The sample gives us reliable information about each individual's health care expenditures, social protection (existence of supplementary insurance coverage), morbidity and socio-demographic characteristics (e.g. age, social and occupational group, net income). The sample is exclusively composed of people living in regular households. Therefore, our study does not cover the field of long-term care, which essentially concerns people living in institutions.

3.2 The measure of health care expenditures

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, 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 coefficient⁵ 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 the price of innovations, 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 gen-

⁴EPAS (i.e. *Echantillon Permanent d'Assurés Sociaux*), recorded by the French public health insurance of employed workers (*CNAMTS*), which covers about 83% of the population [5]

⁵Source : DREES and Ecosanté

eral 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.

3.3 The measure of morbidity

The survey provides information about several indicators of morbidity. We observe for each individual his or her number of pathologies, level of invalidity and level of vital risk. These indicators are detailed in appendix A. The exogeneity of these individual morbidity indicators in our models might seem questionable. Indeed, we will use them as explanatory variables of the use of health care services. Since these indicators result from answers of the individual to the survey, they are affected by subjective appreciation and may be correlated with individual unobserved heterogeneity. Notice, however, that physicians check the survey and correct for discrepancies between objective information (e.g., type of medication taken) and health status declaration. Furthermore, previous studies having used the same dataset have shown that the hypothesis of exogeneity of these indicators cannot be rejected [8]. We will thus consider them as acceptable measures of individual health condition.

4 Basic features of the data

4.1 Descriptive analysis

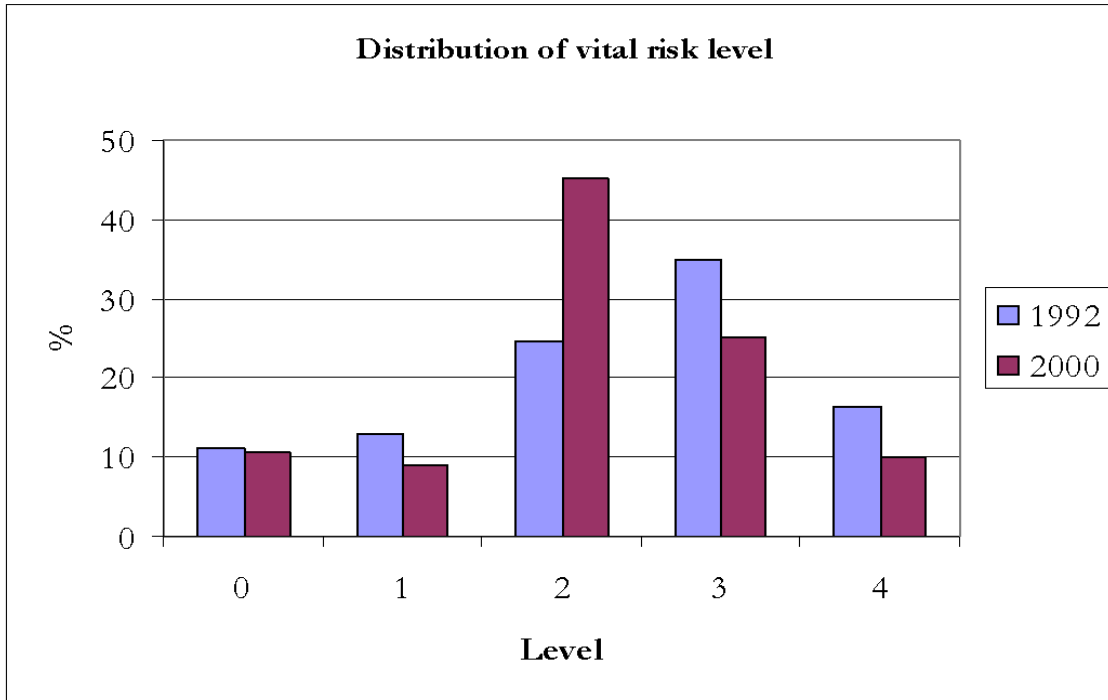
In this subsection we describe the sample we are working on. The basic features of the sample are presented in Table 1. In the following subsection, we show that the changes in the distribution of morbidity levels confirm that health is globally improving. Then, graphs representing the changes in the levels of expenditures, conditionally and unconditionally on participation, coupled with the changes in participation rate, clearly show the interest of analysing separately the three kinds of expenditures we are interested in.

| | 1992 | 2000 |
|----------------------------------------------------------|---------|---------|
| N | 3265 | 4804 |
| Average age | 34,11 | 34,01 |
| % women | 54,14% | 50,55% |
| Average number of pathologies per individual | 3,29 | 3,23 |
| Average HCE per capita (current FF) | 3674,58 | 5152,39 |
| Participation rate | 85,88% | 91,96% |
| - The structure of HCE - | | |
| HCE studied (% of total HCE) | 84,04% | 88,08% |
| Proportion of physicians' expenditures in studied HCE | 47,91% | 42,92% |
| Proportion of pharmaceutical expenditures in studied HCE | 33,77% | 35,99% |
| Proportion of hospital expenditures in studied HCE | 18,31% | 21,08% |
| Rise in physician expenditures (1992-2000) | | 12,81% |
| Rise in pharmaceutical expenditures (1992-2000) | | 43,52% |
| Rise in hospital expenditures (1992-2000) | | 35,73% |
| Total rise in mean HCE studied (1992-2000) | | 27,38% |
| Of which : | | |
| Contribution of physician expenditures | | 6,14% |
| Contribution of pharmaceutical expenditures | | 14,70% |
| Contribution of hospital expenditures | | 6,54% |

Table 1 : Characteristics of the sample

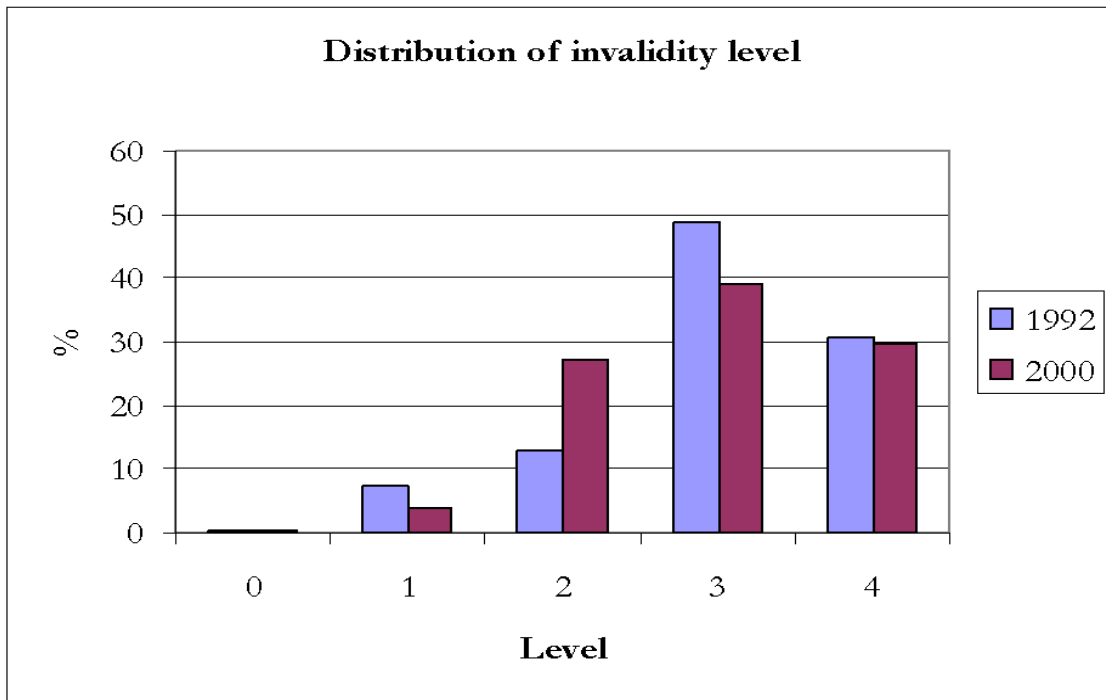
4.1.1 Changes in morbidity between 1992 and 2000

As we saw on Graph 1, the French population has gradually been ageing between 1992 and 2000. But health condition is slightly improving : graphs 3 and 4 present the distributions of vital risk and invalidity levels for people aged 50 and older for both years. It appears clearly that the proportion of people having high levels of morbidity is dropping⁶.



Graph 3 : Distribution of the level of vital risk by year, people 50 and more

⁶Highest levels of invalidity (levels 4 and up) and vital risk (levels 4 and up) have been grouped.



Graph 4 : Distribution of the level of invalidity by year, people 50 and more

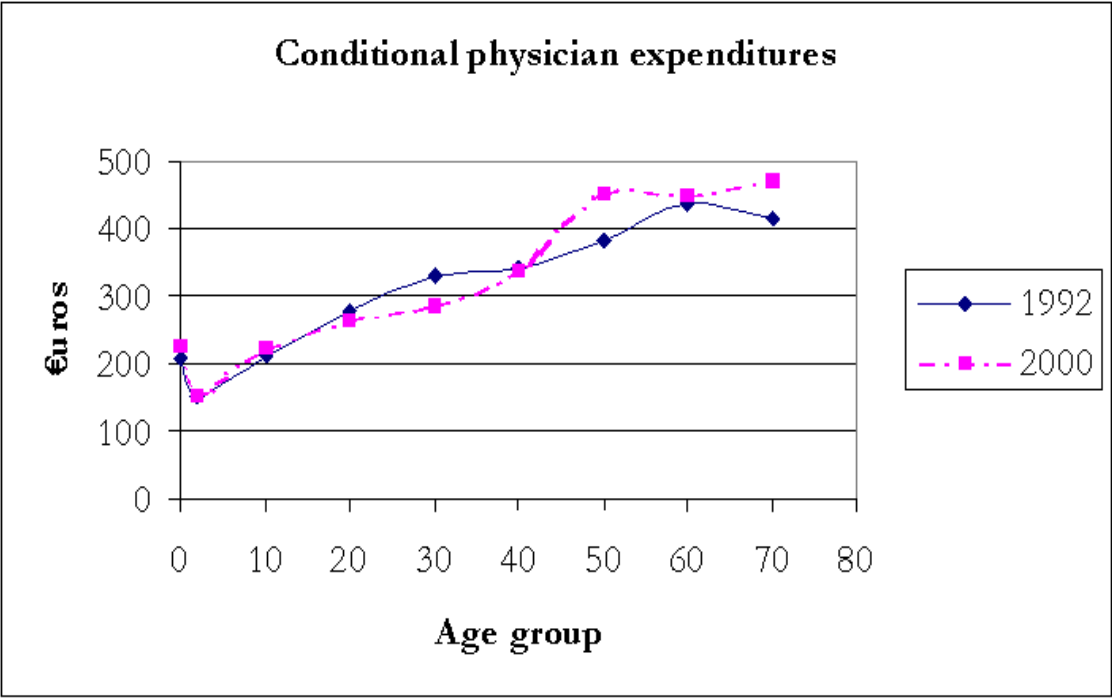
4.1.2 Profiles by age of conditional health expenditures

Graphs 5A, 5B and 5C display the average health care expenditures by age group for the years 1992 and 2000, for each kind of expenditure we are interested in. We present here the conditional mean, i.e. the mean computed over the individuals who actually used health care services. These graphs show the health care expenditures profile and its changes between 1992 and 2000.

