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Restrictions on the number of physicians and intergenerational inequalities: experience, time and vintage effects in GP's earnings*

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Restrictions on the number of physicians and Intergenerational Inequalities : Experience, Time and Vintage effects in GPs' earnings*

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Abstract

This paper analyses the regulation of ambulatory care and its impact on physicians' careers, using a representative panel of $6,016$ French self-employed GPs over the $1983-2004$ period. The beginning of their activity is influenced by the regulated number of places in medical schools, named in France *numerus clausus*. We show that the policies aimed at manipulating the *numerus clausus* strongly affect physicians' permanent level of earnings.

Our estimates allow us to identify experience, time and vintage effects in physicians' earnings. The estimated cohort (or vintage) effect appears to be very large, revealing that intergenerational inequalities due to fluctuations in the *numerus clausus* regulation are far from negligible. Cohorts of GPs beginning during the eighties have the lowest permanent earnings: they faced both the baby-boom numerous cohorts and the consequences of a high number of places in medical schools. Conversely, the decrease in the *numerus clausus* led to an increase in permanent earnings of GPs who began their practice in the mid nineties. Overall, the estimated gap in earnings between "good" and "bad" cohorts may reach 25%. We performed a more thorough analysis of the earnings distribution to examine whether individual unobserved heterogeneity could compensate for average differences between cohorts. Our results about stochastic dominance between earnings distributions by cohort show that it is not the case.

1 Introduction

In France, general practitioners (GP) are paid under a fee-for-service scheme; their earnings are therefore closely related to the amount of services they provide. In such a system, the number of physicians is a key determinant of the level of their earnings. The level of GPs' earnings influences both the attractiveness of the profession and the incentive for GPs to induce demand. Our article examines the link between the regulation of the number of physicians in France and physicians' earnings and careers.

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This issue is addressed using longitudinal individual data about French GPs. Firstly, we estimate GPs earnings functions. This allows us to identify experience, vintage and time effects in physicians' earnings. Time effects correspond to year events that affect all physicians identically. Experience effects refer to the evolution of activity since the beginning of the practice, and cohort effects relate to earning differences between cohorts of physicians (defined by the first year in practice). Secondly, we go further the estimation of average earning differences between cohorts by using stochastic dominance tests between distribution of earnings.

This article is of major interest for two reasons. Firstly, we provide empirical evidence that the regulation of the number of physicians has a lasting impact on physicians' careers. More precisely, we show that physicians' "permanent" earnings are strongly influenced by changes in the *numerus clausus, i.e.* the number of places in medical schools. Secondly, such an analysis was made possible thanks to a representative panel of $6,016$ French self-employed GPs observed over the $1983-2004$ period, which corresponds to $81,691$ individual-year observations. Our sample is drawn from an exhaustive source of information : the administrative files about self-employed physicians collected by the public health insurance. Reliable data about self-employed workers are not numerous. But the French organization of ambulatory care (GPs are paid by patients who are reimbursed by the public health insurance) leads to administrative data which do not suffer from a lack of reliability.

Literature about physicians' earnings is not plentiful and most studies focus on gender differences in GPs' earnings or on the impact of payment schemes on care provision. In addition, studies about self-employed professionals are very scarce. A pioneering work was performed by Friedman and Kuznets in 1945 [11] to compare physicians to other professionals (lawyers, dentists). Then the issue of careers of self-employed professionals was adressed on cross-sectional data by Lazear and Moore [14]. To our knowledge, no paper has so far addressed the issue of physicians' careers on longitudinal data.

This paper is organized as follows. The following section describes the data. Then we briefly show how ambulatory care is regulated in France and perform a descriptive analysis of GPs' careers. The next section is devoted to the identification of time, experience and cohort effects in physicians' earnings. Then, we perform a more thorough analysis of the earnings distributions, using stochastic dominance tests. The final section concludes.

2 Data

We have at our disposal an extraordinary source of information on physicians' careers in France. Our data set is a 10% random sample of all self-employed GPs practicing between 1983 and 2004. The sample is drawn from an administrative file about French self-employed GPs collected by the public health insurance (Caisse Nationale d'Assurance Maladie des Travailleurs Salariés, CNAMTS). Given that the public health insurance is mandatory and universal in France, our sample is drawn from the exhaustive source of information about self-employed physicians. The latter account for 84% of physicians operating in ambulatory care; the others are salaried doctors who work in schools or firms.

The panel is unbalanced: each physician i is observed for a period T_i, which can begin after 1983 (beginner physician) or end before 2004 (retiring physician). For each physician i at year t, we have information about age, gender, year of PhD, year of the beginning of practice, level and composition of activity (office visits, home visits, surgery or radiology acts), location (with two administrative levels: *département,* with 95 digits and *région,* with 22 digits), practice earnings. We also know if the GP has or not a *MEP* specialization, *i.e.* a specific activity such as acupuncture or homeopathy.

In France, self-employed physicians are paid according to a fee-for-service scheme. More than 80% of physicians belong to sector 1, where fees are fixed by an administrative process. Free setting of fees is only authorised for a minority of physicians, those enrolled in sector 2. As the choice between sector 1 and 2 has only been possible between 1982 and 1992, most physicians are paid under a fee-for-service sheme and fixed prices. Their income only relies on their level of activity. In order to keep an homogeneous sample to study the relationship between activity and earnings, we focused on sector 1 doctors. We also selected GPs who began their practice between 1970 and 2001. On the whole, the final sample consists of 6,016 physicians with a total of 81,691 individual-year observations over years 1983 to 2004.

Table 1 summarizes the structure of the sample. It gives a clear idea of the richness of the available information: 32 cohorts (defined by the first year in self-employed practice) and 95 to 290 physicians per cohort are observed over years 1983 to 2004. Seniority ranges from 1 to 34 years. This database will therefore allow a very flexible specification using dummy variables to identify experience, time and cohort effects in physicians' earnings. Information about cohorts relative to years 1945 to 1969 and $2002-2003$ is also available. For these cohorts, however, the number of observed physicians was unstable and too small (between 12 and 85) for a relevant econometric analysis: these observations were eliminated.

Basic features of the data are displayed in table 2. The proportion of female physicians increases rapidly over the period, from 13% in 1983 to about 25% in 2004. The average seniority triples between 1983 (5.8 years) and 2004 (17.6 years). This reflects the ageing of the physician population, due to the combined effects of the baby-boom and of the restrictive policies, implemented from the mid $70s$ to reduce the number of physicians. The change in the average seniority derives also partly from the sample selection process, given that cohorts 1945 to 1969 were eliminated. Computing the same statistics for the whole sample, one finds a still sizeable but less spectacular increase in the average seniority, from 11 years in 1983 to 18 years in 2004.

Earnings are defined by the total fees received by the GP during the year. Matching our database with fiscal records, we were able to compute earnings net of charges at the individual level for years $1993-2004$. In 2004, the average earnings net of charges equal € 62,024. Using the OECD Health Database and measuring the earnings in US \$ PPP, international comparisons of GPs' earnings levels can be performed. These data show that the earnings of American self-employed GPs are 91% higher than the earnings of their French counterparts. As for Swiss, Canadian and British GPs, their earnings are, respectively, 29%, 26% and 12% higher. To sum up, the earnings of French GPs appear to be rather moderate.

