

# How do sponsored links on search engines affect market competition?

ARNOLD Michael A.<sup>\*</sup>, DARMON Eric<sup>†</sup>, MARTIN Ludivine<sup>‡</sup>,  
PÉNARD Thierry<sup>§</sup>

April 2009

---

## Abstract

It is often claimed that entry costs are relatively lower for firms engaging in online markets (either for pure players or for brick-and-mortar firms) than for those prevailing in traditional markets. Thus, one critical issue is to be visible in order to attract a higher number of customers and increase its market share. Beside word-on-mouth mechanisms, one way to achieve a greater visibility is to pay for being favourably indexed by search engines such as Google or Yahoo!. This gives birth to a competition among sellers for being referenced by these intermediaries. In this paper, we study the impacts of this type of competition on index and price strategies. Based on a dataset collected from two portals (namely Google and Yahoo!), we first present some empirical evidences about keywords competition. From that, we analyse such competition within a simple model of horizontal differentiation. Two firms sell homogeneous products and consumers have a differentiated ex ante perception of these two firms. Beyond 'organic results', the two firms can choose a strategy based on sponsored links to get a higher visibility. We consider the outcomes (search strategy, price and market share outcomes) arising in a Stackelberg game where the firms make their index strategy first and then compete in price.

**Key words:** sponsored links, search engines, Internet, advertising competition

**JEL Classification:** O33, J81, L22

---

<sup>\*</sup>University of Delaware - Alfred Lerner College of Business and Economics - [arnoldm@be.udel.edu](mailto:arnoldm@be.udel.edu)

<sup>†</sup>University of Rennes 1, CREM - Center for Research in Economics and Management (UMR CNRS 6211), [M@rsouin](mailto:M@rsouin), [eric.darmon@univ-rennes1.fr](mailto:eric.darmon@univ-rennes1.fr)

<sup>‡</sup>CEPS/INSTEAD, CREM (UMR CNRS 6211), [M@rsouin](mailto:M@rsouin), [ludivine.martin@ceps.lu](mailto:ludivine.martin@ceps.lu)

<sup>§</sup>University of Rennes 1, CREM (UMR CNRS 6211), [M@rsouin](mailto:M@rsouin), [thierry.penard@univ-rennes1.fr](mailto:thierry.penard@univ-rennes1.fr)

# 1. Introduction

Search engines like Google, Yahoo! and Microsoft Live Search take an increasingly part in the way consumers look for information on goods or services before deciding to purchase on the online and offline markets. Search engines benefit from this key position on the Web to sell advertising spaces (*i.e.* spaces the firm buy to appear alongside organic Web search results) to the firms that commercialize the products Internet users look for. Thus, sponsored search advertising becomes the fastest growing source of income for search engines. This form of advertising accounts for more than 40% of the online advertising market. In 2006, indeed, the global revenue generated by sponsored search advertising is estimated at more than 10 billions dollars in the world of which 2.2 billion euros in Europe (Jupiter Research, DoubleClick and Forrester Research). Moreover, the annual growth is around 50% between 2005 and 2006 and is estimated to have a 35 percent annual growth rate until 2010 (Ghose and Yang, 2007). According to Majestic Research's estimates, 17% of searches with Google result in a paid click and Google earns on average 9 cents (dollars) for each query they make (Lahaie, 2006). The dynamism of sponsored links is driven by the fact that, 94% of consumers use search engines to find information on the Web, and 81% of those find the information they are looking for every time (Nielson//NetRatings quoted by Ghose and Yang (2007))<sup>1</sup>.

The main advantage of sponsored links is that, unlike online banners<sup>2</sup>, they are not invasive and annoying since they appear after a request formulated by a consumer who is looking for a specific information related to the search term or "keyword" typed, the firm can reach a more targeted audience. Consequently, it is not surprising that, 75% of Internet users who use search engines to find information purchase a product after this step in France (Insee)<sup>3</sup>. Sponsored search results appear in two separate parts of the page above and to the right of the organic results of a search engine. Sponsored search results look like organic results. They include a title, a short text and a hyperlink referring to the Website but unlike organic results for which

---

<sup>1</sup>In France, 80% of consumers who use Internet to find information on some product, use search engines for this purpose (Insee).