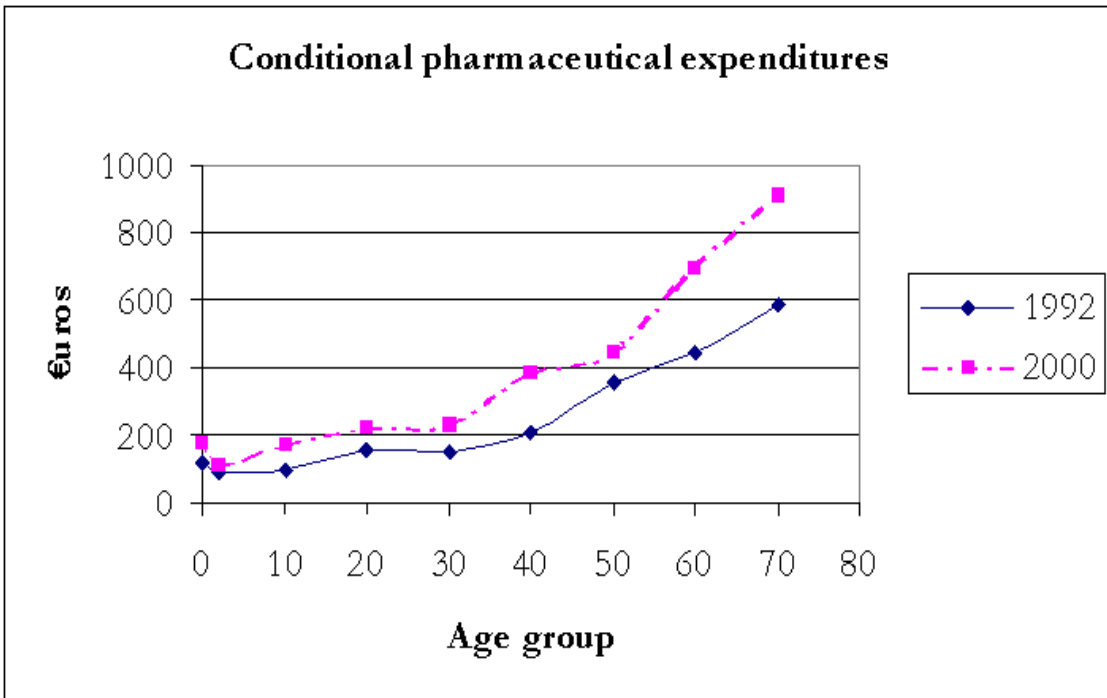
For ambulatory care (physician and pharmaceutical expenditures), the profile is clearly increasing with age. A noticeable upwards drift of this profile between the years 1992 and 2000 is noticeable for people aged 40 and over. While both are increasing with age, this drift is much larger for drugs than for physician visits.

As for hospital expenditures, there is a clear increase with age of the profile for people aged 60 and over, but no upward drift is clearly noticeable. A downward shift is even visible for people aged 30 to 59. This absence of an upward shift of the profile might be attributed to the global budget used in France for the financing of hospitals. Indeed, a very low growth of the global budgets during the

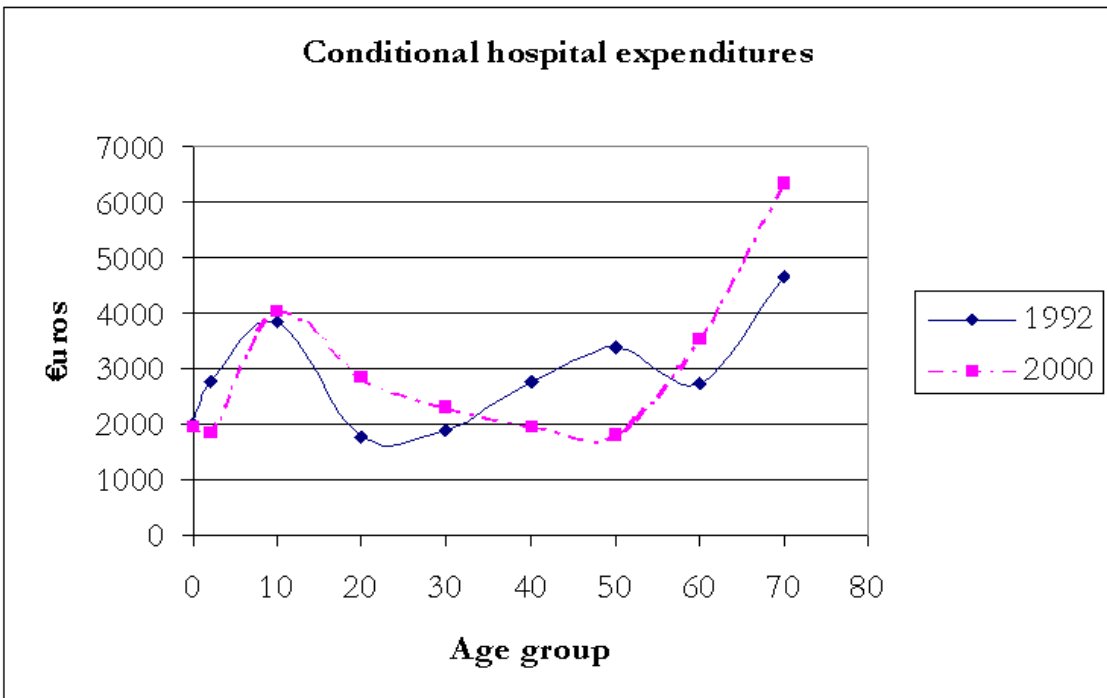
years 1995-2000 induced a severe financial constraint for public hospitals. However, we need more thorough investigations to confirm such an interpretation.



Graph 5A : Conditional physician expenditures by age group



Graph 5B : Conditional pharmaceutical expenditures by age group



Graph 5C : Conditional hospital expenditures by age group

4.1.3 Profiles by age of the participation rates

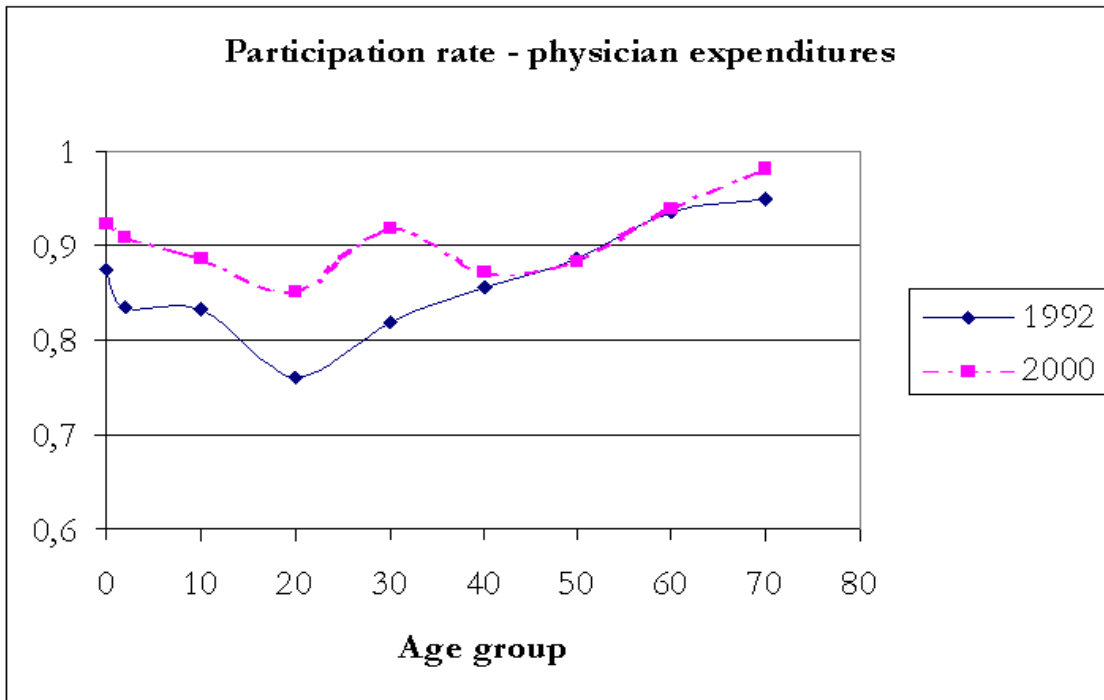
The average participation rate (proportion of health care users) by age group is presented in graphs 6A (physician expenditures), 6B (pharmaceutical expenditures) and 6C (hospital expenditures). We first notice the high proportion of non-users (80% to 90%) as concerns hospital care. The proportion of non-users is much smaller for ambulatory care and drugs (10% to 30%) but not negligible.

The profile is increasing : the participation rate is increasing with age.

