Commitment to social fares : the "Familles Nombreuses" card case study, a stated preference approach

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Introduction During the past 20 years, public sectors faced many changes. These changes cause trouble for the way public authoritues step in. Organization and financing of public service obligations are one of the most difficult point. Thought is continuing with debates about general economic interest services. On the one hand, European Union doesn't forbid to set up public utilities. But on the other hand, terms of financing have to be evaluated wuith essential rules for State subsidies. Public utilities obligations financing hase caused an active discussion in european instances, about doctrine and law interpretation. Concerning this point, Altmark judgement i snow a reference point. It records incontrovertible criterias and gives the common european basis for State subsidies and for firms in charge of economic interest services :

- public utilities obligations have to be clearly and beforehand defined ;
- calculation criterias of compensation have to be objectively and with full transparency implemented;
- subsidy cannot go past what is necessary to cover the public utilities obligations

costs, and must take int consideration an intelligent profit.

It exists a fourth critera when firm in charge of public utilities obligations has not been chosen by invitation to tender, but directly. In that case, subsidy must be determined on comparison with costs put up by an average and well administrated firm, considering revenue and reasonable profit too. Another element has to be taken into consideration: it is often considered that public utilities obligations could not be set up with commercial modalities and had to be necessarily financed by community. But we can observe that firms set up other services whose content and prixe can make public utilities obligations obsolete. For example, the competition between commercial and social fare.

On that point of view, "Familles Nombreuses" social fare is a typical case :

- can we determine the social advantage of this tariff?
- How can we estimate its cost which has to be logically recouped?
- What make difference between social tariff and commercial tariff set up by the firm own initiative ?

This paper aims at providing quantitative components in order to estimate opportunities to restructure this social tariff in collaboration with SNCF and highlight hypothetical pathes to some reforms. First we explain history and bauises of "Familles Nombreuses" card. Then we explain the stated choice survey we implemented to bring into light the attachment to different characteristics of this card. And finally, we present the logit mixt estimation results. This model leads to sustainable results and permits to evaluate after some possibilities of changing, for firm and community.

1.The "Famille Nombreuses" Card

1.1 Description and using

SNCF proposes social tariffs. They are preferential fare imposed by the State. They aim at supporting the access to railway for some people or some types of runs. Eight tariffs have this denomination [1]. As they are public utilities obligations, they are supported financially. [2]. They have a main characteristic: all users enjoy discounts without any constrainst in tem of travelling period or booking pre-emption in comparison with other commercial fare. It implies there is no quota for social fare, they are always available in all trains, except when the train is full. "Familles Nombreuses" Card is a social tariff. It has been created in 1921 (by a law about the new railway regime). The goal was to help large families in order to relaunch natality after the First World War. Since the creation, "Familles Nombreuses" Card has been changed many times,

[1]There are eight social tariffs : season tickets for workers, season tickets for schoolchildren, students and apprentices, tariff for paid holiday, civil disabled person guides, children walk for school trips and dead militaries families during the First World War

[2]Social tariffs are defined and imposed by the State. They are supported in accordance with SNCF requirements (article 32) and a inside tranport law (LOTI – article 24). The compensation goal is account equilibrium. In 2005, compensation amount to 350 M€

principally enlargment of beneficiaries. But, application and using conditions have been changed rarely.

The card offers 30 to 75% fare for families with 3 children or more aged of 18 years old. They can use it for individual or family trips. There are 1,8 million card today (72% cards with 30% fare, 17% cards with 40% fare, 6% cards with 50% fare, 4% cards with 75% fare). Eligible people are in majority families with 3 children. The very large families are in fact rarer and rarer. The distribution is the same in families who have a card.

"Familles Nombreuses" Card produces the majority revenues of social tariffs before the paid holiday tariff and season tickets, with 36% in 2005 (long distance and regional traffic). 6,5 millions trips made with this card in 2005, in majority in the second class (90%), but also in the first class (10%), more than other social tariff (3%).

Finally, we would emphasise on one point : "Familles Nombreuses" Card is historical, very old and has a symbolic meaning. For users and families associations, it is more than a simple condition to have a train discount.