Cohort (First year in activity)	Sample size	Number of observed physicians	Years observed	Range of experience (1)
1970	1,290	97	1983-2004	13-34
1971	1,565	107	1983-2004	12-33
1972	1,656	100	1983-2004	11-32
1973	1,549	92	1983-2004	10-31
1974	2,539	154	1983-2004	9-30
1975	3,014	179	1983-2004	8-29
1976	3,961	238	1983-2004	7-28
1977	5,154	304	1983-2004	6-27
1978	5,129	290	1983-2004	5-26
1979	4,609	265	1983-2004	4-25
1980	4,011	250	1983-2004	3-24
1981	4,256	241	1983-2004	2-23
1982	4,107	252	1983-2004	1-22
1983	3,837	237	1984-2004	1-21
1984	4,095	255	1985-2004	1-20
1985	3,881	250	1986-2004	1-19
1986	3,276	208	1987-2004	1-18
1987	2,764	190	1988-2004	1-17
1988	2,972	215	1989-2004	1-16
1989	2,658	204	1990-2004	1-15
1990	2,929	238	1991-2004	1-14
1991	2,306	202	1992-2004	1-13
1992	2,183	201	1993-2004	1-12
1993	1,561	167	1994-2004	1-11
1994	1,246	149	1995-2004	1-10
1995	1,113	150	1996-2004	1-9
1996	1,001	139	1997-2004	1-8
1997	906	151	1998-2004	1-7
1998	730	131	1999-2004	1-6
1999	620	137	2000-2004	1-5
2000	509	138	2001-2004	1-4
2001	264	95	2002-2004	1-3
1945 to 1969 2002-2003	The number of observed physicians per cohort lies between 12 and 85, which is not enough for relevant statistical inference at the vintage level			
Total	81,691	6,016	1983-2004	1-34

(1) Experience is defined as the year of observation – first year of activity

Table 1: Cohorts included in the working sample

	1983	1993	2004
gender (proportion of female)	0.132 (0.338)	0.187 (0.389)	0.247 (0.431)
seniority	5.779 (3.322)	10.736 (5.956)	17.663 (7.968)
seniority (cohorts $1945-2003$)	11.106 (9.429)	12.847 (7.905)	18.037 (8.507)
earnings (€ 2004)	$90,144$ $(42,948)$	$97,145$ $(42,020)$	$119,598$ $(48,309)$
earnings net of charges (€ 2004)	-	$44,160$ $(22,815)$	$62,064$ $(28,724)$
Number of observations	$2,458$	$3,761$	$4,496$

Working sample : French GPs, sector 1, period $1983-2004$, $81,691$ observations, cohorts $1970-2001$

Standard errors are in parentheses.

Table 2: Basic features of the data

3 The French regulation of the ambulatory care

3.1 Insurance coverage

In France, about 99% of the population is covered by the mandatory public health insurance, which covers about 70% of individual health care expenses. Each treatment has a reference price fixed by agreement between physicians and the health insurance administration. In addition to the public system, individuals can subscribe to a voluntary private insurance scheme or be covered through occupational group private insurance. These complementary insurance contracts cover the share of expenses (30 %) not covered by the public health insurance. In 2000, a reform (CMU, i.e. *Couverture Maladie Universelle*) was implemented to provide a free complementary coverage to low-income people. Thanks to these different kinds of insurance schemes, 80% of the population get 100% of the reference price reimbursed over the period 1983-2004, and the coverage is even higher from 2000 on. Moreover, patients freely choose the type of practioners they consult and can visit several GPs for the same illness.

3.2 The number of practicing physicians

The supply of physicians is mainly defined by the number of students who succeed in their diploma in medicine in France. Foreign doctors came only recently. Education to become a GP is provided by faculties of medicine. The medical studies consist of 6 years, common to all medical specialties and 1 more year (until 1988) or 2 or even 3 more years (after 2001) as a junior practitioner. These studies end with a PhD. A reform implemented in 2004 introduced a common exam to manage the student's choice between various specialties, General Practice being one of them. This introduced a great change in the choice for General Practice: depending on their ranking, students were given the possibility to choose another specialty.

Places in medical schools have been regulated since 1971 via the *numerus clausus.* This is a strong selection at the end of the first year in medical school : only 10% (more recently, 17% given the increase in the *numerus clausus*) could go on with their medical education after the first year. The French situation, where medical education is almost free, shows a strong contrast with the American one, where tuition is rather expensive and amounts to a sizeable investment for the student. In the United States, selection is less severe and there are about two applicants for a spot in medical school (McGuire, 2000).

An inventory of the French situation concerning ambulatory care does not show serious difficulties but recurrent problems. Among OECD countries, France has one of the highest physician:population ratio (Bourgeuil et *al.*[2]). At the geographical level, despite the high level of medical density, the location of doctors in very uneven, which induces inequality in the access to care (distance to the doctor). Moreover, one of the consequences of the 2004 reform of medical education has been the decrease in the number of students choosing to specialize in General Practice (Billaut [1]). Furthermore, less students are willing to practice as self-employed doctors. They more often choose a salaried practice at the end of their studies (Bourgeuil [3]). Finally, there is an empirical evidence of supply-induced demand as concerns french GPs. This behaviour is more prominent in *départements* where the level of medical density is high, corresponding to more than 110 GPs per $100,000$ inhabitants (Delattre and Dormont [7]).

As a consequence, three major imperatives are at stake to regulate the supply of GPs properly. Firstly, one must provide an equal access to care. This will be possible if physicians are numerous enough. Secondly, the attractiveness of the GP profession must be restored, mainly through earnings. Thirdly, one must avoid induced demand behaviour especially in regions with a high level of medical density.

3.3 The cohort pyramid

Graphs (1) and (2) display "cohort pyramids" drawn from our dataset, each cohort being defined by the first year in self-employed practice. These pyramids have a really chaotic shape, interpretable using information on events that happened years before: i) demographic changes, using the number of births 30 years earlier (as GPs begin their practice at the average age of 30); ii) changes in the *numerus clausus* 9 or 10 years earlier (the average length of medical education).

The small number of physicians belonging to the pre-1970 cohorts is due to retirements : 95% to 100% of those physicians retired during the $1983-2004$ period. The huge increase in the number of physicians belonging to the 1974 to 1978 cohorts (graph (1)) is explained both by the baby-boom and no regulation of the number of places in medical schools. The impact of the *numerus clausus* appears clearly on graph (2). Before its implementation, the growth in the number of practicing physicians followed the French population growth. This reform introduced a discrepancy between changes in the number of GPs and the general demographic growth, as shown on the right side of graph (1).