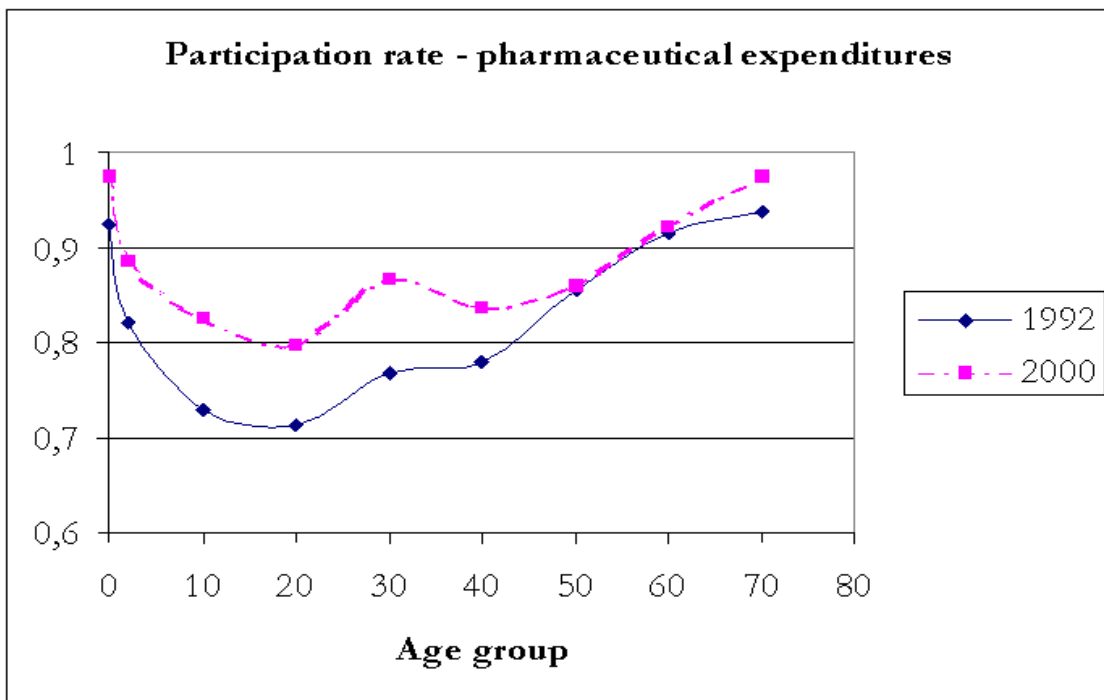
As for ambulatory care, a slight upwards drift is visible for people aged 70 and older (graphs 6A and 6B). However, the most noticeable upwards drift is the one visible for people aged 39 and younger. An explanation of this phenomenon could be the existence of induced demand, linked to the regulation of the ambulatory care sector in France. Indeed, physicians are paid according to a fee-for-services scheme with exogenously fixed fees, and during the period 1992-2000 the physician:population ratio was very high and even increasing [9]. However, we also need more thorough investigations to assess such an interpretation.

Turning to the use of hospital care, we observe an upwards drift. The use of hospital is thus increasing between 1992 and 2000. This drift is visible for every age group but more pronounced for the elderly.

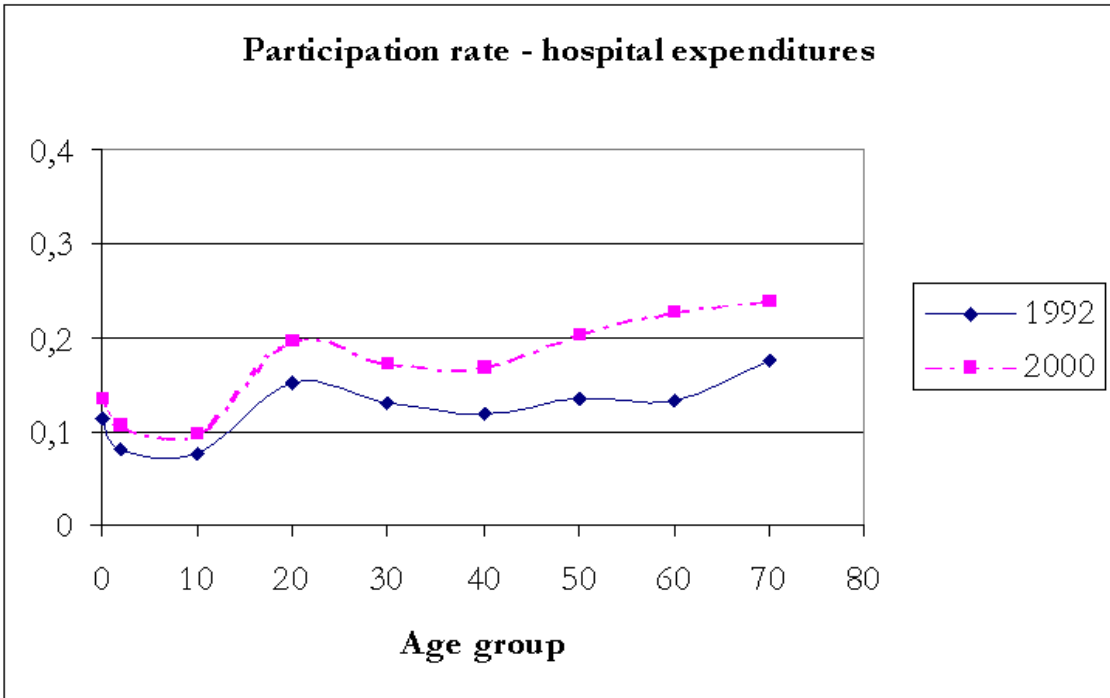
On the whole, observing simultaneously the average conditional expenditures and participation rate for ambulatory care, it appears that the less than 40 year-olds and the more than 40 year-olds have behaved differently between 1992 and 2000. The former had their participation rise and their consumption remain somewhat stable, whereas the latter had their participation remain stable and their consumption rise.



