The role of supply and demand in the Long Tail effect: an experimental study

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Abstract

Recent studies have shown that the development of the Internet has generated a long tail in many markets, such as entertainment and cultural industries (Anderson, 2006). Whereas off-line consumption is highly concentrated on a few popular goods, it appears less concentrated on-line, mostly to the benefit of niche products. This paper aims at explaining the emergence of this phenomenon by disentangling two possible effects: the increase in volume and variety offered by on-line retailers that leads mechanically to a better match with consumers' preferences (or *supply-side effect*) and the additional information available that gives to consumers a better view of the product quality (or *demand-side effect*). To examine the respective role of these two effects, we use an experimental approach. In the experiment, subjects have to choose an experience good within different sizes of the choice set and different levels of information availability. Although behaviors in experimental conditions cannot be extrapolated 'to the wild' without caution, our experimental results shed some light about the relative importance of supply and demand-sides effects. First, we observe that the larger the level of information availability, the

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more subjects tend to choose niche products. In contrast, subjects tend to choose more niche products within smaller choice sets than within larger ones, possibly linked to a *choice overload* effect. Altogether, these results suggest that the lower concentration of experience-good consumption seems to stem from the opportunity to easily find information rather than from larger choice.

Keywords Long Tail; Experience good; Supply; Information; Choice overload; Experiment

1 Introduction

Traditionally, entertainment and cultural industries are characterized by a concentration of sales on few star products. The "Pareto principle" states that in these domains less than 20% of products account for more than 80% of the sales. With the development of the Internet, Anderson (2006) hypothesized that this principle should be replaced by the "long tail effect". This phenomenon refers to the idea that, whereas demand is highly concentrated on few popular goods (or "superstar" products) in the bricks-and-mortar world, on-line demand should shift toward niche products. Recently, some empirical studies have tested the existence of such an effect in the markets of videos (Elberse and Oberholzer-Gee, 2007; Kumar et al., 2011), books (Brynjolfsson et al., 2012; Peltier and Moreau, 2012), music (Benghozi and Benhamou, 2010) and clothes (Brynjolfsson et al., 2011). They provide evidence of less concentration in on-line sales, even if the superstar effect is not totally eroded.

Two broad, possibly complementary, explanations are usually provided for this evolution: a market shift both on supply and demand sides (Brynjolfsson et al., 2006). On the supply side, the number of available goods is larger on-line than off-line as physical space restrictions and logistics are reduced. For instance, bricks-and-mortar bookstores offer on average between 40,000 and 100,000 book titles, whereas an on-line retailer proposes a choice set of over 2 millions of titles. In CD and DVD industries, the off-line choice sets of typical stores are estimated between 5,000 and 15,000 CDs and 500 and 1,500 DVDs, whereas the on-line supply sizes are respectively evaluated at over 250,000 and 18,000 (Brynjolfsson et al., 2006). As the Internet retailers offer higher volumes and broader variety than traditional stores, individuals face a larger choice set contain-

ing more niche products, that lead product consumption to mechanically shift to a less concentrated distribution. This is based on the assumption that when individuals have highly heterogeneous tastes and when they are informed about the quality of the goods, more choice among differentiated products let them satisfy their own particular preferences as their tastes are met more accurately (Mussa and Rosen, 1978). As Salop (1979) theorizes, if a set of sellers is evenly distributed on a product space and if one of them is removed, consumers with differentiated preferences suffer on average from higher travel cost to reach the closest alternative and their utility are reduced. We will refer to this phenomenon as the *supply-side effect*.

The second effect that could explain the long tail stems from the massive development of information that accompanied the development of IT. When individuals face experience goods (Nelson, 1970), they have to collect information about their quality to reduce the risk inherent to their consumption. As they also try to reduce the opportunity cost of time for searching information (Stigler, 1961), they use characteristics easily observable such as stars they already know (MacDonald, 1988), advices from experts (Sorensen and Rasmussen, 2004; Ashworth et al., 2010) or word-of-mouth (Sorensen and Rasmussen, 2004). Traditionnally, these behaviors often lead individuals to choose the most popular products (Stigler and Becker, 1977; Crain and Tollison, 2002). [1] With the rise of the Internet, information flows more freely (or circulate at a reduced cost). In fact, consumers are better informed within the adoption of on-line social networks and IT systems, such as search engines, discovery tools, or recommendation mechanisms. As Chen et al. (2013) experimentally show, search engines allows individuals to collect information with greater convenience and at lower costs on-line than off-line. Moreover, adoption of recommandation systems increases sales volume (Chevalier and Mayzlin, 2006; De et al., 2010; Seneca and Nantel, 2004) and lower sales concentration (Feng and Zhang, 2010; Brynjolfsson et al., 2011; Oestreicher-Singer and Sundararajan, 2009). For instance, Brynjolfsson et al. (2011) provide evidence that demand is shifted by better informed consumers toward more diversified products when recommendations are offered. We will refer to this effect as the *demand-side effect*.

[1] This phenomenon is also known as the *superstardom* (Rosen, 1981) or *winner-take-all* (Frank and Cook, 1995)

The aim of this study is to examine the relative role of these two effects in the emergence of a long tail in consumption patterns. To this end, we use an experimental approach where individuals have to choose and 'consume' in the lab an experience good. By systematically varying the size of the choice set and the number of information pieces, we can identify the relative influence of each variable in the final choices made by individuals. The experimental approach seems particularly relevant to this problem, since, *by nature*, the evolution of consumption in real market conditions requires that both supply and demand are affected, and the relative effect of one versus the other on individual (and by extension to aggregate) consumption is difficult (if not impossible) to assess. Moreover, disentangling these two effects is of importance: on the one hand, if the main driver of the long tail is the supply-side changes, then it would suggest that the demand was virtually always there but market conditions (*e.g.,* transaction costs) made it impossible for it to be satisfied; on the other hand, if the main driver is a shift of demand due to the cheap acquisition of information by consumers, the trend toward less product concentration may run deeper and IT may have a broader impact of product segmentation. More generally, does the effect of the Internet on consumption trends is likely to see the further development of mega-retailers with enormous catalogues of product, or more information-intensive niche retailers? Or to put it more bluntly, do on-line retailers like Amazon.com own their success to their giant catalogues or to the information and recommendation systems they have set?