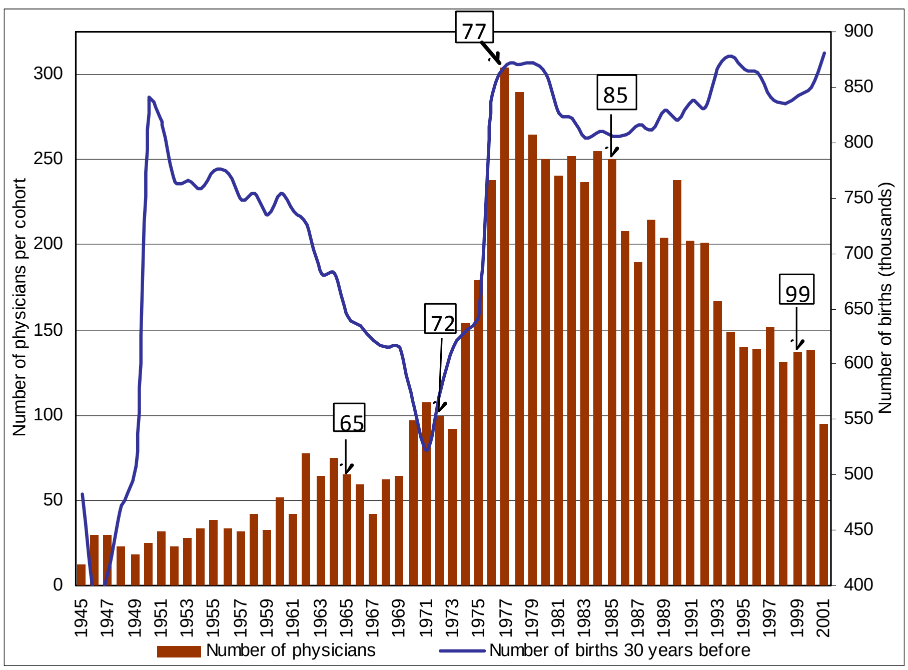


Figure 1: Cohort pyramid (by year of setting) and number of births 30 years before

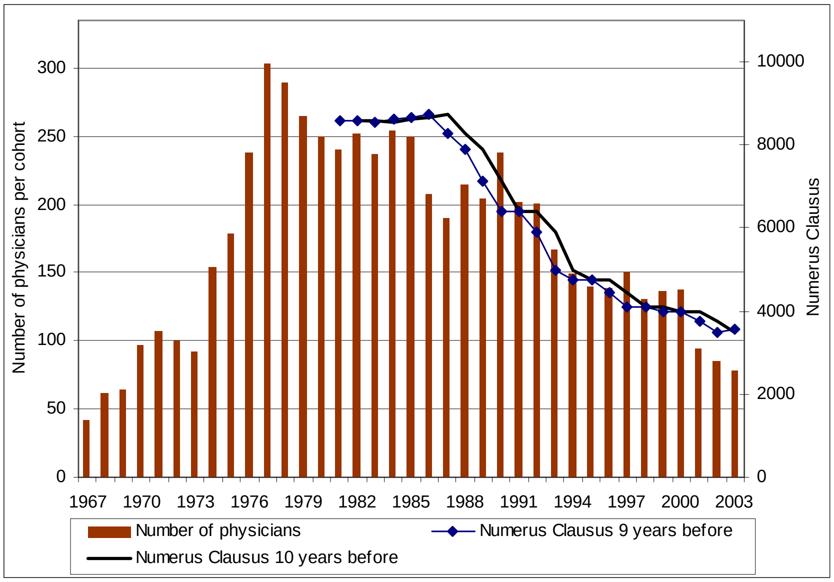


Figure 2: Physicians per cohort and numerus clausus 9 and 10 years before the first year in activity

3.4 A descriptive analysis of French GPs' careers

Graph (3) gives the average GPs' earnings (in 2004 euros) by cohort and seniority. We observe a reversed "U-shaped" profile, which could characterize experience effects. However this graph is built using raw earnings: cohort, time and experience effects are mixed up. A more relevant approach is to draw average earnings net of time effects, by cohort and seniority. Let w_{ict} denote the earnings in year t of the i^{th} physician belonging to the c^{th} cohort. Graph (4) shows the values of $w_{.ct} - w_{..t}$ where $w_{.ct}$ stands for the average earnings of cohort c in t and $w_{..t}$ is the average earnings in year t. For a better readability, only 7 cohorts are displayed. These cohorts are also labelled on graph (1) to locate them clearly on the cohort pyramid as we will concentrate on these cohorts throughout the analysis. On graph (4), the 1972 cohort has the highest earnings. Then earnings decrease for the 1977 cohort and even more for the 1985 and 1993 cohorts. These results suggest that there are inequalities between cohorts. The econometric estimation will make it possible to disentangle cohort, experience and time effects.