Graph 6A : Average participation rate by age group - physician expenditures

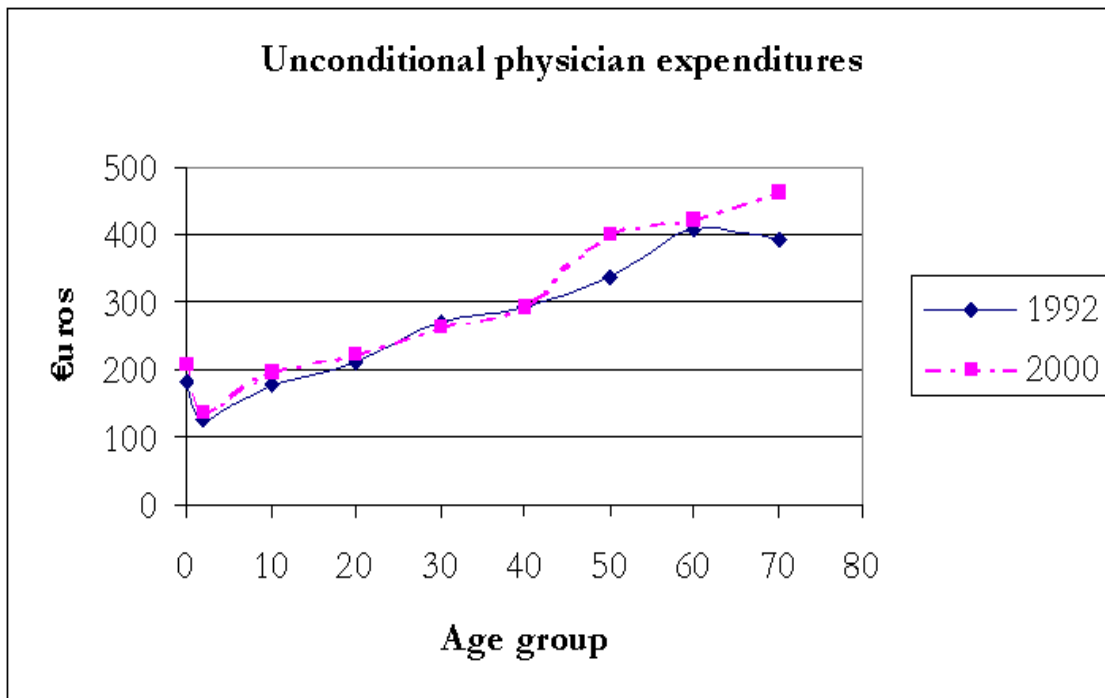


Graph 6B : Average participation rate by age group - pharmaceutical expenditures

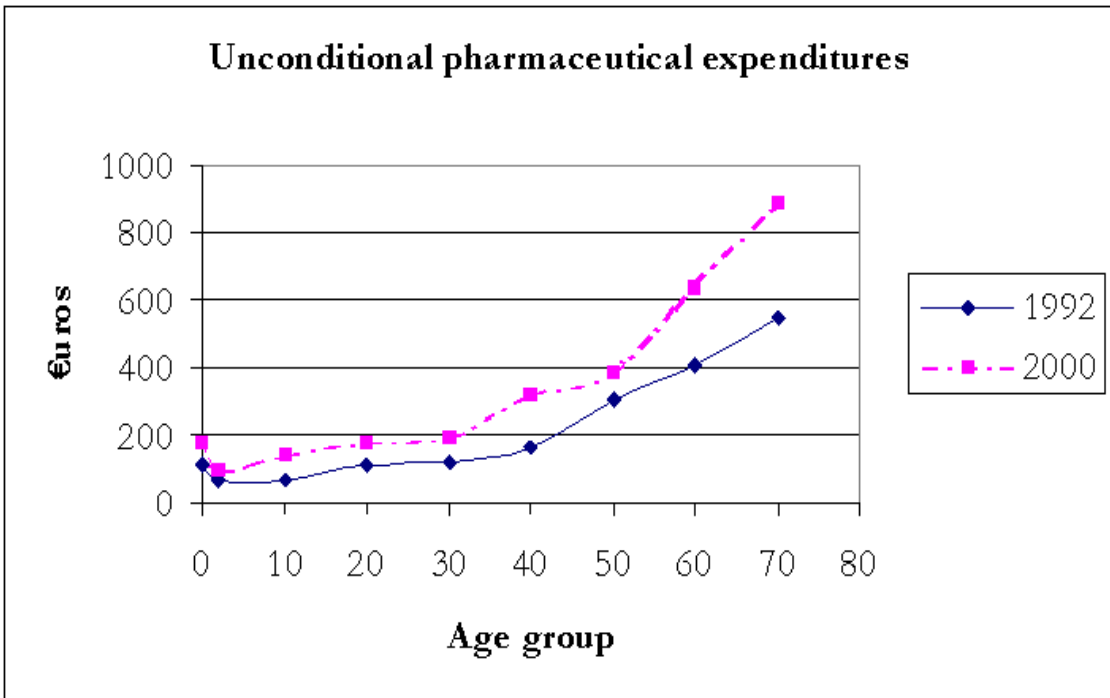


Graph 6C : Average participation rate by age group - hospital expenditures

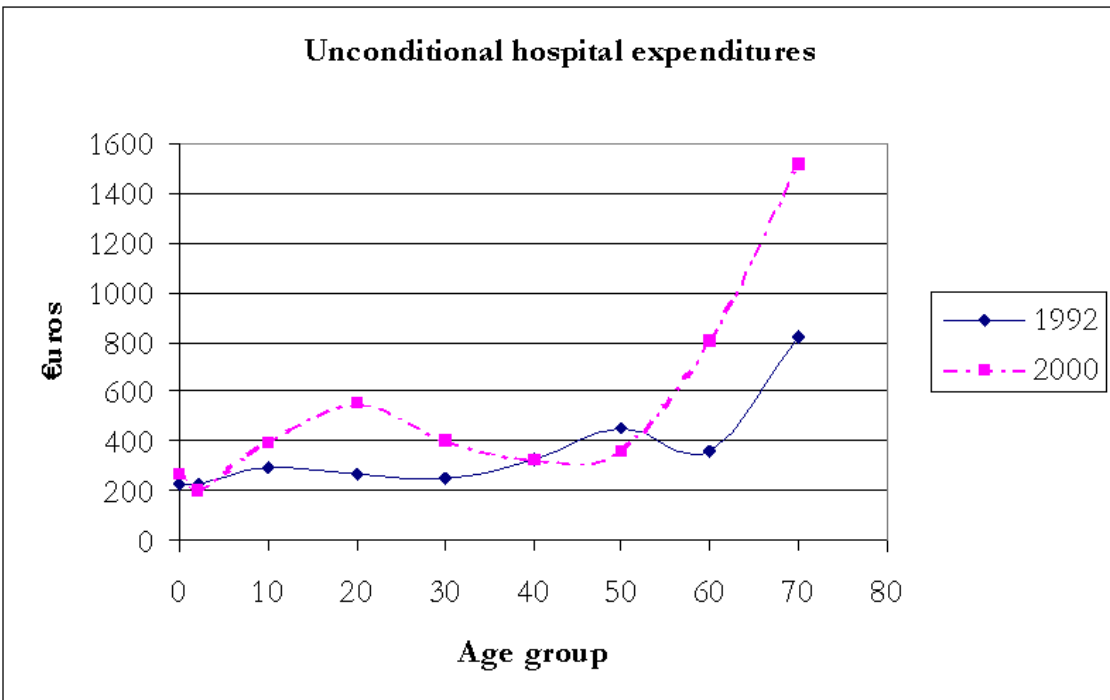
4.1.4 Profile by age of unconditional health care expenditures



Graph 7A : unconditional physician expenditures by age group



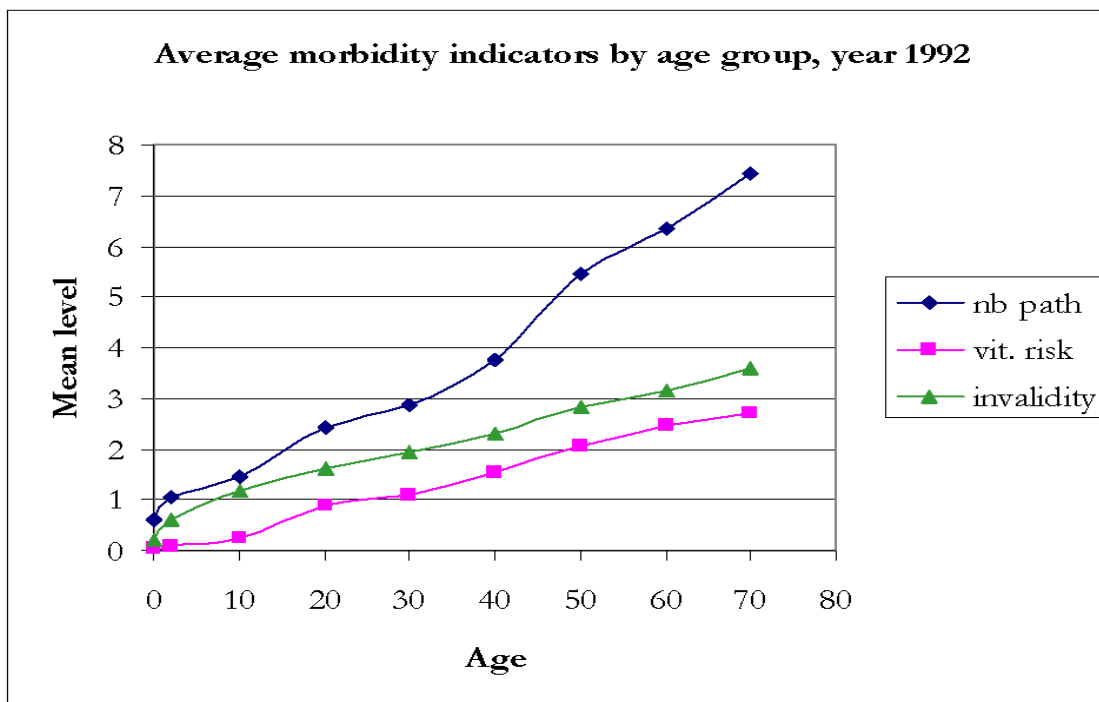
Graph 7B : unconditional pharmaceutical expenditures by age group



Graph 7C : unconditional hospital expenditures by age group

4.2 The influence of morbidity on the health care expenditures profile by age

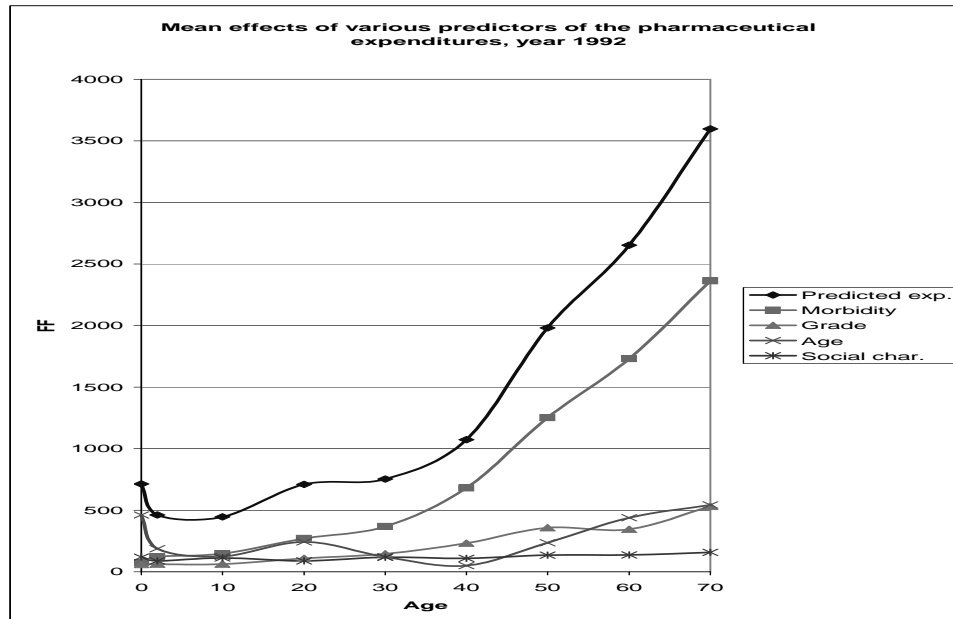
As we can see on graph 8, morbidity increases strongly with age. The average number of diseases, level of vital risk and level of invalidity increase with age.



Graph 8 : Average number of pathologies, vital risk and invalidity by age group, year 1992

Actually, morbidity is by far the main determinant of the health care expenditures profile by age group, far beyond any other explanatory factor. A simple OLS analysis performed on untransformed data shows us that the increase in morbidity with age explains the major part of the expenditures profile by age. Graph 9 presents, for the year 1992, the prediction of this profile obtained by the estimation of such a model, and the respective effects of the various groups of explanatory variables (a comparable graph can be obtained for the year 2000 and for other types of expenditures). It can be seen that the level of expenditures rises strongly with age, and that this increase is explained almost entirely by the increase in morbidity with age. 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 age⁷.



Graph 9 : Effects of different predictors of HCE (drugs, year 1992)

5 The 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 two 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

⁷Note : we included the variable "grade" (grade of self-assessed health) in this purely descriptive analysis, but this variable was dropped in our central work because of its lack of reliability.

of changes in practices between 1992 and 2000, for a given level of morbidity. 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 simulations.

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 (Graph 6C). As regards consultations and drugs, the proportion of non-users is smaller, but not negligible (Graphs 6A and 6B). Such a configuration requires specific estimation techniques. Many papers addressed the issue of the choice between the sample-selection model (Heckit [10]) and the two-part model [11, 12, 13]. Monte Carlo studies implemented by Manning, Duan and Rogers [13] 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 [12] 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:

$$P_{ij} = \mathbf{1}_{P_{ij}^* > 0} \quad \text{with} \quad P_{ij}^* = W_{ij}'c + M_{ij}'b + a_j + u_{1,ij} = X_{1,ij}'d + u_{1,ij} \quad (1)$$

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

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

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) [10].

$X'_{1,ij}$ 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 α_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) [14].

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 the 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 $\text{Log}(C_{ij})$. The log transformation reduced the skewness in the dependant variable to small values such as, for instance, -0.14 for consultations expenditures, -0.06 for drugs and -0.77 for hospital in 2000. 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 :

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

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 [15] suggested to use a non parametric "smearing estimator", where $\int \exp \{ u_{2,ij} \} dF(u_{2,ij})$ is estimated by $\hat{\psi}$ defined by [16]: $\hat{\psi} = \frac{1}{N} \sum_{i=1}^N \exp \{ \hat{u}_{2,ij} \}$. Following this definition, we can estimate:

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

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. In this case, we can estimate:

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

$$\text{with : } \hat{\psi}' = \frac{1}{N} \sum_{i=1}^N \exp\left\{\hat{w}_{ij}\right\}.$$

However, 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 [15], Manning and Mullahy [17] and Mullahy [18] suggest to use alternative procedures.