Our innovative experiment consists of six treatments that differ with respect to the size of the choice set and the size of information set. In each treatment, subjects have to choose and consume in the lab an experience good. We use content websites as they are related to the entertainment industries (Caves, 2000) and as they can easely be "consume" in the lab. Each treatment proceeds under identical rules. Subjects are first informed of a choice set comprising of web addresses of the available options. The size of the choice set differs with the treatments: 4 options in the treatments with a small choice set and 8 in the treatments with a large choice set. In all cases, the composition of the choice sets are similar with respect to three popularity categories: 25% of 'superstar', 25% of middle-star and 50% of niche websites. Subjects have then the opportunity to collect information about the different websites. As for choice, information is also varied systematically across treatments: in the low and high information conditions, subjects

can consult respectively 25% and 50% of the available information, whereas in the treatments with no information, they can not collect information. After accessing to the available information, subjects have to rank the websites according to their preferences following an incentive compatible mechanism: subjects have to spend 30 minutes with one of the ranked websites in the final stage of the experiment, following the rule "the better ranked, the more likely the website is to be selected".

The aim of the experimental design is hence to test the underlying assumptions that could account for the long tail effect. The supply-side effect implicitly assumes that when more choice is available, consumers tend to make less concentrated choices, with more of them going for niche products, or equivalently less of them choosing superstar or familiar products. By the same token, potentially better informed consumers would tend to distribute among more differentiated products, leading to a more dispersed consumption pattern as a population. In part, some recent papers in economics, psychology and consumer research have identified some effects of choice that may challenge some of these assumptions. They have shown that, in large choice situations, individuals tended to be less likely to purchase an item and to be less satisfied (Tversky and Shafir, 1992; Iyengar and Lepper, 2000; Scheibehenne et al., 2010). Moreover, Iyengar and Kamenica (2010) provide evidence that individuals facing a larger choice set exhibit a stronger preference for simple and easy-to-understand alternatives. Possible effects of this *choice overload* effect may challenge some of the accounts for the long tail.

Partly in contrast with the supply-side explanation of the long tail, our results show that niche websites are better ranked in the treatments with smaller choice sets. In the presence of large choice set, subjects tend to choose popular or superstar items more frequently, possibly because of a *choice overload*. On the other hand, the information availability seems to lead subjects in less concentrated consumption: niche items are better ranked when more information is available. It seems though that rather than plain effects of information and choice, both interacts in non-monotonic ways. Altogether, our results suggest, if to be extrapolated, that the long tail effect seems to mainly originate in consumers' improved information, rather than from a mere increase in the number of available products.

The remainder of the paper is organized as follows. Section 2 describes the experiment. Section 3 presents our main findings. Section 4 discusses and concludes.

2 Experimental design and procedures

2.1 Experimental design

The experiment consists of six treatments that compare individuals' choice of experience good with varying sizes of choice sets and information settings. On the choice dimension, two different conditions are set: a large choice (C+), comprising 8 options, and a small choice (C-), comprising 4 options. In addition, three information settings were tested. The number of available information was depended on the size of the choice set, but subjects' access to information was constrained according to the information setting: in the no information condition (0), subjects do not have access to information (except the option names); in the low information condition (I-), subjects could access 25% of the available pieces of information while in the high information condition (I+), subjects had access to half the available pieces of information. These two experimental variations form a 3x2 design composed of 6 treatments, as summarized in Table 1. [2]

[2]The specific number of options or information pieces for each treatment calls for some justification. Clearly, the number of options or pieces of information available are not directly comparable to the gigantic sets that consumer faces on-line. In our experiment, the relatively small number of options offered to subjects, and correspondingly the number of available pieces of information, was set to correspond with specific conditions of the lab in terms of time and stakes to a reasonable level of effort in gathering of information. Moreover, the experimental task, which finally consists of ranking all items of the choice set, is more demanding than simply choosing an item. Hence, although relatively small sets of choice and information in comparison with the outside world, they seem relatively large with respect to lab conditions or past experiments. Another point is regarding the available number of pieces of information. We chose to maintain the ratio of information available by the number of options constant. There may be good reasons to believe that the level of information is not necessarily constant in between 4 options with 6 pieces of information, and 8 options with 12 pieces of information. But this seems to be most neutral design. Indeed, one can argue that given the increasing marginal cost of treatment of information, subjects are better informed in the C-/I+ condition than in the C+/I+ condition, or alternatively that the freedom given in what kind of information can be revealed lead subjects to make more informed choices in the C+/I+ treatment than in the C-/I+ one (for instance, because a subject can choose to uncover pieces of information on options that are right from the start more relevant to her). Overall, we believe that first the direction of such effects are a priori unclear, second that if they exist in one specific direction focusing on rather relatively small choice set and information sets mitigate strongly their effects and third, that if such effects exist it is actually of interest to see their potential

	Small Choice (C-)	Large Choice (C+)
No Information (0) (0 % of info.)	4 options 0 piece of info.	8 options 0 piece of info.
Low Information (I-) (25 % of info.)	4 options 3 pieces of info.	8 options 6 pieces of info.
High Information (I+) (50 % of info.)	4 options 6 pieces of info.	8 options 12 pieces of info.

Table 1: Treatment matrix

The experience goods proposed to subjects were content websites, that is websites offering their own content, which excludes e-commerce sites and social networks. We choose this type of goods for three reasons. First, content websites are experience goods and are considered as part of the entertainment industries (Caves, 2000). Secondly, the consumption of such goods can be easily implemented and controlled in the lab. Finally, websites generally come with lots of information to be used within the experiment: ratings by users on other websites, comments, but also reliable indicators of popularity, which are useful for goods categorization as superstar, middle or niche products.