1.2 "Familles Nombreuses" Card defaults and dysfunctions

In spite of its symbolic meaning and its strong attachment, "Familles Nombreuses" Card calls into question now. Its interest and its social redistributive effect seem to be questionable (for other social tariffs too).

The first question deals with the financing. The compensation became fixed since the early 2000's for longue distance traffic. It means that the firm has no visibility on the subsidy distribution for each social tariff. It means that the compensation amount is not indexed on traffic changings too. Compensation is reducing gradually (-27% between 2002 and 2007) whereas traffic is reducing more slowly (-4%). This fall questions about the State public interference on these social measures. If the compensation would be reduced over, what do "Familles Nombreuses" card and other social tariffs become? This question is quite important in public utilities liberalization context in Europe which seeks more profitability and transparency and takes a new look at traditional modalities public utilities obligations financing.

Secondly, questions appear about the "Familles Nombreuses" card basis and use. On the one hand, demographic progresses in French society make this tariff frail. Families are less and less large and their trip behaviour has changed. They run more and more with less expensive and more practice car. Railway is the exclusive way of land transport no more, as in the 1920's when the social tariff has been created. On the other hand, "Familles Nombreuses" card interrogates about its use. It is not now used in respect of its original goals. It's more and more used for professional trips whereas it has been created for family trips; 17% trips with "Familles Nombreuses" card have a professional pattern. To explain this problem, we can take the example of the trips distribution during the week and according to the class. In the first class, "Familles Nombreuses" card is used essentially from Tuesday to Friday (77% during the week, and 23% during the week end). In the second class, "Familles Nombreuses" card is used essentially during the week end (62%). Moreover trip destinations of "Familles Nombreuses" card beneficiaries are destinations sometimes considered as professional destinations.

In addition, social and demographic characteristics of beneficiaries contravene the

original redistributive objective of this tariff. Families who own a “Familles Nombreuses” card are in majority executives families (40%) and only 5% worker families, whereas in French large families worker families are in majority.

Social tariff traffic have been cut down because of a double competition : the competition of other mode of transport and the competition of commercial tariff range which compete against social tariff with attractive reduced fare for all. Since 1996, trips with “Familles Nombreuses” card have reduced slowly but gradually. The fall is clearer since 2002. Concerning the revenue, we can observe a small drop too (1 or 2% per year). The part of “Familles Nombreuses” card has decreased of 39% between 1980 and 2000 and of 6% between 1996 and 2000. This decrease is general for all social tariffs (-24% between 1980 and 2000).

This watchings question about the existence, presence and legitimacy of social tariffs all the more, so the redistributive efficiency is not proved if you want to give a really social aim to this card. Nora [3] and Guillaumat [4] French reports suspected this point too. Nora suggested finding other manner to obtain the same effects. Guillaumat came to conclusion that *“the efficiency of these measures interrogates because the objective has a so important social meaning no more or because intervention ways are adapted no more”*. Both reports advised a detailed analysis of “Familles Nombreuses” card and the financing by French familial allocation fund, which would be the preamble before a change in a direct aid.

1.3 A necessary reform

Because the “Familles Nombreuses” social tariff financing is more and more problematic, because it is no more in adequacy with the original goal and because dysfunctions are numerous, the question of a reformation and a better use of public money are now open. It’s an active question for SNCF which have to arbitrate between social and commercial goals and for the State which has to set up the transport right but also takes into consideration liberalization and regionalization of public utilities.

However reforming a tariff is not easy. Determining possibilities supposes to have a great knowledge of studied item, to evaluate needs and smelling of people who use th tariff and perceive all constraints. The case of “Familles Nombreuses” card is complex because it is today without any constraints and it is quite symbolic. How can we change a so advantageous tariff without sparking off an active reaction from users and families associations? For this delicate job, the most appropriate method to test out amendments of “Familles Nombreuses” card is the stated choice method. It lets to estimate characteristics “Familles Nombreuses” card weight in the choice of users, characteristics which would support the acceptability of changing and the characteristics which would jam the changing on the contrary. From this point, it is possible to test the acceptability of some reforms, to determine a subscription rate and to calculate benefits or losses for users, SNCF, and the State. This method is interesting because it is simple, little expensive and lead to evaluate the attachment of beneficiaries for their card.