Since heteroscedasticity is likely to be introduced by the taking into account of the inverse Mill's ratio [19], we performed a Breusch-Pagan test to check whether the disturbances w_{ij} of (6) were homoscedastic or not. Except for hospital expenditures, most of the tests rejected the homoscedasticity hypothesis. In these cases, we assumed a normality distribution for $w_{i,j}$, which leads to the simple retransformation formula $\exp\left\{\frac{1}{2}\sigma_{w,i}^2\right\}$. This can be applied through the use of an estimator $\hat{\sigma}_{w,i}^2$ obtained by the identification of the variance function of the error $w_{i,j}$. For that purpose, we estimated 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 $\hat{\sigma}_{w,i}^2$ is then defined by:

$$\hat{\sigma}_{w,i}^2 = V'_{ij}\hat{\theta} \quad (8)$$

To check whether we had correctly identified the variance function of $w_{i,j}$, we applied the weighted least squares to (6) and performed a Breusch-Pagan test on the transformed model. These tests always led not to reject the homoscedasticity hypothesis, therefore validating the estimation (8). Notice, however, that we used expression (6) and not the weighted specification to compute the predicted expenditures. On the

whole, in the case of heteroscedasticity⁸, we predicted the expenditures following the expression:

$$\hat{E}(C_{ij} | P_{ij} = 1; X_{2,ij}) = \exp \left\{ X'_{2,ij} \hat{\delta} + \hat{\mu} \hat{\lambda}_{ij} \right\} \cdot \hat{\psi}'' \quad , \quad (9)$$

with $\hat{\psi}'' = \exp \left\{ \frac{1}{2} \hat{\sigma}_{w,i}^2 \right\}$ and $\hat{\sigma}_{w,i}^2$ defined by (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 (9) 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:

$$\hat{\pi}_{ij}^{92,92} = \Phi \left(X'_{1,ij} \hat{d}_{92} \right) = \Phi \left(W'_{1,ij} \hat{c}_{92} + M'_{ij} \hat{b}_{92} + \hat{a}_{j,92} \right)$$

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

$$\hat{\pi}_{.j}^{92,92} = \Phi \left(X'_{1,j} \hat{d}_{92} \right) = \Phi \left(W'_{1,j} \hat{c}_{92} + M'_{.j} \hat{b}_{92} + \hat{a}_{j,92} \right) \quad (10)$$

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.

⁸In that case, we used asymptotic standard errors estimators robust to heteroscedasticity (White (1980) [20]) to perform the significancy tests of the coefficients of (6).

Given the role of morbidity on the expenditure profile (see section 4.2), 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 (10):

$$\hat{\pi}_{.j}^{m92.b00} = \Phi \left(W_{1,j}^{92} \hat{c}_{92} + M_{.j}^{92} \hat{b}_{00} + \hat{a}_{j,92} \right) \quad (11)$$

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, $M_{.j}^{00}$:

$$\hat{\pi}_{.j}^{m00.b00} = \Phi \left(W_{1,j}^{92} \hat{c}_{92} + M_{.j}^{00} \hat{b}_{00} + \hat{a}_{j,92} \right) \quad (12)$$

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

$$\hat{\pi}_{.j}^{00.00} = \Phi \left(X_{1,j}^{00} \hat{d}_{00} \right) = \Phi \left(W_{1,j}^{00} \hat{c}_{00} + M_{.j}^{00} \hat{b}_{00} + \hat{a}_{j,00} \right) \quad (13)$$

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 (9) to compute⁹ $(C|P)_{.j}^{92.92}$, $(C|P)_{.j}^{m92.b00}$, $(C|P)_{.j}^{m00.b00}$ and $(C|P)_{.j}^{00.00}$. On the contrary, we did not find significant selection bias or heteroscedasticity for hospital and thus used expression (5) to compute the simulations.

To sum up :

⁹Notice that because of the taking into account of heteroscedasticity, there are explanatory variables (such as the morbidity indicators) and coefficients subject to be changed in the term ψ'' of expression (9), in order to compute the various steps of the simulations .

- 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.

What we call 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 [21].

The effects of changes in practices can be seen in changes in the estimated coefficients \hat{b} and $\hat{\beta}$, which measure the influence of morbidity on the participation rate and level of 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 $\hat{\alpha}_j$.

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 Results

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 participation¹⁰. 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 52 % and 73 %. The effect of a vital risk equal to 3 or 4 on the conditional pharmaceutical consumption is 31 % or 77 %. 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 for each of the three components of health care services¹¹. 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 and age dummies. 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 [12], we computed, for each year and health expenditure component, the R^2 of the regression of the inverse Mill's ratios λ_{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 hospital¹².

Table 4 in appendix B displays, for each year and health expenditure component,

¹⁰Detailed results are available on request.

¹¹Its impact is not significant only for participation to hospital care services.

¹²These values are much smaller than the R^2 equal to 0.9997 obtained by Seshamani and Gray [3] running on their data the approach of Zweifel et al. [1]

the estimated coefficients of the inverse Mill's ratios as well as the p-values for significance tests. 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 ρ 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 (therefore, $\rho = 0$).

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

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 obtained are displayed on graphs 10, 11 and 12, A to C. The cor-

responding changes are computed, for the unconditional expenditures, in table 2. These results show that :

- The effect of changes in morbidity on health care expenditure profile is always negative
- The strongest positive effect arise from the changes in practices for a given morbidity. This drift is increasing with age, especially for ambulatory care.

Results are slightly different as concerns ambulatory care (physician and pharmaceutical expenditures) on one side and hospital care on the other side, and deserve separate comments.

6.1 Ambulatory care

The descriptive analysis has shown that ambulatory care stands for 78.91% of the level of studied health care expenditures. Its growth contributes as 76.11% to the rise in health care expenditures between 1992 and 2000 $((14.70+6.14)/27.38$, see Table 1).

For ambulatory care, the bulk of changes are essentially due to changes in expenditures conditional on participation and not to changes in participation. This appeared clearly in graphs 5 to 7, A to C and in table 5 in the appendix.

Results clearly differ for people before and beyond 40 years of age.

6.1.1 People aged 40 and over

Very small changes in participation can be observed for people aged 40 and older (see graphs 11A and 11B), whereas a sizeable drift in the profile by age can be observed between 1992 and 2000 for conditional expenditures, and consequently for unconditional expenditures. See for example graphs 10A, B and 12A, B.

- As concerns physician expenditures, simulations show a sizeable drift due to changes in practices for a given level of morbidity (see graph 10A, changes from the profile p92b92 to the profile p92m92.00). These changes are increasing with age.

Changes in morbidity induce a downward drift of the profile which partly compensates the positive influence of changes in practices (see graph 10A, changes from the profile p92m92.00 to the profile p92m00.00).

- Pharmaceutical expenditures rise tremendously : + 43.52% between 1992 and 2000 (see table 1). Consequently, they contribute to more than 50% to the rise in health care expenditures between 1992 and 2000 (14.70/27.38, see Table 1). 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" (see graph 10B, changes from p92b92 to p92m92.00, and from p92m00.00 to p00b00). 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 was observed for physician expenditures. This can be observed in table 2 and by comparing graphs 10A and 10B, 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. There is thus a large innovation component in this observed drift. These results concern pharmaceutical expenditures, which are responsible for more than half 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 can rather be linked to the supply of new products on the health care market.

6.1.2 People younger than 40

For people younger than 40, the only noticeable change that occurred is mostly related to the participation rate, which is rising between 1992 and 2000. The upward drift is not explained by changes in practices for a given level of morbidity, nor by changes in morbidity (see graph 11A, B, changes from p92b92 to p92m92.00 and to p92m00.00). It rather appears as the outcome of other changes in practices and

behaviours. In any case, the influence on the expenditures profile of these changes in participation is negligible. Indeed, there is no noticeable difference for young people between graphs 10A, B and 12A, B.

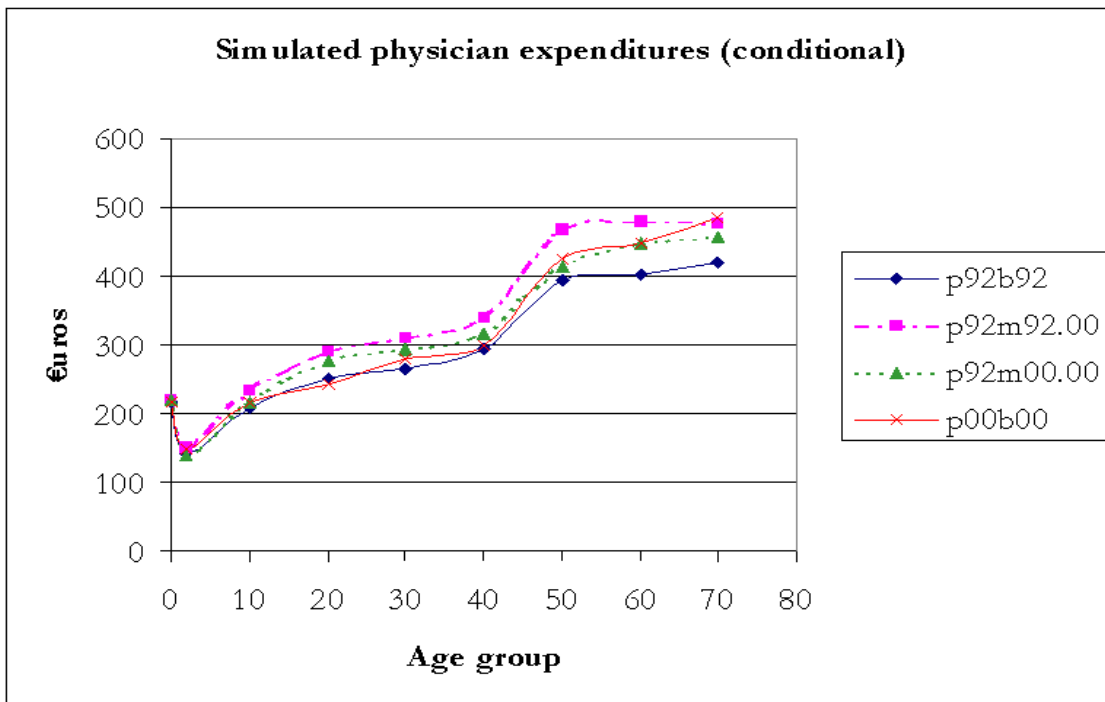
6.2 Hospital care

As stated above, hospital care stands for 21.08% of the health care expenditures level. Its growth contributes as 23.89% to the rise in health care expenditures between 1992 and 2000 (6.54/27.38, see Table 1).