Our six treatments are identical with respect to the general rules and instructions and consist of a five-stage individual decision problem, summarized in Table 2.

(0)		(1)		(2)		(3)		(4)
Select a type of content	⇒	Choice set (websites)	⇒	Information (or not)	⇒	Rank alternatives	⇒	Consumption (30 minutes)

Table 2: Timing of the experiment

In the *preliminary stage (0)*, subjects have to indicate which type of content they were interested in among several ones. The offered groups were general news, sports, culture and pop culture, economics, games, movies and TV series, cooking. This was set so to guarantee that the motivation of subjects when making a choice was high enough for them to consider seriously all the options, and the available information. It also implies

effect (for instance through cognitive overload).

that alternatives in a choice sets are relatively undifferentiated regarding the thematics, allowing for a clear test of the effect of the status of superstar, middle and niche product comparison.

In the following stage *(1)*, subjects were presented the choice set they would face for the whole experiment. The only information given to subjects was the websites URL addresses (*e.g.,* www.lemonde.fr) and the size of the choice set differs across treatments (4 websites in the *Small choice set* and 8 in the *Large choice set*). Moreover, all choice set are composed by three websites categories, distributed in the same manner: 25% of *superstar*, 50% of *middle-star* and 25% of *niche* websites. The category of a given website was determined in the following way: 'superstars' products were generally chosen among 'blockbuster' websites (sometimes attached to off-line national-wide printed press or TV channels, as Le Monde), middle-stars among 'pure-players' (*e.g.,* Slate.fr), and niche among blog-like or amateur-like content (*e.g.*, AgoraVox)[3]. This partly unsystematic categorization was complemented and its robustness tested by the use of an external indicator of popularity, namely the number of 'like' the website collected on facebook.fr.[4]

Stage 2 was the information stage. After discovering their choice set, subjects had the opportunity to collect information about their options. Three types of information were available per website: an objective description, a popularity index (i.e., the number of 'like' on facebook.fr) and a comment from a user.[5] The collection of information proceeds as follow: subjects face a set of information pieces and have to select some of them. In the treatment with *Low Information* set, subjects are able to consult 25% of the available information, whereas in the treatments with *High Information* level, they can consult 50% of the available information. Note that in the treatments with

[3]The given examples would correspond in US to the Washington Post, Herald Tribune or the NY Times for Le Monde; Slate or the Huffpost for Slate.fr; and Indymedia for the latter category.

[4]This indicator was used relatively to a website category to evaluate whether websites of the same categories had similar popularity rankings, and whether websites in different categories were distinct enough with respect to this criterion.

[5]The comments were drafted in the following form: 'I recommend this website/I do not recommend this website' plus an explanation. To control for the nature of information, 50% of the websites of a category (superstar, middle star and niche) were provided with a positive comment and 50% with a negative comment. Moreover, the positive and negative nature of information was reversed across sessions.

No Information, the second stage is not implemented and the only information subjects have is the name of the different websites.

During the *stage 3*, subjects had to rank the different alternatives of the choice set according to their preferences. To induce them to reveal their true preferences, subjects had to spend half an hour in the lab, with sole source of entertainment the access to one website. The website they could access was chosen randomly but in accordance to their ranking: the probability they face the website ranked first is higher than the probability they face the website ranked second, etc. Table 3 presents the probability that a decision is drawn by the computer program according to the size of the choice set. Such a procedure ensures that revealing one's true ranking leads to a stochastically dominant strategy, and hence the procedure is incentive-compatible. Having subjects reveal their ranking of choice sets, although more demanding, is of interest in this study to understand why individuals choose niche items. If subjects were only asked about their preferred item, that would have lead to a potential difficulty in measuring the relative attractiveness of such websites. Moreover, observing the ranking allows us to have a finer measure and to identify relatively subtle changes across treatments.

Rank	Small choice set	Large choice set
1	0.50	0.45
2	0.30	0.25
3	0.15	0.15
4	0.05	0.07
5	-	0.05
6	-	0.02
7	-	0.01
8	-	0

Table 3: Websites' probability of being drawn depending on ranks

The *last stage (4)* is the consumption stage. At the beginning of this stage, subjects are informed of the website eventually selected. Then, they can consult this website,

and only this one, during 30 minutes. The Internet access of the subjects' computer was locked to this particular website and subjects were not authorized to use their phone or any documents. This constraint was set to reinforce the incentive of the ranking and the information gathering tasks performed in the former stages: knowing that one has to spend half an hour with as sole resource a given website, whose determination is based on one's choice, provides an incentive strong enough to carefully consider the options and information available.

2.2 Procedures

Treatment	Choice set (C)	Information (I)	Subjects
C+/I+	Large (+)	High (+)	66
C+/I-	Large (+)	Low (-)	60
C+/I0	Large (+)	No (0)	47
C-/I+	Small (-)	High (+)	60
C-/I-	Small (-)	Low (-)	60
C-/I0	Small (-)	No (0)	48

Table 4: Number of subjects per treatment

The experiment was held in November 2013 and February 2014 at the Center for Research in Economics and Management (CREM), University Rennes 1, France. The experiment was computerized using the Z-tree program (Fischbacher, 2007) and consisted in 17 sessions summarized in Table 4. We used a between-subject design. In total, 341 subjects (46,6% of female) were recruited among a population of undergraduate students from a variety of majors. On average a session lasted 90 minutes, including initial instructions and subject payment. The payoff was a fixed show-up fee of 12 Euros. In addition, subjects could earn some money in a side experiment (which took place at the end of the website consulting period) by taking an Holt and Laury (2002) tasks, aimed at grossly measuring their attitude towards risk. [6] On average, the total payoff was 15 euros.

[6]The purpose being to take into account risk attitude in their consumption choice and providing a control for it (given the large literature, see above in the introduction) that links uncertainty about the quality of (experience) products and the concentration of consumption.

