PAYMENT SYSTEMS, FINANCIAL INCENTIVES AND HETEROGENEITY IN HEALTH CARE SUPPLY : EVIDENCE FROM 1078 BREAST CANCER PATIENTS IN A FRENCH AREA.

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1/ INTRODUCTION

Tensions appeared twenty years ago within the western health care financing systems. That's when European governments started to have problems controlling the medical expenses increasing rate. From a macroeconomic point of view this new phenomenon appears when the health expenses rate grows faster than the income per capita (elasticity above one). Medical practice variations were often pointed out as the major cause of this phenomenon observed within OECD countries.

From a microeconomic point of view, there are two main explanations to the heterogeneity of medical practices. The first starts with the works on supply-induce demand : as a matter of fact doctors are able to flex the patients demand curve as they are supposedly better informed then patients upon the therapeutic strategy to apply to their case.

The second, lies within the doctors management of uncertainty. The lack of well established treatments, scientifically based for each pathology leads us to heterogeneous behaviours, sometimes explained by objective socio-economic or clinic differences between the patients' characteristics, sometimes explained by practice style effects. Lastly, the management of uncertainty differs whether the doctor behaves as the patient's perfect moral agent or cares about public health matters.

Our thesis is to say that supply-induce demand and medical uncertainty are only display and that the real matter lies above within the financial context of medical activity. Indeed, the higher the reimbursement rates the more the doctors will be inclined to prescribe and the patients to accept. Furthermore, considering that patients and doctors are risk-adverse, if the health care financing regime as a mean to regulate the whole health care system fails to restrict these natural tendencies, medical practices will be more and more heterogeneous.

To our knowledge works trying to make a link between prices and differences within medical practices are scarce. In the United States some articles put the stress on financial incentives that modify doctors' strategies. In fact, their practices deviate from the expected ones : Drop in the birth rate and overuse of cesarean delivery during the seventies (Gruber, Owings, 1996, Keeler, Brodie, 1993), variability of medical prescriptions upon the patients' insurance (Ligon, 1994, Swartz, Brennan,1996, for example). Nevertheless, in France this type of work has not yet been developed, when two different financial systems are coexisting ie. a Public sector with a prospective payment system like financing regime and a private sector where costs are retrospectively reimbursed according to an official quotation, fundamentally involves different choices of therapeutic policies.

The aim of the study is to find evidences of differences within medical practices due to incentives of two different financial systems.

There is no doubt in our minds that the objective functions of the health suppliers are not the same where the Public sector (public hospital and cancer institutes) attempt to maximise the health output subject to budget constraint, the Private sector attempt to maximise the financial output subject to standard constraints of health output.

2/ BREAST CANCER : EPIDEMIOLOGY, MANAGEMENT OF THE PATIENT TAKE OVER

Breast cancer is a major public health challenge : More than half a million new cases are diagnosed every years in the world (Boyle, 1988) and 24% of new cancers diagnosed for women in Europe are breast cancers. This represents 135 000 new cases per years and makes it the most frequent cancer for western women. In France, the incidence rate is stabilising itself around 77.4% for women after having been growing 2% per year during the last twenty years. Hence 25 000 new cases of breast cancer are diagnosed every year. During her lifetime one woman over 17 will develop a breast cancer (Bremond, 1994).

The breast cancer death rate is 33.7 for 100 000 women and so 18.2% of the whole cancer death rate. The rate increases with age and during time. Thus the breast cancer death rate have been growing about 10% since the late 60's. Nevertheless breast cancer remains a potentially curable disease. The twenty years survival rate for good prognostic breast cancer cases reaches 80%. Yet this rate decreases with the grade of the disease. During the last fifteen years the breast cancer treatment has taken advantage of numerous therapeutic innovations, some are specific to this pathology (adjuvant hormonotherapy), some are coming from cancerology general

innovations over solid tumours (hematopoïetic growth factors making possible intensive chemotherapy, the peripheral blood stem cells / bone marrow swap, the taxans new drug class, the new picturing techniques useful for early diagnosis and relapse detection). This pathology stands aside from others for its needs of numerous different specialists such as surgeon, oncologist, chemotherapist, radiotherapist, anatomo pathologist, tumour's biologist..., and offers large fields of investigations. Thus, both private and public hospitals are taking over breast cancer patients.