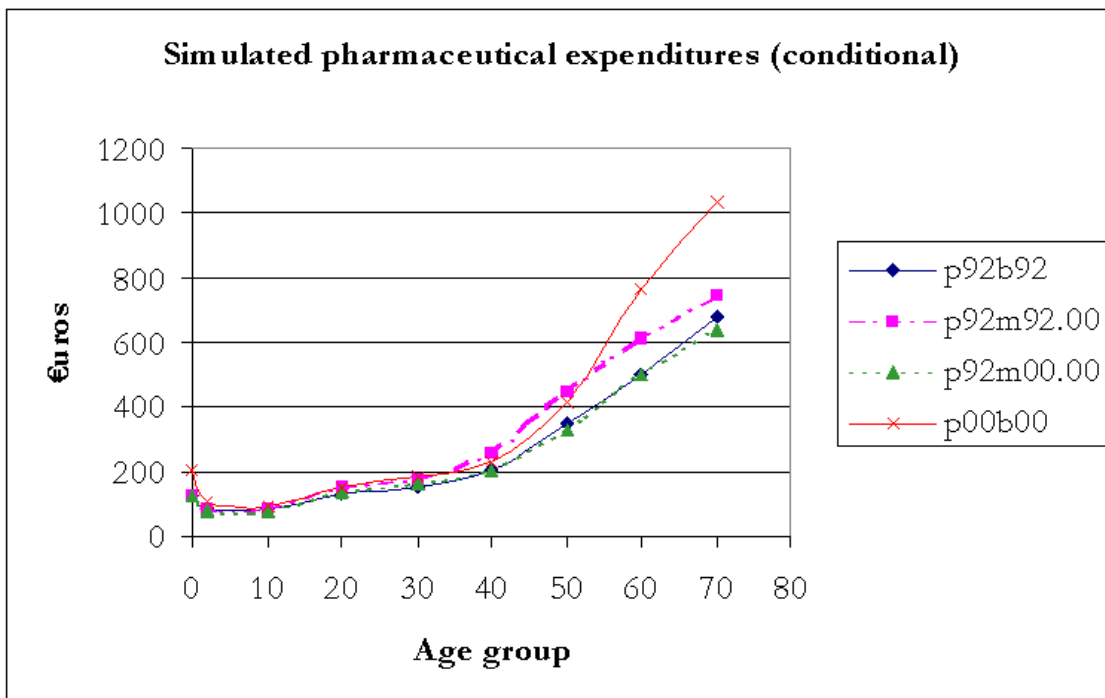
What is observed for hospital care contrasts strongly with ambulatory care. Indeed, the bulk of changes is now due to a drift in the participation profile by age (see graph 6C and table 5 in the appendix). The drift in participation rates is observed for every age group, but appears to be increasing with age (see graph 11C). Our simulation shows that this upward drift is entirely due to changes in practices for a given level of morbidity (see graph 11C, changes from p92b92 to p92m92.00).

As for unconditional expenditures (Table 2), 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 : + 179.27% (see table 2). This jump is only visible on graph 12C (unconditional expenditures), since it is only due to a change in participation behaviour, which is entirely due to changes in practices for a given level of morbidity (graph 11C). 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 [2, 3, 1]. Indeed, the dependent variables of these studies is reduced to hospital care as concerns Seshamani & Gray [2, 3] or mainly influenced by hospital expenditures as concerns Zweifel, Felder & Meiers [1]. However, the jump we observe is only due to changes in participation, not linked to changes in morbidity level when people are close to death. Therefore the

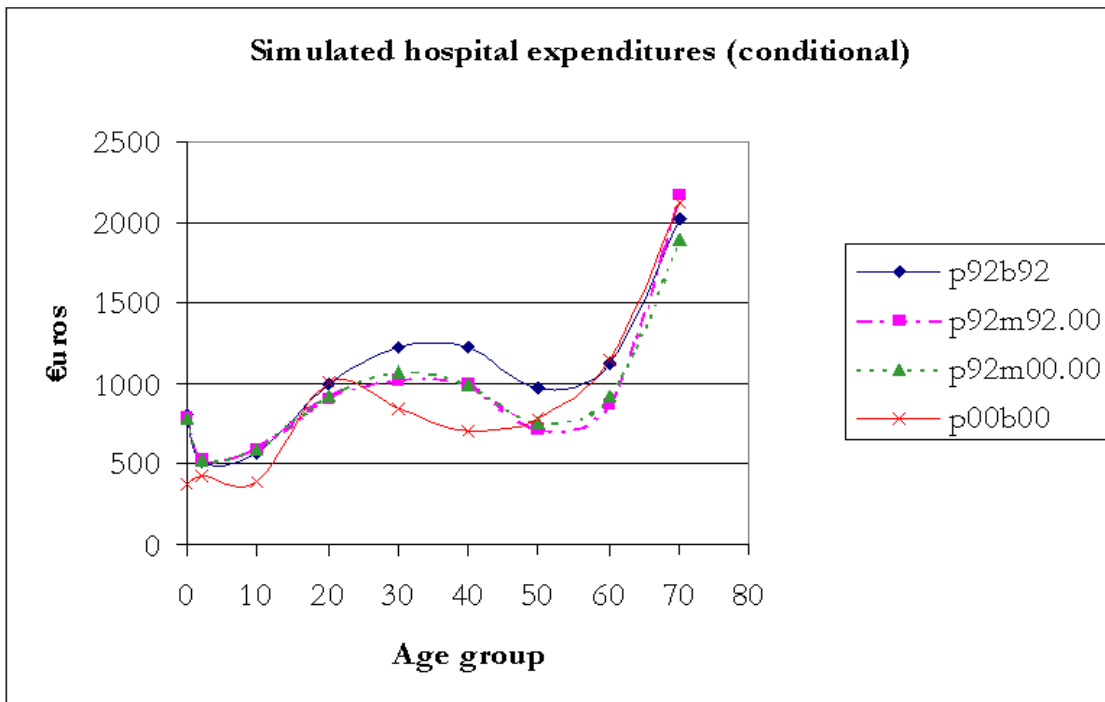
interpretation is radically different.



Graph 10A : Simulated profiles : physician expenditures (conditional)



Graph 10B : Simulated profiles : pharmaceutical expenditures (conditional)



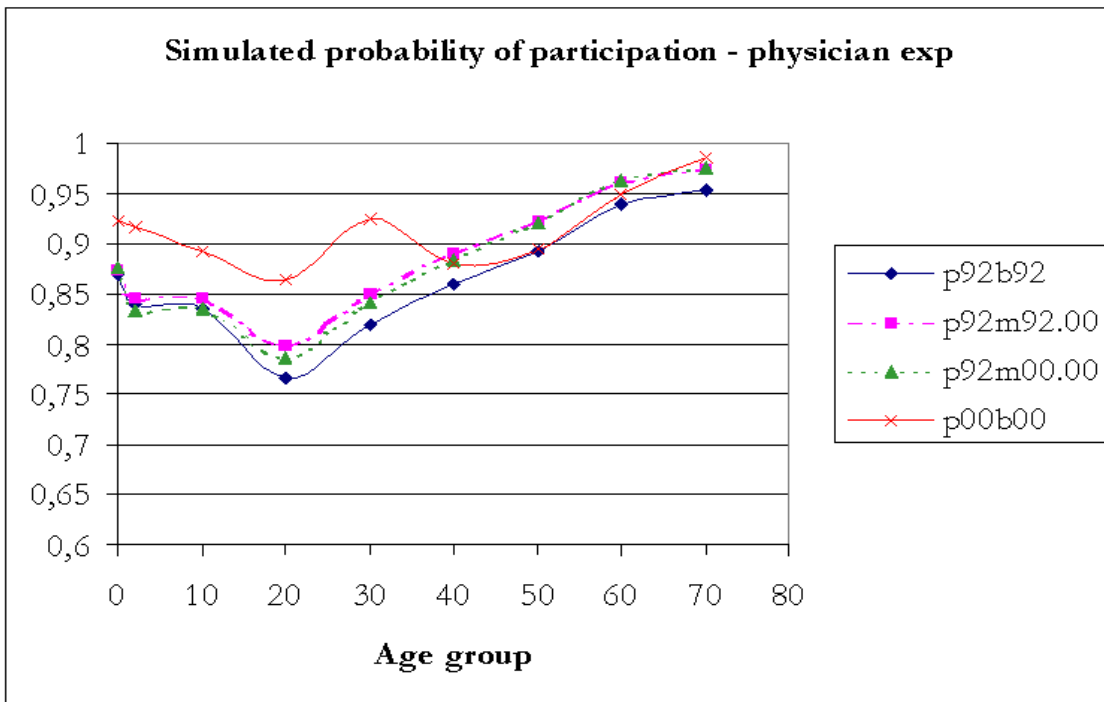
Graph 10C : Simulated profiles : hospital expenditures (conditional)