In addition to the experiment itself, we asked subjects to report their initial knowledge of the websites offered as options, between the third and the fourth stages. For each website, they had to indicate whether they knew the website prior to the experiment, and whether they had already visited it before the experiment. Table 5 presents the responses of this question. It shows that the *a priori* classification among superstars, middle-stars and niche websites is consistent with subjects' prior knowledge and experience: on average, 74% of subjects do not know the niche websites of the choice set they face. Conversely, 78% of subjects have already visited the superstar websites of the choice set they face, with intermediate figures for middle-star websites.

Category	Mean proportion of subjects		
	'*I do not know this website*'	'*I know this website*'	'*I have already visited this website*'
Superstar	0.06	0.16	0.78
Middle-star	0.23	0.34	0.43
Niche	0.74	0.19	0.07

Table 5: Knowledge of items per category

2.3 Hypotheses

Our hypotheses can be summarized along two broad lines: the effect of the availability of information and the effect of the size of the choice set. Regarding the first dimension, when the size of the choice set is constant, the ability to collect more information about items is expected to imply that subjects are more likely to choose niche items, or more generally that the choices will be less concentrated. The basic intuition is the following: if subjects are heterogeneous in terms of preferences, providing more information allows them to find an item that better matches their specific individual tastes, more likely to be found in highly differentiated products such as niche. Hence we expect to observe less concentration of choice. An implicit assumption is that costs of information processing are negligible. As framed earlier, we refer to this as a demand-side effect:

Hypothesis 1 (Demand-side effect) *Supply being equal as measured by the size of*

the choice set, subjects are more likely to choose a niche item if the number of information pieces available is larger.

With respect to the second dimension, that is the effect of the size of choice set the most natural hypotheses stems from the intuition that a larger number of (differentiated) items increases the probability that a subject identifies an item that corresponds to her preferences. Once again, under the assumption of heterogeneous preferences among subjects, concentration of choices is expected to be lower when the choice set is larger. We refer to this as a supply-side effect:

Hypothesis 2 (Supply-side effect) *Information availability being held constant, subjects are more likely to choose a niche item if the choice set is larger.*

Yet, based on the empirical results pointing toward choice overload, it is also possible that the size of the choice set has a negative effect on the diversity of final choices. This, opposite, hypothesis predicts that increasing the number of alternatives leads subject to choose more frequently popular or already known item. This is built on the assumption that individuals suffer from cognitive costs of making choice and processing information. In such cases, they tend to stick with familiar options.

Hypothesis 3 (Choice overload effect) *As subjects could suffer from cognitive costs of making choice and processing information, subjects will be more likely to choose a niche product if the choice set is smaller and/or if the information set is smaller.*

3 Results

Figures 1-3 display the distribution of individuals' first choices in each treatment, *i.e*, market shares of each website category for each treatment.[7] If subjects choose randomly a website they want to have access in the consumption stage, we expect that market shares of superstar and middle-star items are for each equal to 25% and niche items

[7]Hereafter, *website category* refers to the position of websites as superstar, middle-star or niche websites.