For these reasons, breast cancer is often taken as a typical example for medical activity in general and cancerology in particular. It is representative for the coordination of the activities it requires

3/DATA

This study is based upon an investigation by the health-insurance-fund into 1078 female breast cancer patients from a south-eastern French region who asked for the exemption of patient's contribution towards medical treatment cost, in the first half of 1994 and who have been followed up to the end of the treatment. The follow up began with the screening and stopped at the end of the primitive treatment. The treatment was made by one or more of the following sequences : surgery, radiotherapy and chemotherapy.

The factors taken into account for our analysis are the following : the characteristic of the patients (age and socio professional classes), the main characteristics of the diagnosis (the axillary nodes, the SBR grade and the tumour size), the speciality of the physician, the institutional sector of hospital, the dates and a qualitative description of treatment (type of surgery and radiotherapy, molecules and doses used in chemotherapy). And this for each step of the treatment.

About chemotherapy we looked first on the choice to give the patient a chemotherapy treatment or not, then on the choice of molecules and then especially on the way the treatment was given to the patient.

We used the "Standards, Options et Recommendations (SOR)" manual, written by a group of experts on the base of scientific data available on breast cancers, it offers standards and treatment options as well as counsels on the take over of this very pathology.

Usually, the standard treatment stops after surgery and radiotherapy for the good prognostic breast cancer, but if at least one prognostic factor goes down, the patient gets an adjuvant poly-chemotherapy and a radiotherapy after the surgical act.

The explanation of different practices by different financing schemes coming from institutional discrepancies is supported by econometric and statistic results. We have used logistic and linear regressions to point out the explicative factors in the determination of the treatment .

4/PAYMENT SYSTEMS AND CHEMOTHERAPY PRESCRIPTION'S BEHAVIOURS

4.1 Access to chemotherapy

A synthetic rule of decision

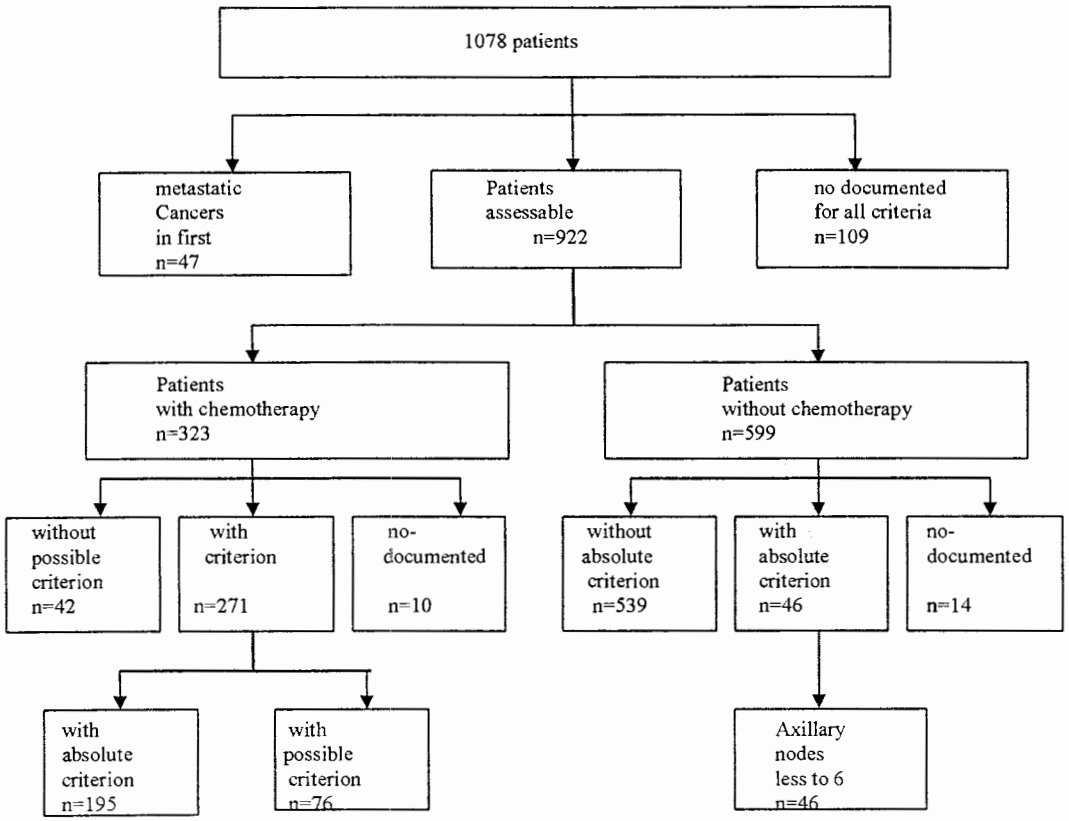
The clinician's decision to give or not an adjuvant chemotherapy depends on the observations of several prognostic factors. The rule of decision may be complex.