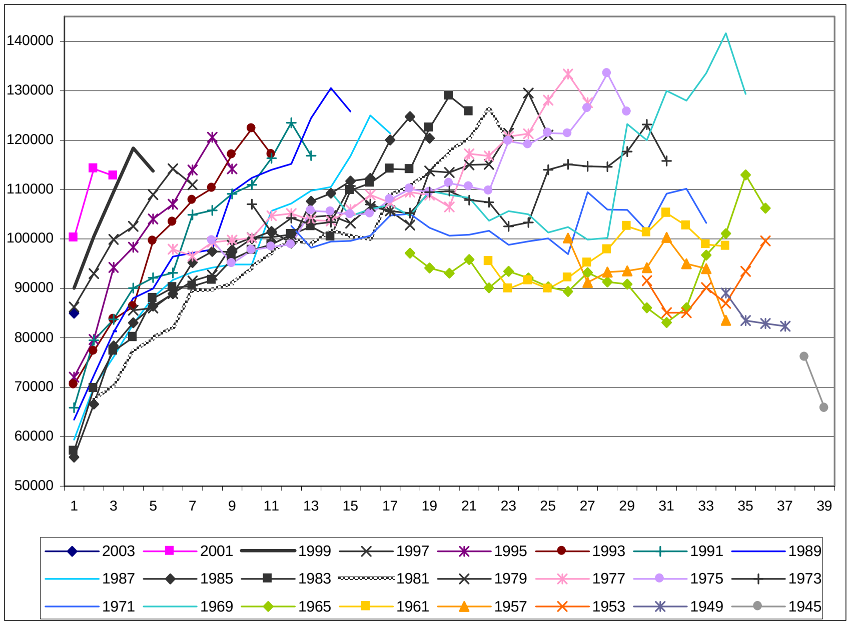


Figure 3: Mean earnings by cohort and seniority

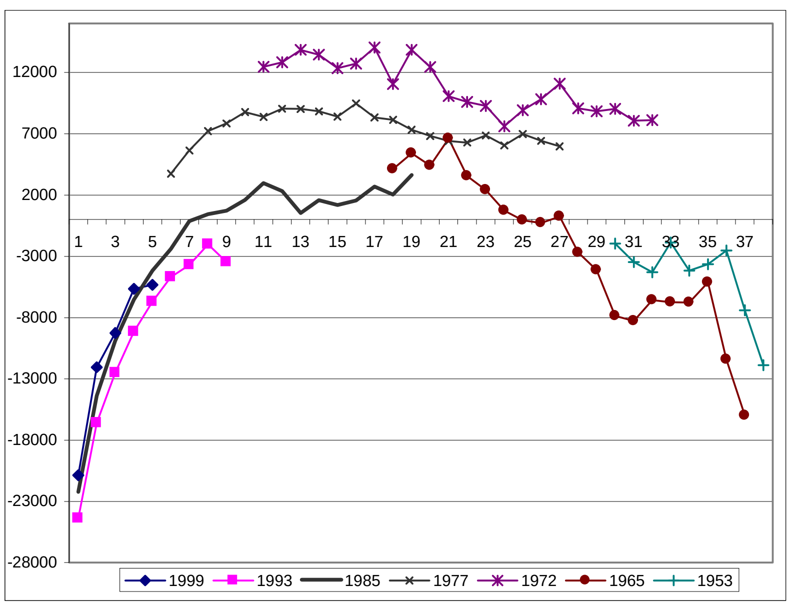


Figure 4: Mean earnings, net of time effects, by cohort and seniority

4 Estimating the earnings function

In this section, we identify experience, vintage and time effects in physicians' earnings and evaluate their relative impact.

4.1 The econometric specification

Our model is taken from the human capital earnings function (Mincer [18]). This model is used to measure returns on human capital and on accumulated experience. The log of individual earnings in a given time period is often decomposed into an additive function of a linear education term and a quadratic experience term. As we concentrate on GPs' earnings, the meaning of this specification is slightly different. Indeed, GPs all have approximately the same stock of initial human capital. Moreover, a positive effect of seniority on earnings is more likely to derive from the pratician's number of patients than from an increase in productivity due to human capital accumulation.

Let y_{ict} denote the log of earnings (in 2004 euros) in year t of the i^{th} physician belonging to the c^{th} cohort. One has :

$$y_{ict} = a + D_{ict}b + Z_{ic}^{'}d + \alpha_e + \delta_t + \gamma_c + \varepsilon_{ict}, \tag{1}$$

$$i = 1, ...N, c = 1....C, t = 1....T \text{ and } e = 1....E$$

where the explanatory variable D_{ict} is the medical density (the number of GPs per $100,000$ inhabitants in the *département* where physician i works) which varies during the period of observation. $Z_{ic}^{'}$ includes variables which are fixed during the period, such as gender (takes the value 1 if female and 0 if male), the number of years between the year of PhD and the first year of practice, region of practice (using dummies), type of practice (full-time independant GP or not), MEP physician or not, location of practice (city center, suburban area, urban sprawl or rural area).
Our data set allows us to specify experience effects as fixed effects which is more flexible than the traditional polynomial function. Therefore, α_e $(e = 1, ..., 34)$ stands for an experience fixed effect estimated by introducing dummy variables. Experience is defined as the number of years since the first year of practice. Similarly, δ_t $(t = 1983, ..., 2004)$ and γ_c $(c = 1970, ..., 2001)$ are time and cohort effects. Cohort is defined as the first year in self-employed practice.

However, the extensive use of various fixed effects raises identification problems. Our specification is not identifiable without constraints on the fixed effects. We used two constraints:

$$\sum_e \alpha_e = 0, \sum_t \delta_t = 0 \text{ and } \sum_c \gamma_c = 0 \tag{2}$$

$$\sum_c c * \gamma_c = 0 \tag{3}$$

Constraint (2) comes down to define a reference category for each of the three effects. For experience and time effects, we impose this constraint by defining a reference category for, respectively, an experience level equal to 7 and a time effect equal to 1983. For cohort effects, we use the constraint that all effects sum to zero.

Constraint (3) is specified to deal with another colinearity source : for each physician i, one has $t = c + e$. For instance, in year 1990, GPs belonging to cohort 1970 have, by definition, 20 years

of seniority. Imposing no trend on cohort effects (constraint (3)) is a way to solve this colinearity problem.
We could have imposed constraint (3) on time rather than on cohort effects (Deaton [6]). Both methods are mathematically equivalent but actually lead to rather different interpretations of the estimates. No theoretical background is available to choose the effect on which to put the additional constraint. Our challenge was then to find empirical evidence of a lack of trend for the cohort effects. We estimated (1) using fixed effects relative to group-of-cohorts (6 cohorts together) instead of cohort fixed effects (Dormont and Samson [9]). This approach, which eliminated the colinearity source ($t \neq (groups\ of\ c) + e$), led to estimates of group-of-cohort effects with no trend, thus justifying constraint (3). Notice in addition that the information displayed on graph (1) gives empirical support to the idea of no trend on cohort effects.

Our model does not control for unobserved heterogeneity among physicians. However, specifying an error-component model would make it difficult to identify the cohort effects we are interested in.
In addition, we do not take into account the fact that explanatory variables such as the type and the location of practice may be endogeneous.

4.2 Results

Estimates are presented in table (3); experience, time and cohort fixed estimated parameters are reported on graphs (5) to (7). Region fixed effects are on graph (8).

On average, female physicians' earnings are 34% lower than males'. Fees being fixed, this gap is mainly related to differences in the number of hours worked. But why women work less remains unexplained. Rizzo and Zeckhauser [21] present three possible explanations. It can be differences in productivity, in preferences (number of hours per day and number of days worked per week) or gender discrimination (from patients and other practitioners). They show that gender differences in preferences account for the entire differentials in income and income growth rate. In particular, males' "reference income" is higher than females' and males are more likely to spend less time per patient or to focus on more lucrative procedures to close the target income.

The physician:population ratio has a significant and negative impact on earnings. Medical density can be seen as a proxy of the competition intensity and supply shocks faced by the physician in his practice area. Our estimates show that a raise in the level of medical density (for example from 100 to 110 GPs per $100,000$ inhabitants) leads to a $2,5$ percentage points drop in the level of earnings. The impact is sizeable as it comes in addition to the regional variables which include a part of the medical density effect. This can be pointed out with graph (8), where the ordinate is the estimated region coefficient and the abscissa is the average medical density of the region. Some regions, especially in the south of France (like Midi-Pyrénées, Languedoc-Roussillon or Provence) have a high medical density. The average earnings of physicians living in these areas are around 8% less than for those living in the Paris area (the reference). On the contrary, the center and north are quite deserted by physicians. Our estimates show that those physicians earn up to 20% more than physicians practicing around Paris. Recently, policies have been implemented to provide financial incentives for physicians to locate in these regions. Our results show that living in those areas is already financially beneficial. And the malus for living in a crowded area is smaller than the bonus for living in a deserted area.
Our estimates also show that the degree of urbanization accounts for large differences between physicians' earnings. We show that GPs living in suburbs earn 9% more than those living in urban

areas (the reference) and those living in rural areas earn 14% more. These coefficients may reflect a combined effect of medical density and population density on earnings: a highly densely populated area (urban area) often has a high level of medical density. On the contrary, fewer competition between physicians practising in rural areas has a positive impact on their earnings.

We now come to the estimates of time, experience and cohort fixed effects.