2. Setting up of the stated preference survey

[3] Rapport sur les entreprises publiques, avril 1967

[4] Rapport "Orientations pour les transports terrestres, février 1978

Stated preference methods provide us a great opportunity to evaluate how "SNCF famille nombreuses" card holders consider the advantages given by their cards and more in detail, which characteristics are source of satisfaction. Stated preference surveys permit to estimate the influence of some characteristics, usually called attributes, on users' utility while making a choice. However, because estimation are based on declared choices, a certain bias remains, nothing warranting that declarations will become effective (Louviere, 2000). This is the whole challenge while building up a stated preference survey, to control the potential bias thanks to a precise methodology.

Stated preference surveys concept is to confront respondents to fictive situations and to infer from their choices, the attachment to tested characteristics. In our survey, respondents had to choose between two cards, the "famille nombreuses" card they actually had and a fictional one[5]. The fictional cards that are tested are made up with the attributes we'd like to test. While choosing between the two cards, respondents reveal the card providing them the highest level of satisfaction and corollary to deduce the relative importance of attributes selected by the analyst.

2.1 Attributes identification

The first step, while building up a SP survey is to select the attributes. These attributes are the only components of the fictive card and must therefore be representative of the card characteristics in real market place. Facing the situations described during the survey, each respondent must be confronted to a real evaluation about which situation would be the most profitable in terms of satisfaction. Fictive situations must be realistic, acceptable and effective (Raux, 1995). In order to do so, attributes must be carefully selected and should not overtake 4 or 5 in order to insure that respondents really take into consideration all described parameters. Attributes must respect some conditions (Pearman and al., 1991):

- They must be clear determinants of the real choice and not only important parameters ;
- They must describe the situation or the product in order to make the judgement based on main components ;
- They must be independent and not iterative attributes, the presence of one of them should not imply the presence of another

Dans le cas de notre étude, nous souhaitons estimer dans quelle mesure les détenteurs de la carte seraient susceptibles de renoncer à/aux privilège(s) qui leur sont offerts par la carte. Il ne s'agit donc pas d'identifier les attributs à la base des comportements de choix mais bien d'identifier **(a)** la ou les caractéristique(s) de la carte sur lesquelles la SNCF est susceptible d'agir pour faire évoluer ce tarif social et **(b)** le(s) levier(s) d'action auxquels les familles nombreuses sont sensibles.

In the context of our study, we want to estimate how card holders would react to some new constraints imposed on their travelling conditions. We do not want here to identify

[5]Between these two cards which one would you choose?

parameters on which users are basing their behaviours when they choose to use train but to highlight **(a)** the card characteristics on which the SNCF may focus to consider fare evolutions and **(b)** the catalyst , the users are sensitive to.

The SNCF fare policy is based, from some years now, on yield management. "Familles nombreuses" card holders have no constraints about their travel conditions. They can benefit from their discounts whenever they travel and even if they book just before departure time. The "SNCF" is therefore interested in knowing if they could implement some incentives in order to impact card holders travel habits. This could eventually lead to more booking pre-emption, and so vacate seats for customers with higher willingness to pay who do have slighter discounts. That's why we included "the departure time" and "booking pre-emption" as two attributes of the new card.

Some pre-information we got on card-holders travel habits showed that some companies used the discounts of their employees to finance business trips. Considered as an improper use, we also tested how card holders would react to a new condition imposing them to travel with a child.

In compensation of these new restrictive rules, an additional discount is offered to card-holders[6]

Each card holders have an Utility function made of these four attributes: the discount rate (P), the constraint to travel at least with a child (E), the constraint to book some days before (R) and a modulate discount respect to travel time[7].

$$U_i = \beta_{pi}.P^a + \beta_{ci}.C^a + \beta_{ri}.R^a + \beta_{ei}.E^a + \varepsilon_i$$

2.2 Attributes levels identification

The attributes being chosen, their levels must be identified. Each possible combination of all attributes will set-up the range of fictitious cards to be tested during the survey. Confronted to different cards, card-holders will evaluate all cards in different way and reveal the importance given to all attributes. So as to produce real comparison, leading users to weigh each times the pros and cons, it is crucial to select levels with significant differences in respondents' minds.