Nevertheless we can define a synthetic rule of decision based on two criterion
Absolute criteria : axillary nodes > 6 and age < 70 years' old
Possible criteria : axillary nodes > 6 and age > 70 years' old

Or no axillary nodes and tumour's size > 2 centimetres
Or no axillary nodes and SBR grade (histological grade) = 3
Or no axillary nodes and age < 40 years' old
Or no axillary nodes and negative hormonal receptors

The figure 1 shows that the therapeutic choice seems to respect the synthetic rule of decision above.

Figure 1
Access to chemotherapy



Explicative factors of the prescription of chemotherapy

We have shown above that the decision to give a chemotherapy or not depends on clinical characteristics. We use our 922 assessable patients to make a logistic regression explaining this decision.

You will find in the table 1 the β coefficient matching the independent variables modality, the p-value matching the Wald test, and the β exponential witch represents the variation factor of the occurrence probability.

The results of the regression confirm the rough idea given by the figure 1. The youth (age below 40 years' old), the positive axillary nodes, the high SBR grade (3 and above), the tumour histological size (pT3) are all pejorative factors that heighten the probability of a treatment by chemotherapy. The foretelling power of the model is quite good (nearly, 78% of the event are foretold accurately) even if the non prescription prediction is more efficient (90.84%) than the prescription (54.79%).

Table 1
Explicative factors to have a chemotherapy
Dependent variable : chemotherapy (0 : no, 1 :yes)
n=922

Variable	Modality	β	p-value	exp(β)
age			0,0000	
	[0, 40[	3,0989	0,0000	22,17
	[40, 60[	2,2757	0,0000	9,73
	[60, 70[	1,2701	0,0000	3,56
Axillary nodes	N>6	2,3794	0,0000	10,80
SBR grade			0,0000	
	SBR I	-1,7395	0,0000	0,18
	SBR II	-2,5699	0,0000	0,08
	SBR III	-1,2258	0,0000	0,29
Tumour's size			0,0000	
	pT 1	0,7210	0,0003	2,06
	pT 2	1,0451	0,0414	2,84
	pT 3	1,9674	0,0012	7,15
constant		-1,4115	0,0000	

Method of estimation : maximum of likelihood and backward elimination

Total of :independent variables
- age (reference category: age > 70 years)
- Axillary nodes (: N ≤ 6)
- SBR grade (: SBR IV)
- Size of the tumour (reference category : pT0)
- type of surgery

4.2 The choice of drugs

What poly-chemotherapy and at what price?

On the whole, 323 patients have been treated by chemotherapy, for a total of 1908 cures (6 cures for each patient on the average). 17 different drugs have been used alone or combined together which gives 59 combinations of one to 7 different drugs.
Antracyclins are very often used for 93% of poly-chemotherapy counts one of them.

Table 2
Molecules of anthracyclins used for chemotherapy

Drug		Patients		Cures	
Name	*Molecule*	*Number*	*% of total*	*Number*	*% of total*
Adriamycine ®	Doxorubicine	33	10.22	155	8.13
Farmorubicine ®	Epirubicine	78	24.15	474	24.83
Theprubicine ®	Pirarubicine	33	10.22	238	12.48
Novantrone ®	Mitoxantrone	156	48.30	832	43.58
Total		300	92.89	1699	99.02

The most frequent poly-chemotherapy are type FC and counts 3 moleculs :an alkylant (in general Endoxan), an anti-metabolic (5FU) and an antracyclin. The treatment of type FC represents 60% of the cures.