Experience effects

Earnings are a reversed u-shaped function of experience (graph (5)). This pattern is rather different from the increasing and concave function of experience usually observed for salaried workers. Major differences can be pointed out for GPs. Firstly, there is a huge increase at the beginning of the practice. Between the first and the seventh year (reference year), the earnings growth is 37%. This can be considered as the time needed by a GP to build up its practice. Secondly, unlike salaried workers whose earnings remain stable during numerous years, there is no period of stabilisation. For GPs the maximum earnings is reached after 12 years and then decreases rapidly. For comparison with the average earnings after 7 years, GPs earnings are 13% lower after 25 years of practice and 24% lower after 30 years.

There are currently numerous debates among labour economists on the influence of age and seniority on the individual productivity. Our results on self-employed doctors shed light on the behaviour of people whose number of hours worked is mostly influenced by individual preferences, contrary to salaried workers whose labour duration is constrained by the demand they face. Our results show that GPs take advantage of the freedom offered by an independant practice by reducing their level of activity much sooner. They concentrate their activity in the first 15 years of practice.

This result strongly differs from the findings of Lazear and Moore [14] who report a flatter earnings-profile for self-employed workers than for salary workers. Refering to Lazear's theory of an earnings profile implemented by the firm to provide work incentives, they argue that such incentives are not at stake for self-employed workers. However, Lazear and Moore results derive from estimates performed on cross-sectional data with a very parametric specification. It is well-known that longitudinal data (as ours) are more appropriate to provide relevant estimates of experience effects. Our results show that GP's career is influenced by the need to reimburse large investments made at the beginning of the practice. The decrease in activity observed after 12 years suggests however some preferences for leisure once reimbursement has been done.

Time effects

The estimates show that there was a large and constant growth in real earnings between 1983 and 2004, with an annual growth rate of $0,9\%$ (graph (6)). Time effects on earnings derive from the estimation of 1 subject to 2 and 3. Time effects on activity derive from the same estimation but performed on a model whose dependent variable is activity, *i.e.* the average annual number of encounters between the physician and his patients. Encounters are of different types: office visits, home visits, surgery or radiology acts. As fees are fixed, the gap between the two curves is only due to the rise in fees granted by the governement after bargainings with physicians' unions and the public health insurance. The major increases were in 1988, 1995, 1998, 2002 and 2003. As a consequence, even though activity remained constant or increased sligthly during these years, earnings did progress a lot. On the contrary, the growth of activity did not lead to much increase in earnings during years without any revalorisation.

Cohort effects

The estimated cohort effects are very large : the gap in earnings between cohorts may reach 25% (graph (7)). The cohort effect is rather high for cohorts prior to 1978, then deeply decreases for cohorts relative to the eigthies and the beginning of the nineties. It gets better for cohorts of the mid-nineties.

Cohorts of GPs beginning during the eighties have the lowest permanent earnings. For example, GPs who began their practice in 1985 earn 8% less than all cohorts. Graph (1) shows that they had to deal with the impact of baby-boom numerous cohorts. Furthermore, graph (2) shows that the number of places in medical schools was still high. Given the large number of praticians beginning their activity at the same time, those cohorts were confronted with a high degree of competition.

The decrease in the *numerus clausus* led to an increase in the permanent earnings of GPs who began their practice in the mid nineties. For instance, cohorts who began in 1999 earn 9% more than all cohorts. A measure authorizing praticians to retire at the age of 60, without any loss of earnings, also helped to reduce the number of physicians and favored the beginning of new cohorts' practice.

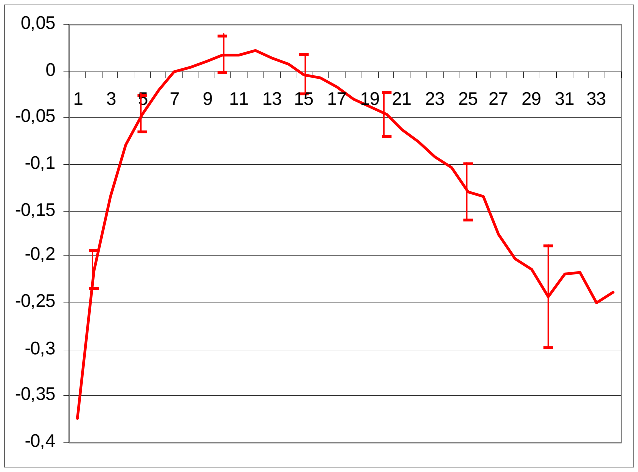
GPs are not the only one to be affected by the Baby Boom. The impact of cohort size on earnings have already been documented for salaried workers' careers. For example, Welch [24] shows a drop in earnings of new entrants in labour markets, coinciding with the arrival of the peak-size cohorts spawned by the baby boom.

To sum up, estimated cohort effects reveal large permanent differences in earnings linked to the first year of practice. This could be qualified as intergenerational inequalities. They can be explained both by the policies aimed at manipulating the regulated number of places in medical schools (*numerus clausus*) and by the effects of baby-boom numerous cohorts.

Matching our data set with fiscal records, we computed earnings net of charges at the individual level for years 1993 to 2004. As the estimates of experience, time and cohort effects on these new earnings do not differ from our first results, we do not present them.

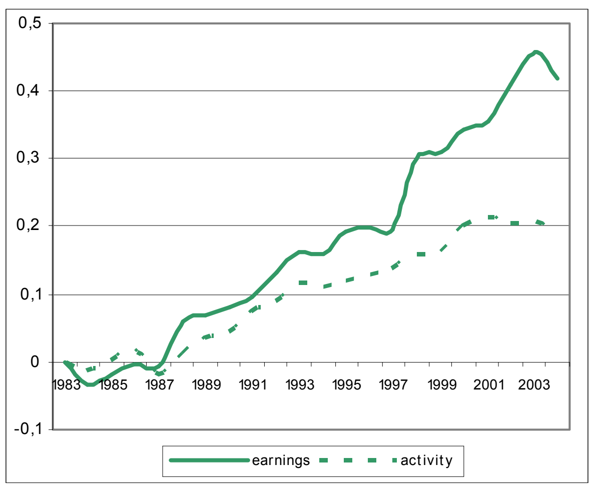
* * * * *

The demographic situation that prevails at the beginning of the practice strongly affect GPs' permanent level of earnings. However, the unobserved heterogeneity affecting GPs' earnings is quite large: the earnings variability explained by our model is only 27% (R^2). Hence, praticians belonging to a bad cohort could compensate for their disadvantage with their dynamism, training, motivation or greater taste for their work. All these earnings determinants are unobserved and thus components of the unobserved individual heterogeneity. Our approach has been a first-order analysis so far, performed on physicians' average earnings. In the following, we use a stochastic dominance approach to take the whole distribution of earnings into account. The unobserved heterogeneity is no more considered as a residual but is included in the analysis. We examine if our results are maintained or if individual unobserved heterogeneity can compensate for average differences between cohorts.