Table 1: Attributes and levels of the SNCF survey

Attributes	Attributes levels
1. accompanying constraint	I'm free to travel alone
	I must travel with a child
2. Booking	I book whenever i want to, even at the last moment

[6] added to the based discount rate of holders, 30%, 40%, 50% or 70%.

[7] The SNCF propose peak and off peak fares respect to travel time

pre-emption constraint	
	I must book at least 2 days before
	I must book at least 5 days before
	I must book at least 1 week before
3. Travelling time constraint	I benefit the same disount whatever the time of my trip
	I benefit a different disount if i travel during peak or off peak period, +5% discount during off peak period and -5% discount during peak period
	..., +10% discount during off peak period and -10% discount during peak period
	..., +15% discount during off peak period and -15% discount during peak period
4. additional discount	+0%
	+5%
	+10%
	+15%

Having chosen only few attributes with common number of levels, it is easier to design the experiment and to respect statistical properties of stated preference surveys.

2.3 Trades off construction

Each card created with the attribute make a different situation. Each respondent have to make here a binary choice between two cards, all these binary combinations create a trade off. In this experiment, each trade off is made of a fictitious card and the actual one (a) to ensure that the trades off are realistic (b) because our survey have been run on phone. From our attributes, 128 cards have been generated. They are all randomly proposed to the whole sample. Each one of the 1000 persons questioned had to face three successive trades off adapted to the actual card discount they have.

In order to create real evaluation of each card, all trades off with a clear dominant card must be taking off the experiment. In the same manner, the three trades off successively proposed must create different valuations. The final design of the experiment have not been made with fractional factorial design, but all dominant situations have been avoided. Our final experiment simultaneously respect some basic methodological principles (Huber and Swerina, 1996):

- **(a)** the design is balanced, each attribute level is tested a quasi identical number of times;
- **(b)** the design is orthogonal, all combine of attributes level occurs with the same

frequency in the experiment;

- **(c)** The utility is balanced, because all dominance have been deleted

2.4 Implementing the survey

We have seen, commenting on the three building steps of an SP experiment that an important methodological framework, based on past researches and theory, ensure a good design of the survey. However, this framework is not sufficient to confirm that the results will have no bias. Beyond statistical properties, some other conditions, common to all surveys must be respected. They permit to avoid what is generally gathered under the terms of formulation and revelation bias (Andan et al., 1995). To minimise them, the questionnaire must be clearly written, all interviewers have to be well trained and tests must be done.

The tests have been run by six different interviewers, each one testing it 5 times. Based upon commentaries, the questionnaire has been corrected and optimised. During the telephonic interviews, a precise survey guideline had to be followed, focusing especially on **(a)** explaining why this survey was conducted, **(b)** how interviewer should present trades-off, **(c)** how to repeat questions when respondents did not understand, **(d)** how to use incentives and non destabilising sentences to help respondents launching themselves into the fictitious situations.

Implementing a SP survey is a heavy and tricky process but which brings great information when it is carefully done. Our survey is kind of specific, confronting always a created situation to the existing one. During the conception, great strains have been focused on practical and methodological aspects of SP surveys. Estimations have then been made with LOGIT and mixture LOGIT models. The original questionnaire is attached hereinafter (1st annex)

3 Estimation of a mixed logit model

3.1 The multinomial logit

The utility of a card with caracteristics x^a is :

$$U(x^a, \beta) = \beta' x^a + \varepsilon^a$$

, with

$$\beta' x^a = \beta_0 + \beta_p p^a + \beta_c c^a + \beta_r r^a + \beta_e e^a$$

. p, c, r, e being the percentage of reduction, the peack load differential, the number of days of reservation and the fact that traveling with a child is mandatory.

The coefficients are the marginal utilities of the attributes and are therefore not dircetly meaningfull. If, for example, on considers the supplementary percentage of reduction which is equivalent to one more day of reservation, one gets :

$$\Delta U = \beta_p \Delta p + \beta_r \Delta_r = 0$$

which implies :

$$\frac{\Delta p}{\Delta r} = -\frac{\beta_r}{\beta_p}$$

The strength of an attribute, expressed in percentage of reduction is so the coefficient associated to this attribute divided by the percentage of reduction coefficient.