Table 3
The most frequent poly-chemotherapies

Poly-chemotherapy		Patients		Cures		Public price
Generic term	*making*	*Number*	*% total*	*Number*	*% total*	*($ 1997)*
FAC	Endoxan ® + 5-FU ® + Adriamycin ®	12	5.39	83	4.35	749
FEC	Endoxan ® + 5-FU ® + Farmorubicin ®	44	13.62	379	19.86	908
FTC	Endoxan ® + 5-FU ® + Theprubicin®	19	5.88	120	6.31	1264
NCF	Endoxan ® + 5-FU ® + Novantrone ®	99	30.65	569	29.81	1701
Total		174	53.87	1151	60.33	

The therapeutic efficiency of each chemotherapy is nearly the same. On the other hand, the list of their side effects is not the same. The side effects of antracyclins are principally cardiac toxicity, marrow depression, nausea, vomiting and hair loss. But intensity of side effect for each antracyclin is not the same. For theprubicin, the effects are lessened . With Novantrone, all side effects are reduced especially cardiac toxicity and hair loss.

Prescriptions and institutional structures : is the price influencing the choice of drugs within chemotherapy?

The four poly-chemotherapy we choose constitute the main body of our data base (the 55 others combinations concerns less than half of the patients),they differ only by the choice of the antracyclin.

We tried to explain this choice with 4 logistic regressions were the dependent variable is the choice of one of the antracyclin against the three others. The independent variables were the same in each model. In this paper, only the Novantrone choice regression results are display below. In fact, the results of the three other models are symetric.

Table 4
Novantrone® versus others drugs in the FC polychemotherapy
Dependant variable : using Novantrone® (0 : yes, 1 : no)
n=238

Variable	Modality	β	p-value	exp(β)
Institutional Structure	private	1,2378	0,0000	3,4479
constant		-0,6538	0,0068	

Method of estimation : maximum of likelihood and back ward elimination

Total of :independent variables
age (reference category: age > 70 years)
Axillary nodes (: N ≤ 6)
SBR grade (: SBR IV)
Size of the tumour (reference category : pT0)
Chemotherapy in first : yes or no (reference category : no)
Speciality of the physician : internal medicine, radiotherapist, gynaecologist, oncologist, others (reference category : others)
Institutional structure : private, public (reference category: public)

The results are presented in the table 4.

We obtained that only the type of institutional structure seems statistically significant and the probability to have a chemotherapy with Novantrone is 3.5 times more important in the private than in the public structure.

The model we built is accurate (more than 2/3 of the choices are correctly predicted). Above all it is efficient for the Novantrone prescription (80% are correctly predict).

One could object that the choice of Novantrone could be explained by others qualitative differences concerning the patients selection others than the ones already included within the model.

In the other words, a sub group of patients with identical clinical characteristics would go to a type of establishment when another sub group again with the same clinical characteristic would go to the other, warping so the selection. The result of the table 5 enable us to counter this kind of argument.

Indeed the patients clinical characteristics are statistically the same, remaining behind the 0,05 usual level of signification from one institutional structure to the other.

The type of structure that takes the patients over is relevant even if it's not the only one.

Financing mechanism linked with the private sector implies incentive to give the most expensive drugs which are also the least toxic ones. Each day of hospitalisation is reimbursed to private hospital and patients' insurances pay chemotherapy. Within such a context, there's no need for a private establishment to barker the price of chemotherapy drug. Even worse the establishment charges 30% of the price as prescription fees and management expenses. On the other side public establishments have a very different objective function to optimise for their general

mission entrusted by the hospital manager, is to lower the cost of pharmaceutical products negotiating public prices or choosing cheaper molecules with the same therapeutic efficiency even at the price of more important or more numerous side effects.