p92b92 : population of 1992, behaviors of 1992

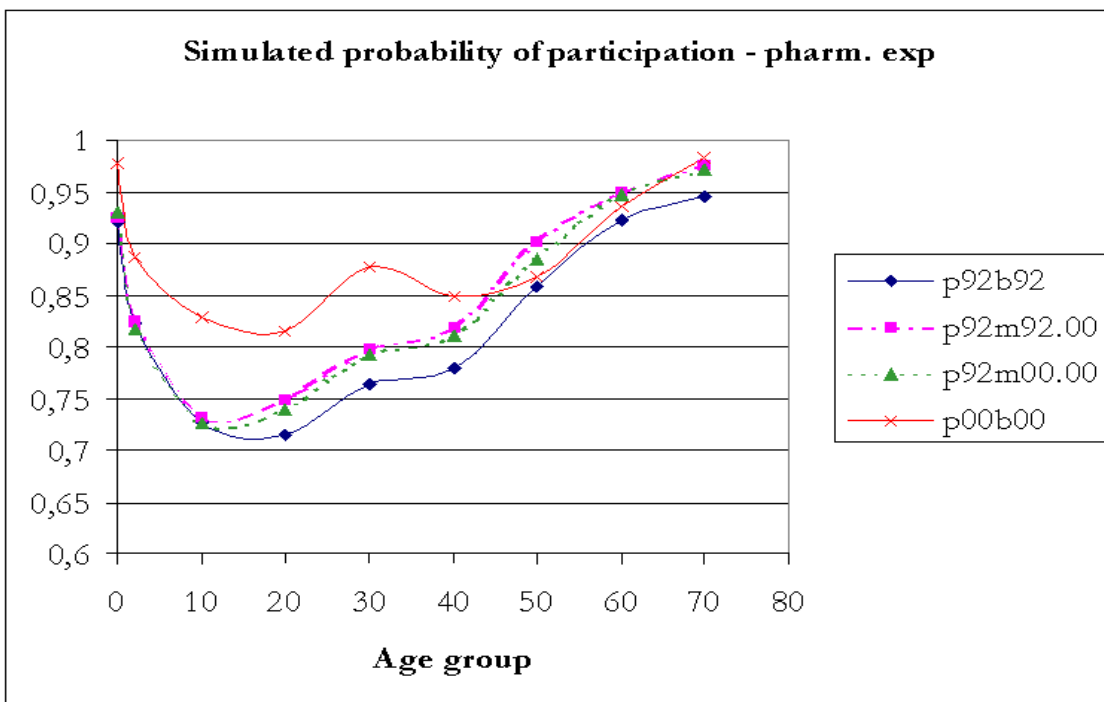
p92m92.00 : population of 1992, morbidity of 1992, practices of 2000 (changes in practices for a given morbidity)

p92m00.00 : population of 1992, morbidity of 2000, practices of 2000 (changes in morbidity)

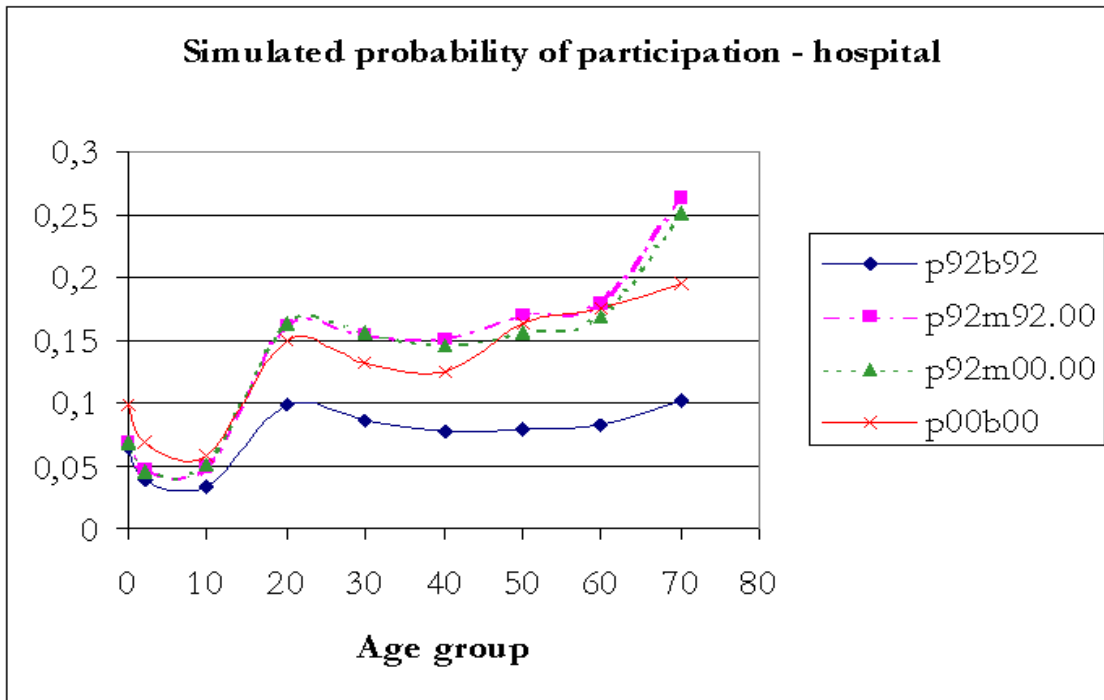
p00b00 : population of 2000, behaviors of 2000 (other changes in population and practices)



Graph 11A : Simulated profiles : participation to physician expenditures



Graph 11B : Simulated profiles : participation to pharmaceutical expenditures



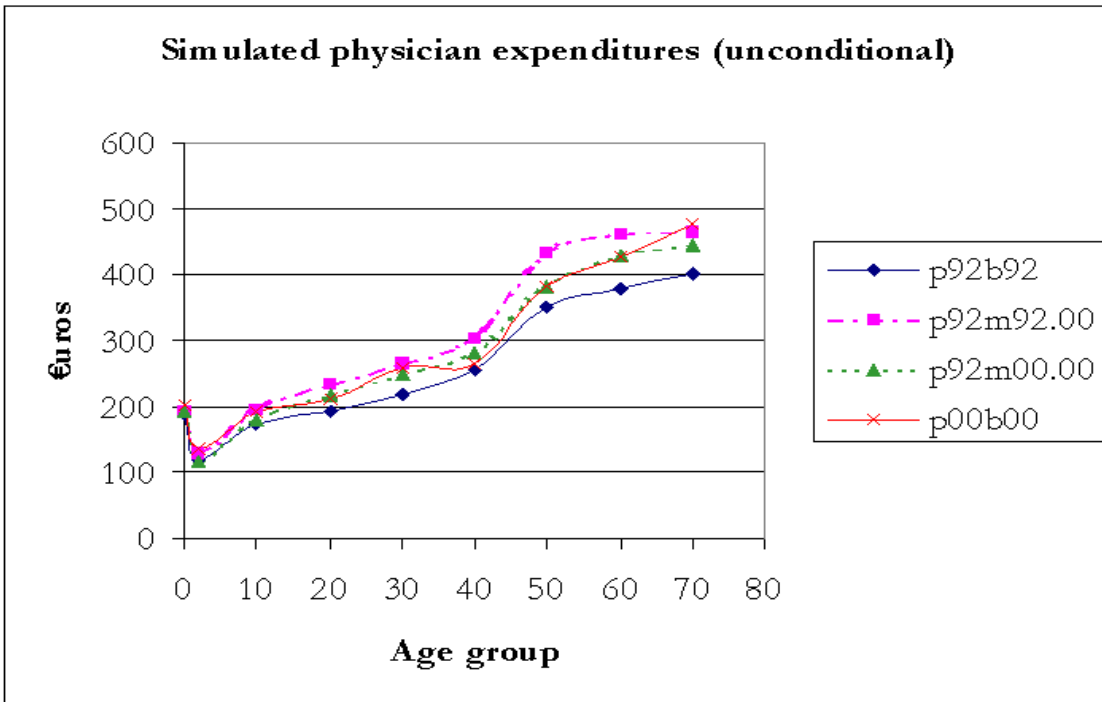
Graph 11C : Simulated profiles : participation to hospital expenditures

p92b92 : population of 1992, behaviors of 1992

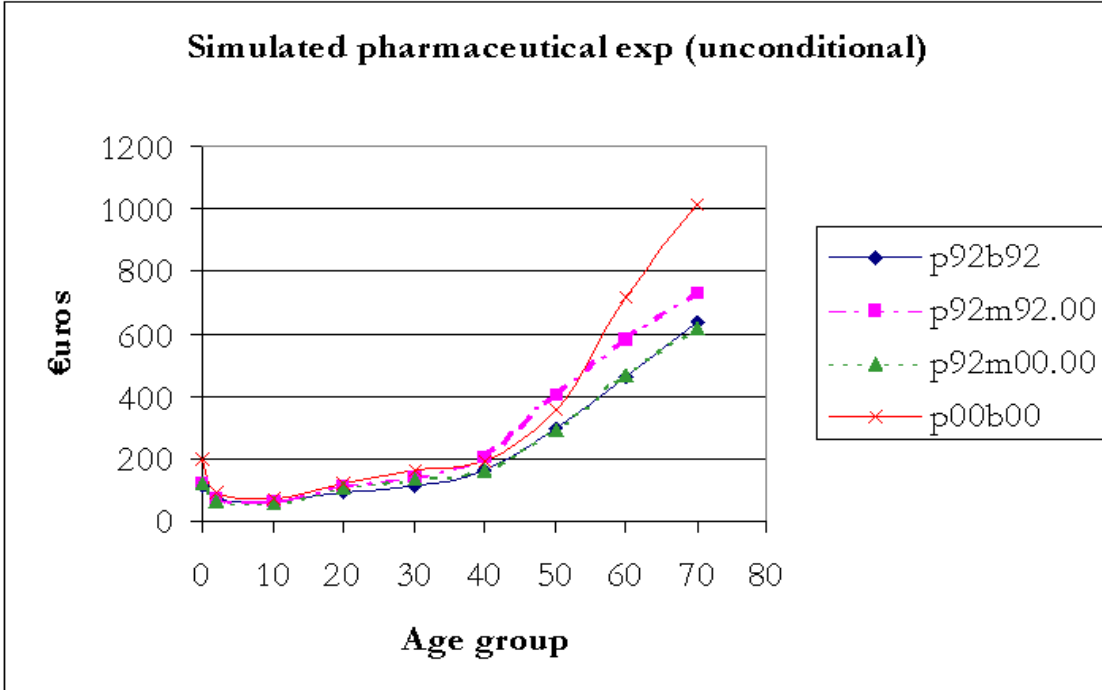
p92m92.00 : population of 1992, morbidity of 1992, practices of 2000 (changes in practices for a given morbidity)

p92m00.00 : population of 1992, morbidity of 2000, practices of 2000 (changes in morbidity)