The present card, denoted o is : $x^o = (p^o, 0, 0, 0)$ where $p^o = 30, 40, 50, 75\%$ depends on the size of the family. One person would whoose the new card if :

$$\Delta U = U(x^a, \beta, \varepsilon^a) - U(x^o, \beta, \varepsilon^o) = \beta' \Delta x + \varepsilon^a - \varepsilon^e \geq 0$$

If the error terms follow a Gumbell distribution, the probability of choice is :

$$P(\Delta x, \beta) = \frac{e^{\beta' \Delta x}}{1 + e^{\beta' \Delta x}}$$

β are the marginal utilies of the attributes. If they are the same for all the individuals, the probability that an individual i chooise the card a is :

$$P_{ia} = P(\Delta x_{ia}, \beta) = \frac{e^{\beta' \Delta x_{ia}}}{1 + e^{\beta' \Delta x_{ia}}}$$

Denoting y_{ia} i's response to the a question (equal to 1 in case of acceptation and 0 otherwise, the probability that the model returns the observed answer for given values of the parameters is :

$$\begin{cases} P_{ia} & si \ y_{ia} = 1 \\ 1 - P_{ia} & si \ y_{ia} = 0 \end{cases}$$

Or,

$$P_{ia}^{y_{ia}} (1 - P_{ia})^{1 - y_{ia}}$$

The likelihood for the whole sample for a given set of the parameters is the product of these probabilities for all the individuals and all the questions :

$$L(y, x, \beta) = \prod_i \prod_a P_{ia}^{y_{ia}} (1 - P_{ia})^{1 - y_{ia}}$$

Or, in log :

$$\ln L(y, x, \beta) = \sum_i \sum_a y_{ia} \ln P_{ia} + (1 - y_{ia}) \ln (1 - P_{ia})$$

3.2 Mixed logit

The multinomial logit make the hypothesis that the parameters are the same for every

individual. For the mixed logit model, we have :

$$P_{ia} = P(\Delta x_{ia}, \beta_i) = \frac{e^{\beta_{i'} \Delta x_{ia}}}{1 + e^{\beta_{i'} \Delta x_{ia}}}$$

where β_i is now a specific vector of parameters for individual i. In terms of estimation one can :

- estimate the parameters for each individual,
- consider the parameters as random coefficients and estimate the parameters of their distribution.

The first solution is hardly interesting: on the one hand, it implies that each individual is asked many questions, on the other hand, the estimation of the parameters of an individual randomly drawed from a population is not interesting *per se*. We'll then consider that β are random variables with a density function $f(\beta, \theta)$, where θ are the parameters of the distribution. The mean of the probability of acceptation is then :

$$E(P_{ia}) = \int_{\beta} \frac{e^{\beta' \Delta x_{ia}}}{1 + e^{\beta' \Delta x_{ia}}} f(\beta, \theta) d\beta$$

For example, if only the coefficient for reservation is random and follows a normal law, we have :

$$\beta_r : N(\mu_r, \sigma_r)$$

$$E(P_{ia}) = \int_{-\infty}^{+\infty} \frac{e^{\beta' \Delta x_{ia}}}{1 + e^{\beta' \Delta x_{ia}}} \frac{1}{\sqrt{2\pi\sigma_r}} e^{\left(\frac{\beta_r - \mu_r}{\sigma_r}\right)^2} d\beta_r$$

There is no closed form for this expression, which should therefore be approximated using numerical methods. For multi-dimentional integrals, simulations are used and the probabilities are obtained as follow :

- start with initial values: $(\hat{\mu}_r^o, \hat{\sigma}_r^o)$ for the parameters of the distribution of β_r ,
- draw a large number of values of β_r in this distribau hasard dans cette distribution $\beta_r^1, \beta_r^2, \ldots, \beta_r^T$,
- compute the porbabilities P_{ia}^t for each values of the parameters,
- approximate the probability by the arithmetical mean for the T draws of β_r .

$$P_{ia}(\Delta x_{ia}, \theta) = \frac{1}{T} \sum_{t=1}^{T} P(\Delta x_{ia}, \beta^t)$$

The likelihood function is then :

$$\ln L(y,x,\theta) = \sum_i \sum_a y_{ia} \ln P_{ia} + (1-y_{ia}) \ln(1-P_{ia})$$