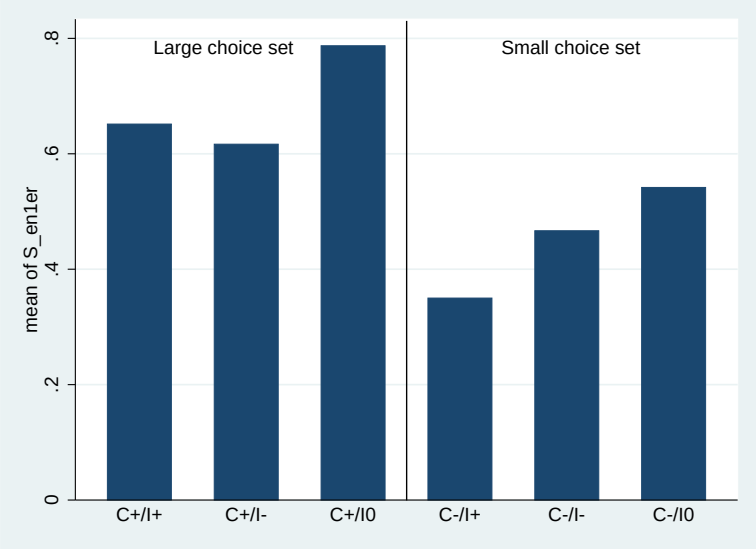

Figure 1: Freq superstar website ranked 1st

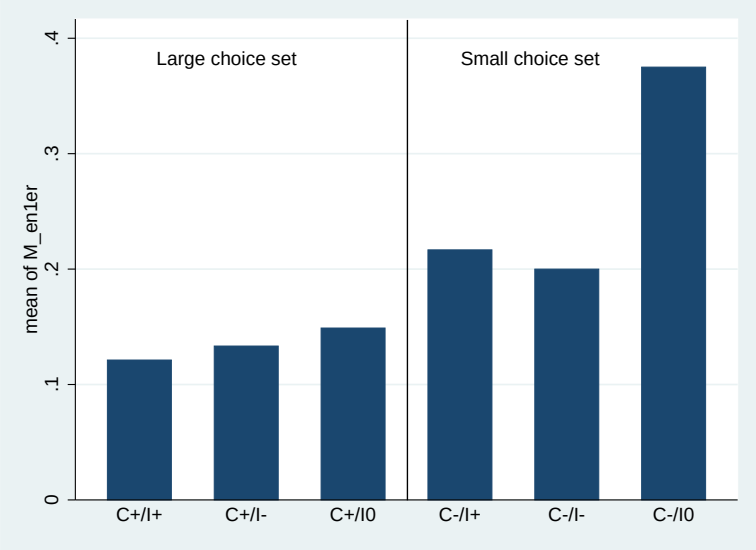

Figure 2: Freq middlestar website ranked 1st

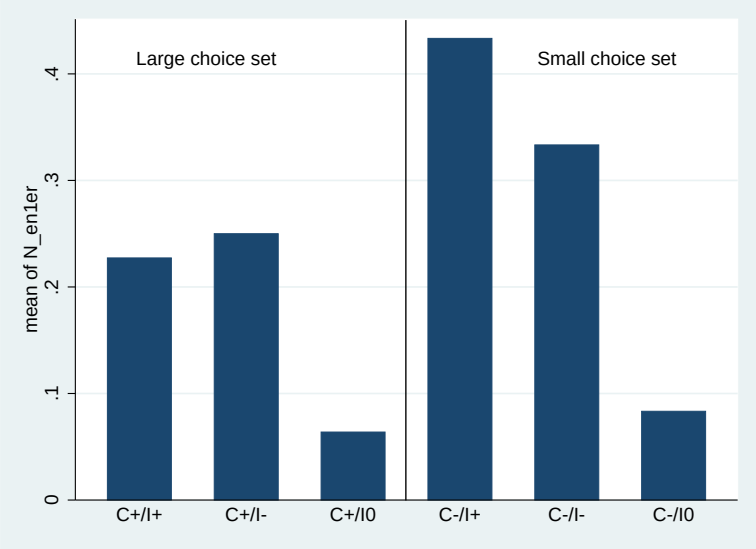

Figure 3: Freq niche website ranked 1st

should represent 50% of first choices. However, a comparison of Figures 1-3 indicates that, on average, subjects are more likely to rank first a superstar rather than a middle-star or niche item.

To assess the divergence between the actual distribution of decisions and the reference situation where market shares are respectively 0.25, 0.25 and 0.50, we apply two divergence indices, namely the Kullback-Leibler and Itakura-Saito indices. [8] These two indices can be written as follow:

$$DV_{\text{K-L}} = \sum_{k=S,M,N} \left(p_k \ln \left(\frac{p_k}{\widehat{p}_k} \right) + \widehat{p}_k - p_k \right)$$

$$DV_{\text{I-S}} = \sum_{k=S,M,N} \left(\frac{p_k}{\widehat{p}_k} - \ln \left(\frac{p_k}{\widehat{p}_k} \right) - 1 \right)$$

[8] These indices are generally used to measure inequality in terms of income. See for instance Magdalou and Nock (2011).

where $\{p_k\}_{k=S,M,N}$ describe the distribution observed for each item category and $\{\widehat{p}_k\}_{k=S,M,N}$ describe the reference distribution: $\widehat{p}_S = \widehat{p}_M = 0.25$ and $\widehat{p}_N = 0.5$.
A high value of these divergence indices indicates a high concentration of choice on a particular item category, and vice versa. Figure 4 displays values of these indices for each treatment. It shows that concentration differs across treatments, i.e., according to the choice set size and the information availability.

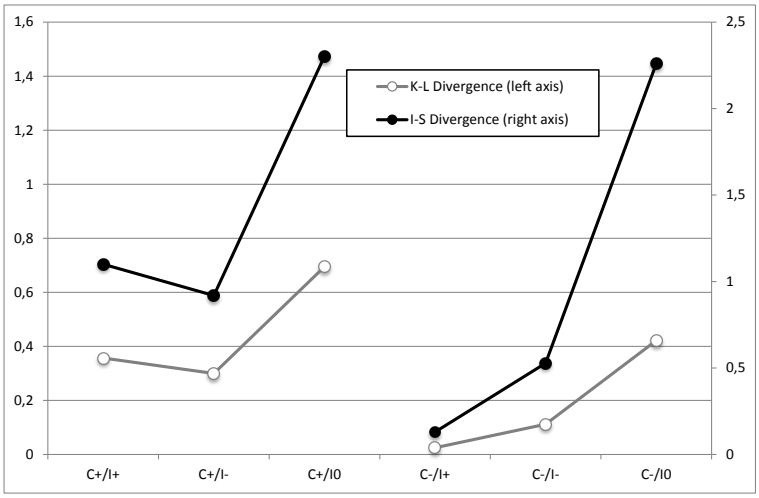

Figure 4: Concentration and divergence indices

3.1 The effect of information

3.1.1 Market shares

We first present the effect of information on the category of items that subjects rank first. Figure 4 indicates that the values of divergence indices are higher in the *No Information* treatments than in the *Low* and *High Information* treatments. This result suggests that providing information reduces the concentration of choices, as compared to a no information situation. The effect of information size differ with respect to the

size of the choice set. The right panel of Figure 4 indicates that, when the choice set is small, values of divergence indices seem lower in the *High Information* treatment than in the *Low information* treatment. Conversely, the left panel of Figure 4 shows that, when the choice set is large, providing more information tends to weakly increase the choices concentration.

Comparison of Figures 1-3 leads to the same results. They show that providing information to subjects contributes to rank first less frequently a super-star item (Figure 1), whereas a niche item is more likely to be chosen (Figure 3). Table 6 displays p-values for χ^2 tests of homogeneity which allow to test the equality of market shares across treatments. It confirms provious observation by showing that the probability a niche item is ranked first is significantly different between treatments *No* and *Low Information* and between treatments *No* and *High Information*.

Figures 1-3 also indicates that the effect of information pieces number may depend on the choice set size. When four items are available (*Small choice set*), more information increases the probability of selecting a niche item as the first choice. However, Table 6 does not support this result as the p-values for χ^2 tests are higher than 10% between treatments with *Low* and *High Information* ($p = 0.260$). When subjects face eight items (*Large choice set*), increasing the number of information has a marginal and non-significant effect on subjects' choice ($p = 0.765$).

Result 1 *Supply being constant, i) subjects choose more frequently a niche item when they can consult information, as compared to a no-information situation. ii) However, increasing the information size has no significant effect on niche item choice.*[9]

3.1.2 Distribution of ranks

In addition to study the effect of information size on subjects first choice, we present results on the subjects overall ranking. Figures 5-7 show the distribution of ranks that subjects gave to the three websites categories(superstar, middle-star and niche).

[9] An econometric analysis confirms these findings: Using a multi-nominal specification, we estimate the probability that website ranked first is superstar, middle-star or niche item. Table 10, available in Appendix, displays the results.