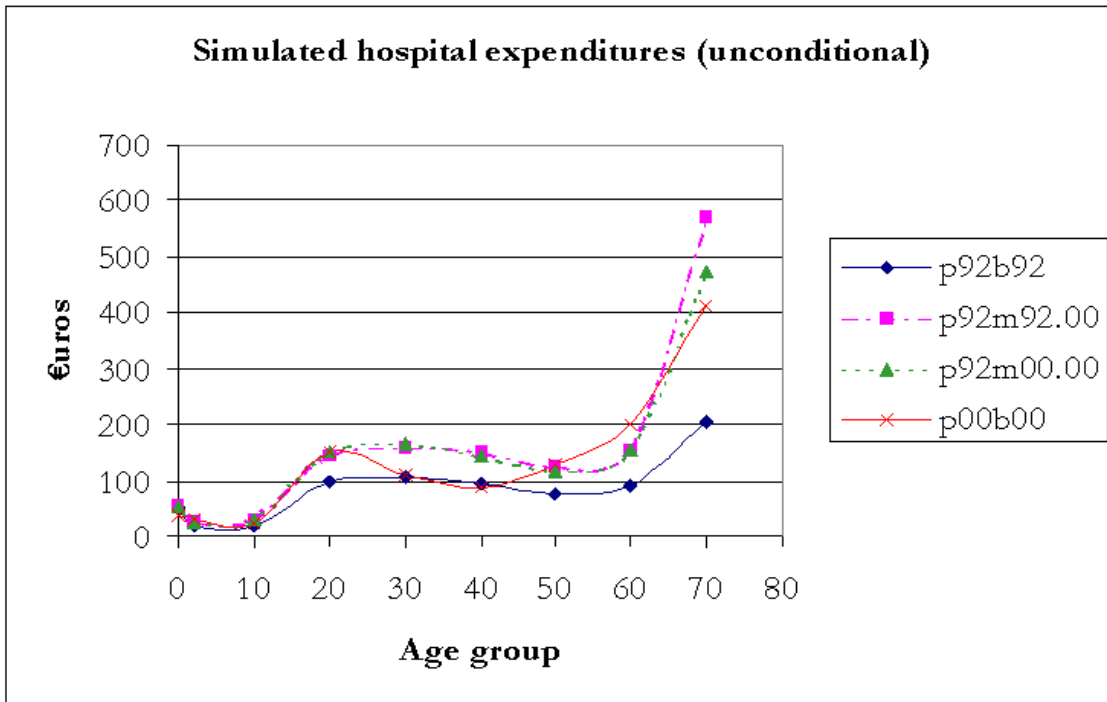
p00b00 : population of 2000, behaviors of 2000 (other changes in population and practices)



Graph 12A : Simulated profiles : physician expenditures (unconditional)



Graph 12B : Simulated profiles : pharmaceutical expenditures (unconditional)



Graph 12C : Simulated profiles : hospital expenditures (unconditional)

p92b92 : population of 1992, behaviors of 1992

p92m92.00 : population of 1992, morbidity of 1992, practices of 2000 (changes in practices for a given morbidity)

p92m00.00 : population of 1992, morbidity of 2000, practices of 2000 (changes in morbidity)

p00b00 : population of 2000, behaviors of 2000 (other changes in population and practices)

| | Phys. exp. | | | Pharm. exp. | | | Hosp. exp. | | |
|----|------------|------------|-------------|-------------|------------|-------------|------------|------------|-------------|
| | Total | Pract. Chg | Morbid. Chg | Total | Pract. Chg | Morbid. Chg | Total | Pract. Chg | Morbid. Chg |
| 0 | 6,10 | 0,82 | 1,24 | 69,51 | 0,87 | 2,07 | -26,70 | 5,96 | -2,61 |
| 2 | 12,46 | 6,36 | -8,48 | 35,34 | 0,19 | -4,77 | 49,73 | 27,42 | -0,53 |
| 10 | 10,47 | 12,83 | -8,25 | 21,15 | 3,45 | -6,20 | 19,91 | 58,22 | -0,35 |
| 20 | 9,56 | 21,20 | -6,12 | 32,24 | 18,58 | -5,96 | 54,63 | 48,41 | 3,78 |
| 30 | 18,37 | 20,91 | -5,78 | 39,35 | 22,36 | -6,59 | 5,62 | 50,10 | 5,84 |
| 40 | 3,96 | 19,58 | -7,55 | 20,03 | 28,57 | -19,80 | -7,57 | 57,20 | -3,05 |
| 50 | 8,84 | 23,14 | -11,54 | 20,23 | 34,87 | -28,01 | 65,55 | 60,34 | -4,51 |
| 60 | 12,51 | 21,60 | -6,61 | 54,90 | 25,04 | -18,60 | 118,15 | 68,25 | 0,18 |
| 70 | 19,29 | 15,81 | -3,83 | 59,15 | 13,94 | -14,80 | 100,54 | 179,27 | -17,38 |

Table 2 : Percentage of variation between the different simulation steps - unconditional expenditures

7 Comparing demographic effects and changes in practices

On table 3, 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.

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. Concentrating on the aggregate expenditure and taking the restrictive definition of the changes in practices, we find that the impact of changes in practices is 4.6 larger than the rise in health care expenditures due to demographic changes. Considering a broader definition (including other changes), we find that the impact of changes in practices is 6.4 larger than the rise in health care expenditures due to demographic changes.

| Variation 1992-2000 (%) | Physicians | Pharmac. | Hospital | Aggregate |
|--------------------------------------------|------------|----------|----------|-----------|
| Total demographic change | 5,37 | 8,30 | 5,85 | 6,58 |
| of which : | | | | |
| part of structural change | 2,41 | 5,26 | 2,88 | 3,58 |
| part of growing size of population | 2,96 | 3,04 | 2,97 | 3,00 |
| Changes in practices for a given morbidity | 18,56 | 20,84 | 86,92 | 30,22 |
| Changes in morbidity | -7,06 | -16,61 | -6,44 | -10,39 |
| Other changes | 1,68 | 41,86 | -12,25 | 11,96 |
| Residual | -0,49 | 0,42 | -11,64 | 0,87 |
| Total variation 1992-2000 (%) | 18,06 | 54,81 | 62,44 | 39,24 |

Table 3 : Simulations at the macro 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 availability of morbidity indicators for every observed individual (and not restricted only to people close to death) 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.

9 Appendices

9.1 Appendix A

9.2 Variables used in the estimations

Variables X_1 :

- Age group
- Gender
- Marital status
- Size of household
- Level of education
- Absence of complementary coverage
- Number of pathologies

- Level of invalidity
- Level of vital risk

Variables X_2 :

- Age group
- Gender
- Social and occupational group
- Household net income
- Absence of complementary coverage
- Number of pathologies
- Level of invalidity
- Level of vital risk

9.3 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

9.4 The 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.

9.5 Socio-demographic characteristics

Marital status :

- 1 : married or living in a couple
- 2 : divorced or separate
- 3 : widow / widower
- 4 : single

Level of education :

- 1 : does not go to school, never went to school, other
- 2 : kindergarten to primary school
- 3 : junior high school
- 4 : high school

- 5 : higher education

Social and occupational group (INSEE classification) :

- 1 : agrarians
- 2 : independent workers
- 3 : intellectual professions
- 4 : intermediary professions
- 5 : clerks
- 6 : qualified workers
- 7 : non-qualified workers

Household net income :

- 1 : belonging to the 20% lowest incomes
- 2 : belonging to the middle 40% of the income distribution
- 3 : belonging to the 20% highest incomes

10 Appendix B

| | Physician (1) | | Pharma (1) | | Hospital | |
|------|---------------|---------|------------|---------|----------|---------|
| | lambda | p-value | lambda | p-value | lambda | p-value |
| 1992 | -0,891 | 0,00043 | -0,681 | 0,0067 | -0,404 | 0,149 |
| 2000 | -0,804 | 0,00896 | -0,687 | 0,0094 | -0,527 | 0,1809 |

Table 4 : Estimated coefficients of the inverse Mill's ratio

(1) In this case, p-values are computed on the basis of asymptotic standard errors robust to heteroscedasticity

11 Appendix C

| Physician | Changes in participation | Changes in conditional HCE | Total : changes in unconditional HCE |
|-----------|--------------------------|----------------------------|--------------------------------------|
| 0 | 6,12 | -0,02 | 6,10 |
| 2 | 9,06 | 3,11 | 12,46 |
| 10 | 6,66 | 3,57 | 10,47 |
| 20 | 12,63 | -2,73 | 9,56 |
| 30 | 12,85 | 4,89 | 18,37 |
| 40 | 2,30 | 1,62 | 3,96 |
| 50 | 0,22 | 8,60 | 8,84 |
| 60 | 1,07 | 11,32 | 12,51 |
| 70 | 3,29 | 15,49 | 19,29 |

| Pharma. | Changes in participation | Changes in conditional HCE | Total : changes in unconditional HCE |
|---------|--------------------------|----------------------------|--------------------------------------|
| 0 | 6,12 | 59,74 | 69,51 |
| 2 | 7,88 | 25,45 | 35,34 |
| 10 | 13,87 | 6,39 | 21,15 |
| 20 | 13,86 | 16,14 | 32,24 |
| 30 | 14,86 | 21,31 | 39,35 |
| 40 | 8,92 | 10,20 | 20,03 |
| 50 | 1,06 | 18,97 | 20,23 |
| 60 | 1,62 | 52,43 | 54,90 |
| 70 | 3,91 | 53,17 | 59,15 |

| Hospital | Changes in participation | Changes in conditional HCE | Total : changes in unconditional HCE |
|----------|--------------------------|----------------------------|--------------------------------------|
| 0 | 53,43 | -52,23 | -26,70 |
| 2 | 80,38 | -16,99 | 49,73 |
| 10 | 73,56 | -30,91 | 19,91 |
| 20 | 51,58 | 2,01 | 54,63 |
| 30 | 53,13 | -31,02 | 5,62 |
| 40 | 60,64 | -42,46 | -7,57 |
| 50 | 104,96 | -19,23 | 65,55 |
| 60 | 112,21 | 2,80 | 118,15 |
| 70 | 90,97 | 5,01 | 100,54 |

Table 5 : impact of changes in participation and conditional expenditures in changes in total health care expenditures

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