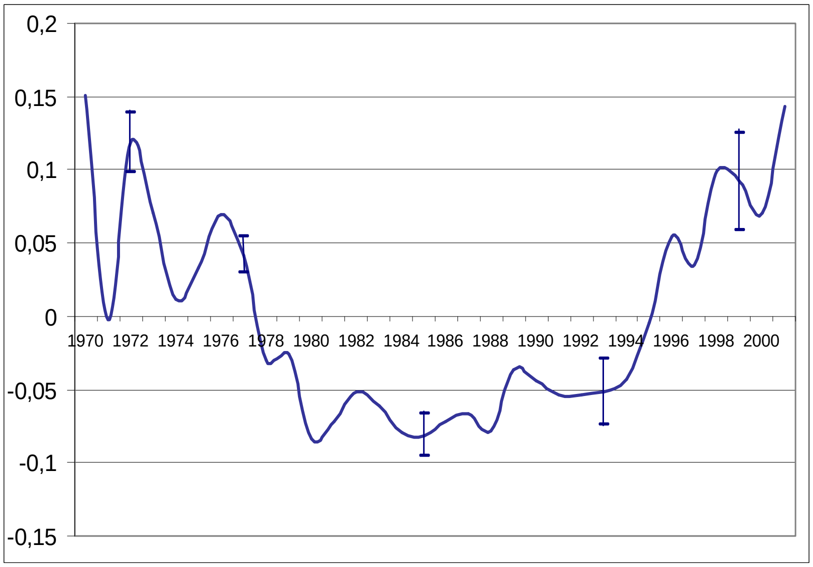
All experience effects, except for experience level equal to 8, 9, 12, 13, 14, 15, 16 are statistically significant

Figure 5: Experience specific effects on earnings



All time effects, except for years 1985 to 1987, are statistically significant

Figure 6: Time specific effects on earnings and activity



All cohort effects, except for cohorts 1971, 1974 and 1995, are statistically significant

Figure 7: Cohort specific effects on earnings

Variable	Coefficient	Standard Error
Gender	-0.34429 (***)	0.00414
Mep	-0.06434 (***)	0.00694
Break	-0.02270 (***)	0.00070099
Part-time independent practice	-0.05250 (***)	0.00452
Part-time Hospital Practice	0.00187 (NS)	0.00245
Suburban area	0.09047 (***)	0.00488
Urban sprawl	0.11295 (***)	0.00787
Rural area	0.14587 (***)	0.00430
Medical density	-0.00246 (***)	0.00015364
R^2	0.2751	
Fisher	271.39	
Sample Size	**81,691**	

*** Statistically significant at the 1% level; ** Statistically significant at the 5% level; * Statistically significant at the 10% level; NS Non significant

Table 3: OLS estimates

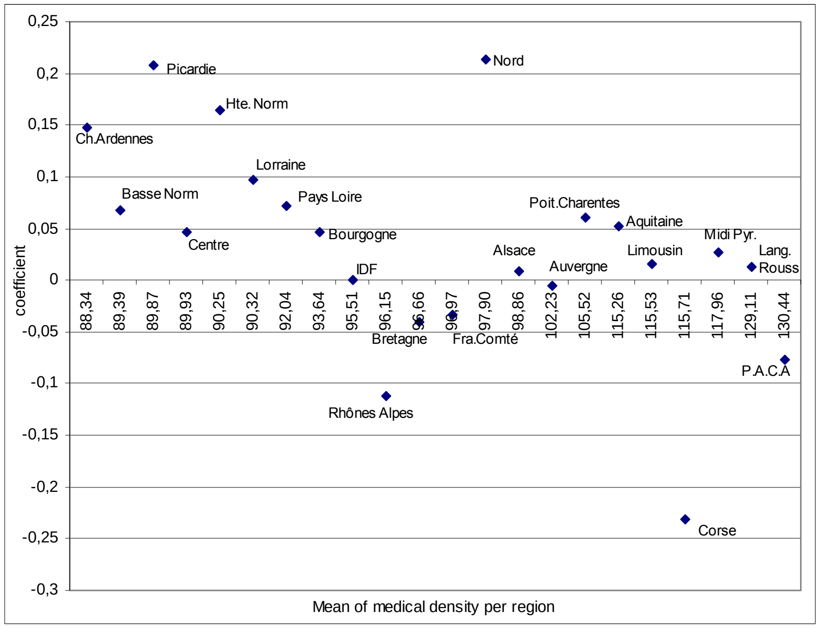


Figure 8: Regional specific effects

5 Stochastic dominance and inequalities between cohorts

We now perform a more thorough analysis of the distributions of earnings, using stochastic dominance tests, to examine whether individual unobserved heterogeneity can compensate for average earnings differences between cohorts.

5.1 Definitions

Let F_C and $F_{C'}$ be the distributions of earnings of two different cohorts. Their cumulative distribution functions (CDF) are $F_C(x)$ and $F_{C'}(x)$, where $x \geq 0$ is the level of earnings.

Definition 1 $F_C \geq_{SD1} F_{C'} \Leftrightarrow \forall x \in \mathbb{R}^+, F_C(x) \leq F_{C'}(x)$, *with one strict inequality.*

If $F_{C'}$ lies nowhere above F_C and at least somewhere below F_C, then F_C displays first-order stochastic dominance over distribution $F_{C'}$. Graphically, it means that F_C is everywhere to the right of $F_{C'}$. In terms of welfare economics, it means that for any $x \geq 0$, the distribution F_C is ranked better than $F_{C'}$ for any welfare function that is both increasing in x and anonymous.

If the two distributions cross, first-order dominance does not hold anymore. One must rank the distributions using second-order stochastic dominance criterion.

Definition 2 $F_C \geq_{SD2} F_{C'} \Leftrightarrow \forall x \in \mathbb{R}^+, \int_0^x F_C(t)dt \leq \int_0^x F_{C'}(t)dt$

If the area under F_C up to x is less than the area under $F_{C'}$ up to x, then distribution F_C is said to (strictly) second-order dominate distribution $F_{C'}$. It means that, for any $x \geq 0$, F_C is a better distribution than $F_{C'}$ for any welfare function with an increasing and concave utility.

Remark 1 $F_C \geq_{SD1} F_{C'} \Rightarrow F_C \geq_{SD2} F_{C'}$. More generally, stochastic dominance of order s implies stochastic dominance of order $s+1$

Remark 2 From Shorrocks [22], scaling up the Lorenz curves to form the generalized Lorenz curve will often reveal a dominance relationship. He suggests to prefer a distribution F_C over a distribution $F_{C'}$ if its generalized Lorenz curve is nowhere below the generalized Lorenz curve of $F_{C'}$. For Thistle [23], generalized Lorenz dominance is equivalent to second-order stochastic dominance.

Graph (9) displays the cumulative distribution functions of 5 cohorts : 1972, 1977, 1982, 1993 and 1999[1]. Overall, 1972 seems to dominate 1977, which dominates 1999 and 1993. 1985 is dominated by all cohorts. As some curves cross, this visual analysis do not lead to robust results. Statistical tests were therefore implemented.