	No vs Low info	No vs High info	Low vs High info
Large Choice			
star	0.058*	0.118	0.685
middle	0.818	0.669	0.838
niche	0.011***	0.019**	0.765
Small Choice			
star	0.439	0.046**	0.194
middle	0.044**	0.071*	0.822
niche	0.002***	0.000***	0.260

Notes. This table reports the p-values for χ^2 tests.
Significance levels. *: $p < 0.1$; **: $p < 0.05$; ***: $p < 0.01$.

Table 6: Effect of information on market shares - χ^2 tests.

Figure 5 reveals that distribution of ranks for *Superstar items* seems to be slightly affected by the availability of information. Table 7 reports the results of the Wilcoxon-Mann-Whitney rank-sum tests for equality of distributions. It indicates that, when there is a large set of opportunities, superstars items are significantly better ranked in *no information* treatment as compared to *low information* treatment, whereas there is no significant difference between *no* and *high information* treatments. The comparison of *low* and *high information* treatments indicates that subjects tend to rank better superstar items when they face a large set of available information, although statistical significance is low (p-value=0.088). When subjects face a small choice set, the probability that a superstar item is well ranked is larger among subjects playing the *no information* treatment, as compared to the *high information* treatment. Table 7 does not report any significant difference between the *no* and *low information* treatments and between *low* and *high information* treatments

Figure 6 shows that distribution of ranks for *Middle-star items*. In the case of large choice set, results seem close to what is happened for superstar items. Table 7 indicates that middle-stars are better ranked when subjects have no information rather than a small number of information. The other differences are not statistically significant. When choice set is small, providing information reduces significantly the chance that middle-star items are well ranked. But, there is no difference between *low* and *high*

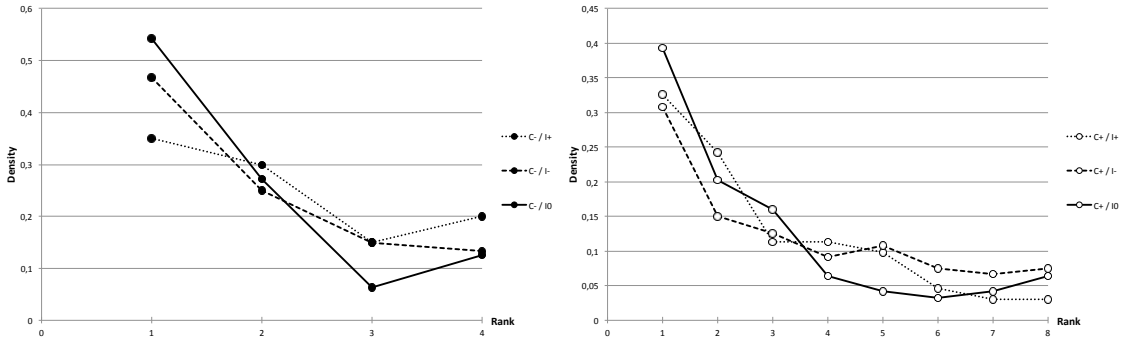

Figure 5: Distribution of ranks for superstar items

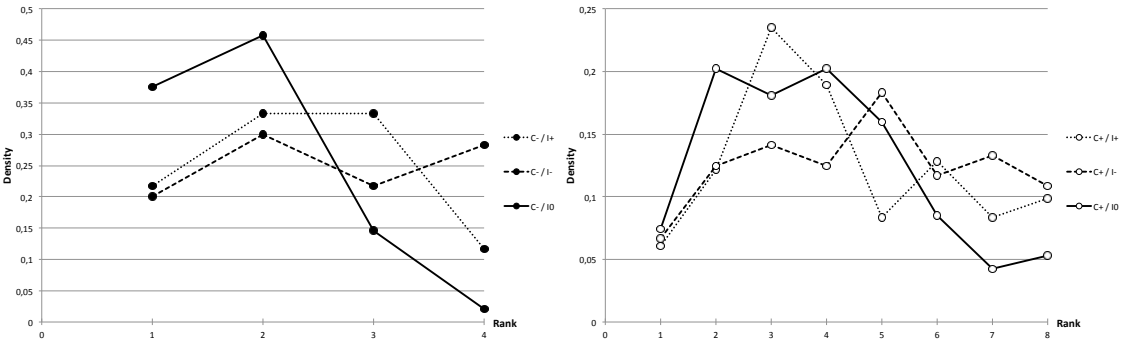

Figure 6: Distribution of ranks for middle-star items

information treatments.

Figure 7 displays that distribution of ranks for *Niche items*. The effect of information on niche items ranks also depend on the size of the choice set. Table 7 shows that subjects facing large choice set are more likely to rank better niche items in *low information* treatment, as compared to *no information* treatment and to *high information* treatment. Moreover, there is no significant difference between *no* and *high information* treatments. When subjects benefit a small extent of choice, there is a clear relation between information availability and ranks: niche items tend to be better ranked when subjects have information rather than no information. As there is no significant differ-

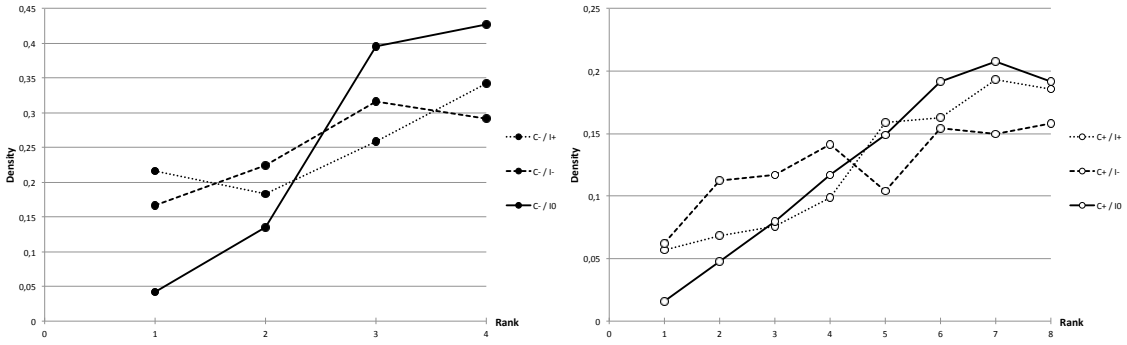

Figure 7: Distribution of ranks for niche items

ence between *low* and *high information* treatments, the level of available information does not appear to play a significant role.