Table 5
Clinical characteristics of patients
And institutional structure

Variable	Modality	Institutional structure (i) public					Institutional structure (i) private					P-value (ii)
Criteria	possible	22	(	**0,2245**[1]	;	*0,2973*[3])	52	(	**0,3059**	;	*0,7027*[4])	**0,151**
	absolute	76	(	**0,7755**[2]	;	*0,3918*)	118	(	**0,6941**	;	*0,6082*)	
Axillary Nodes	0≤N<6	102	(	**0,8644**	;	*0,3969*)	155	(	**0,8289**	;	*0,6031*)	**0,407**
	N≥6	16	(	**0,1356**	;	*0,3333*)	32	(	**0,1711**	;	*0,6667*)	
PT (size of the tumour)	pT 1	69	(	**0,5520**	;	*0,4233*)	94	(	**0,4821**	;	*0,5767*)	**0,215**
	pT 2	38	(	**0,3040**	;	*0,3248*)	79	(	**0,4051**	;	*0,6752*)	
	pT 3	7	(	**0,0560**	;	*0,3684*)	12	(	**0,0615**	;	*0,6316*)	
	pT 4	11	(	**0,0880**	;	*0,5238*)	10	(	**0,0513**	;	*0,4762*)	
SBR (histological Grade)	grade I	12	(	**0,1224**	;	*0,5000*)	12	(	**0,0694**	;	*0,5000*)	**0,080**
	grade II	52	(	**0,5306**	;	*0,3969*)	79	(	**0,4566**	;	*0,6031*)	
	grade III	34	(	**0,3469**	;	*0,2931*)	82	(	**0,4740**	;	*0,7069*)	
age (years)	mean	51,80					53,75					0,149

(i) 1 + 2 = 100% and 3 + 4 = 100%

(ii) $\chi 2$ or Fisher test

4.3 The choice of dose and duration of the treatment

We have choose two indicators to determine the way of the drug are given : the dose per day and the duration of the treatment.

Division of dose and increase of the duration of the treatment : The financing systems effects.

The manual of the SOR recommends the respect of a minimal dose per day for each molecules to keep the best efficacy. The doses are prescribed in milligrams per square meter.
The variability of the doses is may be due to some clinical factors. We think nevertheless that the patients' characteristics alone can't explain every difference in the way the treatment is given to the patient. For us, as like the choice of the drugs, the status of the establishment who has the patient in change is relevant to explain the modalities of treatment.

This study of average dose per day plainly enable us to identify the institutional sector as a relevant factor for practice variability.

It's strikingly clear using linear regressions in the case of two key drugs 5FU and Endoxan (Table 6 and 7).

So, in the case of 5FU, the mean dose per day given to patients amount to 406 milligrams per square meter without the contribution of explicative variables (table 6). More, the results show that the public structure v variable has as effect to increase the dose per day given to patients (42%).

We obtain the same type of results for Endoxan.

Table 6
Mean dose per day (in mg)
Drug : 5 FU®
n=143

Variable	coef.	coef. std	p-value
grade : SBR II	85,025	0,232	0,037
grade : SBR III	94,648	0,259	0,023
Radiotherapist	99,958	0,252	0,004
Public structure	172,052	0,442	0,000
constant	405,919		0,000

Method using : OLS and backward elimination

Independent variables :
- age : 0-40, 40-60, 60-70
- Axillary nodes : N > 6
- grade SBR : SBR I, SBR II, SBR III
- Size of the tumour : pT 1, pT 2, pT 3, pT4
- Chemotherapy in first : yes
- Speciality of the physician : internal medicine, radiotherapist, gynaecologist, oncologist.
- Institutional structure : private, public

R^2 corrected = 0,180, Durbin-Watson=1,810

Table 7
Mean dose per day (in mg)
Drug : Endoxan®
n=143

Variable	coef.	coef. std	p-value
Radiotherapist	169,618	0,643	0,000
Public structure	276,975	1,050	0,000
constant	263,832		0,000

Method using : OLS and backward elimination

Independent variables :
- age : 0-40, 40-60, 60-70
- Axillary nodes : N > 6
- grade SBR : SBR I, SBR II, SBR III
- Size of the tumour : pT 1, pT 2, pT 3, pT4
- Chemotherapy in first : yes
- Speciality of the physician : internal medicine, radiotherapist, gynaecologist, oncologist.
- Institutional structure : private, public

R^2 corrected = 0,198, DW=1,869

Results perfectly symmetric can be obtained with the length of the treatment (Table 8 and 9).