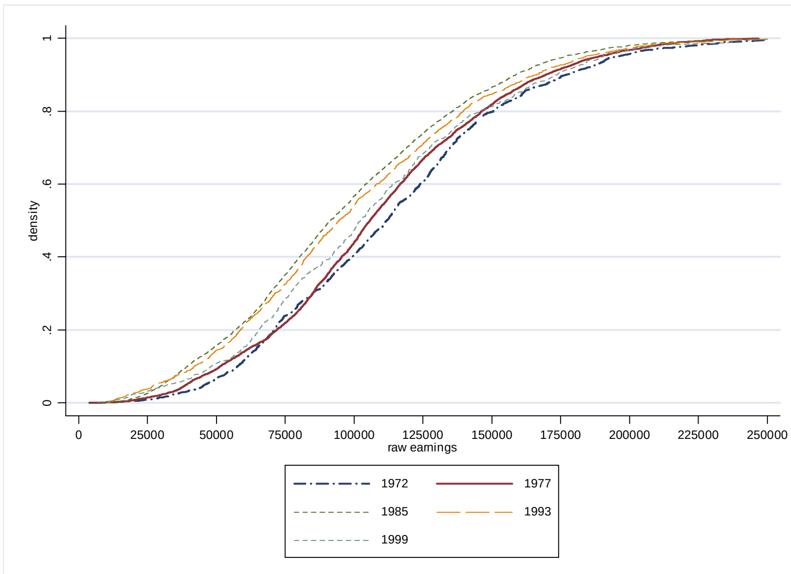


Figure 9: Earnings distributions by cohorts

5.2 Statistical tests of dominance

We follow the methodology used by Lefranc, Pistolesi and Trannoy [15], [16] and by Pistolesi [20] to implement non parametric stochastic dominance tests. In the appendix, we briefly describe their method, based on Davidson and Duclos' work [5].
The conclusions brought by the previous econometric analysis lead us to test whether there is *dominance* of a cohort over another one or not. For all pairs of cohorts C and C', we perform three tests :

1. We test the null hypothesis of first-order stochastic dominance of cohort C over cohort C' and of cohort C' over cohort C. If this test does not give any clear conclusion (*i.e.* if C dominates C' and C' dominates C) we perform test 2. Otherwise, as it means that one cohort dominates another one at different points of the earnings distribution, we may conclude that there are intergenerational inequalities between cohorts C and C'.

[1] We only display the 5 cohorts represented on graph (1) for consistency with the results of the previous section. The analysis was also performed using all cohorts, but we find that the earning distributions of these 5 cohorts are representative of the distributions observed for all cohorts belonging to the same decade.

2. We test the null hypothesis of second-order stochastic dominance of cohort C over cohort C' and of cohort C' over cohort C. Again, without any strong conclusion, we perform test 3. Otherwise, we may conclude again that there are intergenerational inequalities between cohorts C and C'.

3. We test the null hypothesis of equality of cohorts C and C' earnings distributions. If the null hypothesis is accepted, we may conclude that there are no intergenerational inequalities.

The results are presented in table 4. The 1970s cohorts have the highest permanent earnings and dominate all cohorts. Cohorts of the eighties and beginning of the nineties have the lowest earnings. They are first-order stochastically dominated by nearly all other cohorts. New cohorts (1999) have higher earnings than the 1985 and 1993 cohorts but are still dominated by the 1970s cohorts.
Such results would mean that unobserved heterogeneity cannot compensate for average differences between cohorts. Nevertheless, this ranking is performed using raw earnings. Cohorts are compared for different levels of experience and different years. We improve the analysis by combining stochastic dominance tests with microsimulations.

cohorts	1972	1977	1985	1993	1999
1972	-	>2	>1	>1	>1
1977	-	-	>1	>1	>2
1985	-	-	-	$=$	<1
1993	-	-	-	-	<1

Table 4: Stochastic dominance tests for selected cohorts

Note: <s: the column dominates the row for s-order stochastic dominance (s=1 or 2); >s: the row dominates the column for first order stochastic dominance (s=1 or 2); =: the distributions are equal

5.3 Micro-simulations and stochastic dominance

We construct an hypothetical earnings distribution for each cohort. We simulate earnings that physicians would have if they all had the same characteristics. They only differ from each others in their unobserved heterogeneity and cohort[2].
Let $\widetilde{y_{ict}}$ denote the simulated earnings of physician i, at year t, belonging to the c^{th} cohort. One has :

$$\widetilde{y_{ict}} = \overline{D}\widehat{b} + \overline{Z}\widehat{d} + \widehat{\alpha_{10}} + \widehat{\delta_{1995}} + \widehat{\gamma}_c + \widehat{\varepsilon_{ict}} \tag{4}$$

where $\overline{D}$ is the average medical density over the $1983-2004$ period, $\overline{Z}$ stands for male physicians, practicing in Paris as full-independent workers with no Mep specialization and a two-year break before beginning their practice. They are observed in 1995 and all have 10 years of seniority[3]. $\widehat{b}$, $\widehat{d}$, $\widehat{\alpha_{10}}$, $\widehat{\delta_{1995}}$ and $\widehat{\gamma}_c$ are the estimated coefficients from equation (1) and $\widehat{\varepsilon_{ict}}$ are the estimated residuals.
The results are displayed on graph (10) and table 5. Compared to the previous analysis, there are three major differences. Firstly, nearly all cohorts can be ranked using the first-order stochastic dominance criterion. Indeed, differences between cohorts are more pronounced. This means that

[2] Such a micro-simulation analysis has been developed by Bourguignon and *ali.* [4] and used by Dormont and Milcent [8]

[3] Our results do not depend on the year of reference or on the level of experience chosen.

unobserved heterogeneity does not compensate for average differences between cohorts and, even more, heigthens them. Secondly, earnings distributions of cohorts 1972 and 1999 are now equal : with identical characteristics, young cohorts have the same level of earnings as the better-off old cohorts. Thirdly, the 1985 cohort is now first-order stochastically dominated by all cohorts, and more particularly by the 1993 one.
One can notice that earnings dispersion is much lower with simulated earnings. As an example, the Gini coefficient (calculated for selected cohorts) has fallen from $0,250$ to $0,228$ and the Theil-L indice from $0,118$ to $0,093$.

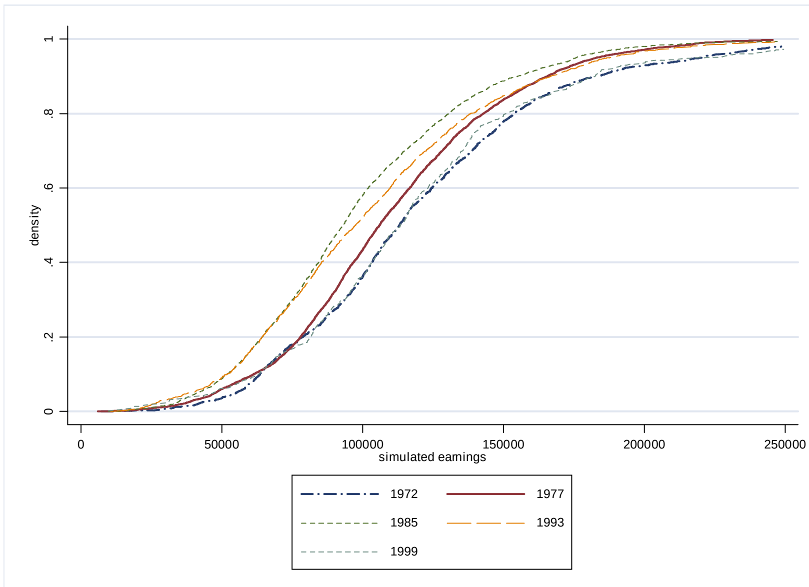


Figure 10: Earnings distributions by cohorts - Simulated earnings

cohorts	1972	1977	1985	1993	1999
1972	-	>1	>1	>1	$=$
1977	-	-	>1	>1	<1
1985	-	-	-	<1	<1
1993	-	-	-	-	<1