To sum up, relation between information effect and distribution of ranks seems to be like a U-shape for star items or inverted-U-shape for niche items. Providing information leads subjects to rank better niche items but, below a certain level of information availability, there is an "information overload" effect.

Result 2 *The effect of information size on niche-item ranking differs with respect to the choice set size. i) When the choice set is small, providing information promotes niche item rank, irrespective of the size of information availability. ii) When the choice set is large, subjects rank better a niche item when they can consult a number number of information, but increasing the information size decreases the rank of niche items.*

3.2 The effect of choice set

Figures 1-3 inform about the effect of supply size on subjects choice. They show that the subjects' choice seems strongly correlated with the choice set size: given a level of information, subjects are more (less) likely to choose a niche (superstar) website when the choice set is small, as compared to large choice set. As a test of robustness, Table 8 reports the results of the χ^2 tests for equality of proportions. Given that subjects

	No vs Low info	No vs High info	Low vs High info
Large choice set			
star	0.035^{**} / $-$	0.429	0.088^{*} / $+$
middle	0.005^{***} / $-$	0.113	0.186
niche	0.001^{***} / $+$	0.279	0.020^{**} / $-$
Small choice set			
star	0.363	0.034^{**} / $-$	0.199
middle	$< 0.001^{***}$ / $-$	0.003^{***} / $-$	0.250
niche	0.001^{***} / $+$	0.004^{***} / $+$	0.930

Notes. This table reports the p-values for Wilcoxon-Mann-Whitney tests.
Significance levels. *: $p < 0.1$; **: $p < 0.05$; ***: $p < 0.01$.
+: more information leads to increase the probability that items are better ranked;
−: more information leads to increase the probability that items are worse ranked.

Table 7: Effect of information on distributions of ranks - Wilcoxon-Mann-Whitney tests.

have no or low information about items, it indicates that the distributions of superstar choice, and in a lesser extent middle-star items choice, are significantly different between treatments *small* and *large choice set*. But, the enlargement of choice set has not significant effect in low information context. When the number of information pieces is high, extending the number of available alternatives affects significantly the distribution of superstar and niche items.

Divergence indices lead to the same results. Figure 4 indicates that a larger choice set implies more concentration of first-choice on superstar items, as values of divergence indices are higher within a large choice set than a small choice set. This effect is consistent with our hypothesis 3 and previous results on choice overload phenomenon: cognitive costs and information processing are higher when choice is too large that increases difficulties to make decisions. To avoid the risk of 'bad decisions', individuals are more willing to choose a popular item. Such an item allows typically to maximize the expected satisfaction in a context where the costs of information treatment is heavy.

Note that assessing effect of choice set size on decisions raises some questions about information availability. Previously, we have considered the effect of the choice set size, given that relative number of information pieces is constant. For instance, in

	No information (C-/I0 vs C+/I0)	Low information (C-/I- vs C+/I-)	High information (C-/I+ vs C+/I+)	6 pieces of info (C-/I+ vs C+/I-)
Superstar	0.011**	0.099*	0.001***	0.003***
Middle	0.012**	0.327	0.151	0.230
Niche	0.716	0.315	0.014**	0.034**

Notes. This table reports the p-values for χ^2 tests.
Significance levels. *: $p < 0.1$; **: $p < 0.05$; ***: $p < 0.01$.

Table 8: Effect of choice set size on market shares - χ^2 tests

treatment with low information, subjects have to collect 25% of available information piÃ¨ces, i.e. subjects collect 3 information pieces on 12 available in treatment C-/I- and 6 information pieces on 24 available in treatment C+/I- (see Table 1). As subjects have to collect more information pieces, that could requires more effort and more processing costs. An alternative interpretation is to considering the effect of the choice set size, given that absolute number of information pieces is constant. In treatments C-/I+ and C+/I-, subjects have to read exactly 6 information pieces, that is the cost of collecting information remains constant in both treatments.

Figures 1 and 3 and Table 8 indicate that increasing the choice set size without modifying the absolute number of available information pieces results in an increase in the proportion of subjects who choose a superstar item. Indeed, proportion of subjects who choose a superstar (niche) item is significantly higher (lower) in the C+/I- treatment, as compared to the C-/I+ treatment.

Result 3 *The effect of the choice set size differ according to the size of the information set. i) In no or low information treatments, the choice set size has no significant effect on the probability that subjects select a niche item. ii) In high information treatments, subjects choose less frequently a niche item. iii) A similar result is obtained when one consider that the absolute number of information remains constant (and is equal to 6).*[10]

	(1)	(2)	(3)	(4)
	All sample		Nb of info pieces = 0 or 6	
	Middle-star	Niche	Middle-star	Niche
	Coef./(se)	Coef./(se)	Coef./(se)	Coef./(se)
Small set	ref	ref	ref	ref
Large set	-1.427***	-.7168	-1.515***	-.8692
	(.5371)	(.8256)	(.5618)	(.848)
No info	ref	ref	ref	ref
Low info	-.1111	1.885***		
	(.5041)	(.6508)		
High info	.0796	2.34***		
	(.5097)	(.653)		
High info×Large set	-.04743	-.7668		
	(.7697)	(.9452)		
Low info×Large set	.547	.0656		
	(.7647)	(.9437)		
Nb of info pieces = 6			.07393	2.232***
			(.5244)	(.6754)
(Nb of info pieces = 6)×Large set			.4653	-.0786
			(.7924)	(.9788)
Control for				
website category	yes	yes	yes	yes
socio-demographics	yes	yes	yes	yes
Nb obs.	341		215	
Pseudo-R2	.1456		.1994	
chi2	97.83		84.72	
p	4.08e-09		3.85e-08	

Base outcome: superstar item.