The length of the treatment (for 5FU and Endoxan) in days is shorter in public structure (30% for 5FU and 40% for Endoxan) aside the usual patients' characteristics (tumour's size, SBR grade and axillary nodes) that influence the duration of the treatment too.

Table 8
Duration of the treatment (in day)
Drug : 5 FU®
n=143

Variable	coef.	coef. std	p-value
Size : pT 3	6,679	0,177	0,031
Grade : SBR II	-3,313	-0,216	0,048
Grade : SBR III	-3,827	-0,251	0,025
Radiotherapist	-4,328	-0,261	0,003
Public structure	-4,834	-0,298	0,001
Axillary nodes N < 6	-4,421	-0,174	0,037
constant	23,090		0,000

Method using : OLS and backward elimination

Independent variables :
- age : 0-40, 40-60, 60-70
- Axillary nodes : N > 6
- grade SBR : SBR I, SBR II, SBR III
- Size of the tumour : pT 1, pT 2, pT 3, pT4
- Chemotherapy in first : yes
- Speciality of the physician : internal medicine, radiotherapist, gynaecologist, oncologist.
- Institutional structure : private, public

R^2 corrected = 0,210, DW=1,817

Table 9
Duration of the treatment (in day)
Drug : Endoxan®
n=143

Variable	coef.	coef. std	p-value
Size : pT 3	7,813	0,193	0,007
Grade : SBR II	-4,506	-0,274	0,008
Grade : SBR III	-6,004	-0,367	0,001
Radiotherapist	-6,730	-0,378	0,000
Public structure	-7,217	-0,413	0,000
constant	25,187		0,000

Method using : OLS and backward elimination

Independent variables :
- age : 0-40, 40-60, 60-70
- Axillary nodes : N > 6
- grade SBR : SBR I, SBR II, SBR III
- Size of the tumour : pT 1, pT 2, pT 3, pT4
- Chemotherapy in first : yes
- Speciality of the physician : internal medicine, radiotherapist, gynaecologist, oncologist.
- Institutional structure : private, public

R^2 corrected = 0,297, DW=1,427

Financial incentives and health efficiency

It seems that the division of doses and the increase of duration are more important in private structure than in public structure. Can the financial system incite to this practice?

Actually, the possibility to invoice each day of hospitalisation and each open packaging of drug, even if the totality of this is not completely used, can incite the private structure to this practice.

5/CONCLUSION

Medical practices heterogeneity gave grounds to numerous economic works and various types of explanations have been put forward. Supply induced demand and doctors management of medical uncertainty are the most frequent.

The coexistence of two different financial systems, prospective payment and retrospective payment allowed us to test hypothetical influence of a financial system upon medical practices.

More specifically within the precise field of chemotherapy for non-metastatic women breast cancer in a given French administrative region our hypothesis is confirmed for some therapeutic aspects.

Of course there is no significant statistical relation between the status of the hospital and the decision to start a chemotherapy; the decision primarily depend on the patient clinical features, nor is there any between the status of the establishment and regards for minimal doses.

On the others hand, our regressions did confirmed our hypothesis of a relation first between the payment system and the choice of drugs, second between the payment system and the way these drugs were administered. Indeed we observed that hospitals under prospective payment have financial incentives to use the cheapest drugs for a given therapeutic efficiency even if these have unwanted side effects upon the patients quality of life. They also tend to prefer associating high daily dosage in a shorter number of days. Hospital under retrospective payment submitted to strictly opposite financial incentives are showing a precise symmetric behaviour.

In a medical field witch stand aside from others for its high standardisation, fruit of medical consensus, it is interesting to remark that this variability hits elements where standardisation gives way to individual discussion. The choice of antracyclin and the posology.

Reading our results, one may think that medical practice is not only based upon the bare patients clinical characteristics or upon an eventual practice style effect but that medical financing systems' heterogeneity may conditioned medical practice heterogeneity. It is crucial then to carry on our line of research : for if different financing systems really imply different therapeutic strategies even slightly different, ethic demands that we test their efficiency.

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