Table 5: Stochastic dominance tests for selected cohorts - simulated earnings

Note: $<$s: the column dominates the row for s-order stochastic dominance (s=1 or 2); $>$s: the row dominates the column for first order stochastic dominance (s=1 or 2); =: the distributions are equal (hypothesis accepted at the 0.10 significance level)

6 Conclusion

Our results show that GPs' earnings are affected by very large cohort effects. Intergenerational inequalities due to fluctuations in the *numerus clausus* are far from negligible. The demographic situation that prevails at the beginning of the practice strongly affects GPs' permanent level of earnings. Our stochastic dominance approach shows that earnings differences between cohorts do not disappear when we take the whole distribution of earnings into account. The unobserved individual heterogeneity does not compensate for average differences between cohorts, and even more, heightens them. Given these results, one can wonder whether the raise in the *numerus clausus* decided in France from 2002 on is really appropriate. As a raise in the *numerus clausus* has a negative impact on physicians' earnings, such a policy may reduce the attractiveness of the profession.

Our study on longitudinal data also provides original results on the careers of self-employed professionals. Our estimates are not affected by confusion between cohort and experience effects that arise when cross sectional data are used. In addition, we specify a very flexible form for experience effects and we find that the curvature of the reversed u-shaped experience profile is much more pronounced for GPs than what is usually observed for salaried workers. They concentrate their activity in the first 15 years and then reduce it strongly. Such a result deserves further investigations in order to assess if this result can be the revelation of a strong preference for leisure, which would not be observable for salaried workers whose labour duration is more constrained.

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Appendix : Stochastic dominance tests

The methodology used by Lefranc, Pistolesi and Trannoy [15], [16] and by Pistolesi [20] follows Davidson and Duclos' work [5]. Stochastic dominance can be expressed and statistically tested by making use of the FGT (Foster, Greer and Thorbecke) class of poverty indices. The poverty index at the order s, for a poverty line z, can be expressed as :

$$D^s(z) = \int_0^z (z-x)^{s-1} dF(x) \tag{5}$$

$D^1(z)$ is also called the poverty headcount ratio, *i.e.* the percentage of population below the poverty line z. $D^2(z)$ is the poverty gap, the mean amount of income to give to people below the poverty line so that they can reach it. Foster and Shorrocks [10] have shown that poverty ordering is precisely dominance ordering.

$$\text{For any positive integer } s,\ F(x) \geq_{SDs} G(x) \Leftrightarrow \forall z \in \mathbb{R}^+, D_F^s(z) \leq D_G^s(z)$$

First (second)-order dominance implies that the poverty headcount ratio (the mean poverty gap) is lower for distribution F than for distribution G. More generally, welfare dominance of order s implies that, regardless of the poverty line chosen, the poverty measure is less for distribution F than for distribution G.
The stochastic dominance tests involve testing the inequality $D_F^s(z) \leq D_G^s(z)$ for a set of different possible poverty lines z. Davidson and Duclos show that with a random sample of N independent observations $x_i (i = 1....N)$ from a population, a natural estimator of $D^s(z)$ (for a nonstochastic z) is :

$$\widehat{D^s}(z) = \frac{1}{N(s-1)!} \sum_{i=1}^{N} (z - x_i)^{s-1} I(x_i \leq z)$$

where $I(a)$ is an indicator function, equal to one if a is true and equal to zero when false.

To use non-stochastic z, we divided our sample in two parts : sample A (with the five selected cohorts on which to test stochastic dominance) and sample B (the original sample minus sample A). Poverty lines were computed from sample B and applied to the distributions of earnings of cohorts belonging to sample A. As a physician in sample A will never be in sample B, the two subsamples are independent.
The results of the tests are influenced by the number of chosen poverty lines. For example, we find that 1972 first-order stochastically dominates 1977 when we use only 10 lines (the deciles and the $95th$ percentile) but second-order stochastically dominates 1977 when we use 19 poverty lines (the $5th$, $10th$, $15th$, ..., $95th$ percentiles). Actually, as CDF cross once, using 19 poverty lines is necessary to get more robust results.

We now make use of the notations established by Lefranc, Trannoy and Pistolesi. For a complete explanation, the reader can consult [16].
Let $\widehat{\boldsymbol{D}^s} = (\widehat{D^s(z_1)}, ...\widehat{D^s(z_k)})$ denote the estimated vector of poverty indices, for a set of k poverty lines and $\sum$ its asymptotic variance-covariance matrix. $\widehat{\delta} = (\widehat{\boldsymbol{D}_C^s} - \widehat{\boldsymbol{D}_{C'}^s})$ is the estimated vector of poverty indices for two different cohorts, named C and C'.As cohorts C and C' are independent, the asymptotic variance-covariance matrix of $\widehat{\delta}$ is $\frac{\sum_C}{N_C} + \frac{\sum_{C'}}{N_{C'}}$.
We implement two tests. First, stochastic dominance tests (at the first and second order). If the distributions cannot be ranked, we then test the equality of distributions.

1. **Stochastic dominance tests**

$H0 : \delta \in \mathbb{R}_+^k$ against $H1 : \delta \notin \mathbb{R}_+^k$.
The null hypothesis is defined by a set of k *inequality* constraints. The Wald test statistic is defined as :

$$\begin{aligned} T_2 &= \min_{\widehat{\delta} \in \mathbb{R}_+^k} \left\| \widehat{\delta} - \delta \right\| \\ \text{with } \|x\| &= x' \sum^{-1} x \end{aligned}$$

where T_2 is distributed as a "mixture of χ^2 distributions", for which Kodde and Palm [12] give the lower and upper bounds of critical values. According to Lefranc, Pistolesi and Trannoy, this method has two advantages : the k constraints are tested simultaneously and the test takes the variance-covariance matrix of $\widehat{\delta}$ into account. This statistic is used for both first and second-order stochastic dominance tests.

2. **Equality tests**

$H0 : \delta = 0$. This is a usual Wald test, for which the test statistic is defined as :

$$T_1 = \widehat{\delta}^{'} \left(\frac{\sum_C}{N_C} + \frac{\sum_{C'}}{N_{C'}} \right)^{-1} \widehat{\delta} \longrightarrow \chi^2_k$$

The assumption is that $\widehat{\delta} \longrightarrow N\left(0, \frac{\sum_C}{N_C} + \frac{\sum_{C'}}{N_{C'}}\right)$.