Significance levels. *: $p < 0.1$; **: $p < 0.05$; ***: $p < 0.01$.

Table 9: Market shares: econometric analysis

3.3 Econometric analysis

To sum up the results of the previous sub-sections, niche items are more frequently chosen the higher the information size is, especially when the choice is small. Moreover,

[10] An econometric analysis confirms these findings: We estimate the probability that website ranked first is a superstar, middle-star or niche item, given the information set size, using a multi-nominal specification. Table 11, available in Appendix, displays the results.

subjects choose less frequently niche items when the size of the choice set increases, especially if the relative size of information is high or if the absolute number of information pieces is constant. To test the robustness of our previous results, we use econometric analysis that estimates the probability that subjects first prefer a superstar item, middle-star item or niche item using multi-nominal regression. The left panel of Table 9 displays the results for all the sample, whereas the right panel of Table 9 reports the results for the sample of subjects who has no information or 6 pieces of information.[11] In the left panel (columns 1 and 2), the exogenous variables are: binary variables associated to information size (High/Low/No) and choice set size (Large/Small). In the right panel (columns 3 and 4), we use binary variables associated to the number of information pieces subjects have access and binary variables relatives to choice set size. Moreover, we control for website thematic groups and individual characteristics in both panel regressions.

Results shows that, whereas the size of the choice set does not seem to influence the probability of choosing niche items(columns 2 and 4), it is correlated with the likelihood to choose a middle-star item (columns 1 and 3): subjects are more likely to choose (i.e., rank first) a superstar than a middle-star item when the choice set is large, as compared to a small choice set. Another result is that the availability of information leads subjects to choose more frequently a niche rather than a superstar item, as the coefficients of information variables are positive and significant (columns 2 and 4). But it seems that having high or low information does not impact significantly this probability. Finally, the coefficients of interaction variables *Info* $\times$ *Large choice set* are not significant, that indicates the effect of information do not differ in large and small choice sets.

4 Conclusion

This paper presented the results from an experiment investigating the origins of the long tail effect. The experiment was based on the choice and the consumption of an

[11]The left and the right panels of Table 9 allow to estimate the effect of relative number of information pieces and the effect of absolute number of information pieces, respectively

item in the lab. Three main findings have resulted from our experiment.

First, subjects of the experiment have chosen more frequently niche items when they faced a small choice set than a large choice set. The corollary is that star items are better off under a high supply level. These results refute the supply hypothesis often cited in the literature as a cause of the long tail effect. Subjects of our experiment seem to suffer from cognitive costs of choosing when choice set is larger. To avoid the risk of 'bad decisions' associated to these costs, they are are more willing to choose a popular item, that allows to maximize the expected satisfaction. This finding provides new experimental evidence of choice overload phenomenon.

Second, we determined that the effect of information differs with respect to the size of the choice set. When subjects face a low supply level, providing information leads them to choose a niche item, irrespective of the information set size. When supply is high, our subjects tend to choose a niche item only when they collect a low level of information. These results indicate that the relation between information effect and distribution of choice respects an inverted-U-shape: providing information leads subjects to rank better niche items but, below a certain level of information availability, we observe a kind of information overload.

Third, considering altogether these two findings leads to conclude that the long tail effect is mainly due to informational availability, i.e., the opportunity for individuals to easily collect information about the different alternatives of the choice set they face.

Finally, our experiment have shown the central role of information in environments characterized by a large extent of choice. They paved the way for examining the type of information helping decision maker. Moreover, this paper displays recommendations for retailers who want to monetarely benefit from the long tail effect. Although behaviors in experimental conditions cannot be extrapolated to 'real' market conditions without caution, they should provide information to consumers that lower their cognitive costs of processing information., rather than a huge catalog. A typical example of helping information are comprised in personalized recommendation mechanisms, such those available on amazon.com, fnac.fr, etc.

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Appendix: Econometric analysis

	Small choice set		Large choice set	
	Middlestar	Niche	Middlestar	Niche
	Coef./se	Coef./se	Coef./se	Coef./se
No info.	ref.	ref.	ref.	ref.
High info.	.08344	2.326***	-.02607	1.645**
	(.5459)	(.6789)	(.5954)	(.7217)
Low info.	-.2087	1.72**	.4244	2.213***
	(.5398)	(.6712)	(.6047)	(.7375)
Control for				
website category	yes	yes	yes	yes
socio-demographics	yes	yes	yes	yes
Nb obs.	168		173	
Pseudo-R2	.1849		.1209	
chi2	66.46		35.5	
p	7.42e-06		.06135	

Base outcome: superstar item

Significance levels. *: $p < 0.1$; **: $p < 0.05$; ***: $p < 0.01$.

Table 10: Information on market shares: multinominal logit analysis

	No info.	Low info.	High info.	Nb of info pieces = 6
	Coef./(se)	Coef./(se)	Coef./(se)	Coef./(se)
Middlestar item				
Small set	ref	ref	ref	ref
Large set	-1.569***	-.7739	-1.81***	-1.025*
	(.5858)	(.5581)	(.6245)	(.586)
Control for				
website category	yes	yes	yes	yes
socio-demographics	yes	yes	yes	yes
Niche item				
Small set	ref	ref	ref	ref
Large set	-.9889	-.5816	-1.727***	-.9798**
	(.9141)	(.48)	(.5331)	(.4923)
Control for				
website category	yes	yes	yes	yes
socio-demographics	yes	yes	yes	yes
Nb obs.	95	120	126	120
Pseudo-R2	.1993	.1048	.2319	.1659
chi2	30.89	24.91	58.9	40.74
p	.0983	.3016	.0000	.0089

Base outcome: superstar item

Significance levels. *: $p < 0.1$; **: $p < 0.05$; ***: $p < 0.01$.

Table 11: Choice set size on market shares: multinominal logit analysis