3.3 Panel data

Several questions are asked to every individual in the sample (3 in this survey), there is therefore a panel dimension which can be taken into account. More specifically, the joint probability for all the questions for eac individual is introduced in the likelihood :

For a given vector of parameters β^t, we have :

$P^t_{i1}=P(\beta^t, \Delta x_{i1}), P^t_{i2}=P(\beta^t, \Delta x_{i2}), P^t_{i3}=P(\beta^t, \Delta x_{i3})$

The joint probability that the model returns the answers of individual i is:

$$l_i^t = \prod_{a=1}^{3} (P_{ia}^{t\ y_i a} (1-P_{ia}^t)^{1-y_{ia}})$$

The mean value of this expression is then approximated by the arithmetic mean of l_i^t for all the draws:

$$\hat{l}_i = \frac{1}{T} \sum_{t=1}^{T} l_i^t$$

and the likelihood is :

$$\ln L(y,x,\theta) = \sum_i \hat{l}_i$$

3.4 Results

Two more points must be taken into account for the estimation:

- our sample is not a random sample. Threfore weights are used in the likelihood,
- working with utility differences, it is custumary to omit the intercept. Our study is specific because one of the scenario is always the actual card. An intercept may in this case be interpreted as a preference for keeping the actual card.

The results of the simple and the mixed logit models are presented in table 1 et 2. For the mixed logit, the percentage of reduction coefficient is not random (the coefficients of all the other attributes are not directly meaningfull and are divided by this coefficient).

Table 2: Simple logit estimation

	coef	t-stat	coef	t-stat
(Intercept)	0.74	6.80		

p	−0.10	−10.77	−0.07	−8.54
c	0.00	0.35	0.03	5.88
r	0.04	4.33	0.06	6.53
a	1.21	12.60	1.40	15.14

Table 3: Mixed logit estimation

	coef	t-stat	coef	t-stat	coef	t-stat
(Intercept)			1.11	7.49	1.10	7.44
p	−0.14	−11.49	−0.21	−12.99	−0.21	−12.84
c	0.08	7.50	0.02	1.54	0.02	1.75
r	0.14	6.94	0.10	6.73	0.10	6.70
a	4.69	10.35	3.98	12.61	4.09	10.69
sd(Intercept)			1.94	11.71	1.87	12.11
sdc	0.15	6.44	0.00	0.06		
sdr	0.32	7.99	0.12	3.17	0.14	3.84
sda	5.56	9.10	3.83	10.86	4.50	9.05

The effect of each attribute, expressed in percentage of reduction is given in table 3.

Table 4: Effects of the attributes

	pointe--creux	réservation	enfants
simple sans cste	0.50	0.83	20.69
simple avec cste	0.03	0.38	12.04
mixte sans cste	0.57	1.00	33.00
mixte avec cste	0.08	0.49	19.53

Two main results appears :

- one the one hand, bigger values are obtained using the mixed logit model,
- on the other hand, these values decrease when an intercept is added.

This last result is explained by the fact that the intercept is highly significant: the value of 1.10 obtained for the mixed logit model means that with a question: the actual card *vs* a ``new'' card identical to the actual card, the probability of choosing the actual card is: $\frac{e^{1.10}}{1+e^{1.10}} = 75\%$.

Considering now the effect of each attribute, we have:

- almost no effect for the peak-load differential,
- for the reservation, about 0.5 point of percentage for one more day (0.4 for the simple logit),
- for the constraint of traveling with a child, about 20 points of percentage of reduction (12 for the simple logit).

The standard-errors of the coefficients are highly significant, except for the peak-load differential, for which the hypothesis of a constant effect is not rejected. For the constraint of traveling with a child, the standard error is greater than the mean. This implies that the coefficients have negative values for a large part of the population (24% for the reservation, 18% for the constraint of traveling with a child).

Conclusion

Market competition led and will lead operators to diversify their products, their services and fare policies. These adaptations are often conflicting with universal services and social fares. The post evaluation show that results from SNCF social policies are not in agreement with the obectives initialy expressed. This lead us wondering if other policies would not be more efficient in terms of redistribution and social equity and if some commercial policies would not be a credible tool, completing or substituing social policies.

The rail transportation sector is a classical case: it is so interesting to look at strategies used by operators in order to bring inovation and to see how public - private combinations can bring positive evolutions.

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