<sup>2</sup>Banners are the traditional Internet advertisement format, they can be animated and include sound or video.

<sup>3</sup>The figures are only available in France. However, as the average number of consumers using search engines to find information is lower in France than in the world, we can assume that the percentage of purchasers after a request on search engines is equivalent or highest.

the information need to be general, the information associated with a sponsored link can be customised according to the keyword or a current promotion. Firms bid for placement on a keyword next to a particular search query. Higher is the amount the company bid, higher are the opportunities for the ad to appear above others on the Web page. Generally, the cost of an ad is a cost per click and the firm pays only if a user clicks on the ad and does not pay for a simple display of the advertisement<sup>4</sup>. Web agencies estimate (Publicis for example) that sponsored search that appear in the top of the first page obtain on average an increase in clicks in the order of 10-15% and for those on the right 1-4% more than organic results.

Knowing that it is difficult to influence the firm ranking in organic results, and knowing the advantages of sponsored search advertising, it becomes an important component of firms' marketing strategy on the Web. Moreover, firms don't only try to get a good position on the result page of the search engine, but also need to choose on which keywords they want to be positioned. We can inventory different qualities of keywords according to their popularity on the Web and we can distinguish two groups. On the one hand, we find high type keywords for which the competition to obtain the best position is high and also the cost per click but with a large audience and, on the other hand, low type keywords for which the competition to obtain the best position is low and also the cost per click but with a niche audience.

Despite the popularity and the growth of sponsored links, we have little understanding of firms' keywords strategy to improve their visibility on the market. On the one hand, the academic literature on search engine advertising pricing has focused on economic models of auctions to allocate multiple advertising slots (Aggarwal, Goel, and Motwani, 2006; Bu, Deng, and Qi, 2007; Edelman, Ostrovsky, and Schwarz, 2007; Edelman and Ostrovsky, 2007; Lahaie, 2006; Varian, 2007). On the other hand, the literature has analysed how search engine advertisements affect consumer search and purchase behaviour (Ghose and Yang, 2007; Chen and He, 2006).

In this paper we focus on an issue that is not very explored: How do firms form their paid advertising strategy? How do advertisers compete on keywords to obtain higher slots in order to target various type of consumers thanks to the different qualities of keyword. Some empirical

---

<sup>4</sup>This other type of payment is called cost per print and is used, for example, for banners.

works study the choice of advertisers in terms of keywords related to their activities (Rutz and Bucklin, 2007). However they focus on a specific firm and, unlike our study, they don't analyse the strategy made by firms evolving on the same market.

First, we present the market of online advertising. On the one hand, we describe the main types of advertisings, sellers can find on the Web and their efficiency in terms of customers' attractiveness and sales. On the other hand, we introduce the business models of the main search engines of the French market with a distinction between two auctions designs to allocate slots to firms' ads.

Second, using a dataset of sponsored links collected during nine months on the French e-tourism market of flights, we study the largest players about their choices on keywords concerning this type of products. We analyse two transactional keywords with a distinction between a high typed keyword and a niche one. For this purpose, we test, on the one hand, whether there is some regularity of the identity of firms placed in the top of the sponsored links. And on the other hand, we classify the most important firms in quantiles and we look at the probabilities of firms' positions evolution in the ranking using Markov chain transition matrices.

Third, we build a theoretical model to account for the choices of keywords made by firms.

The remainder of the paper is organized as follows. In section 2, we present the market of online advertising and the business models of the three major players in sponsored search in France. Section 3 provides an illustration of firms' choices concerning keywords and the rank they obtained in each keywords on the e-tourism market. In section 4 we specify our model. In section 5 we discuss some implications of our findings and then conclude the paper.

## **2. The market of online advertising and business models of search engines**

Internet takes a growing role on the market of advertisings. The expansion of Internet advertising is, in fact, higher than the one of other media (74% between 2004 and 2005 for Internet against 6% for other media combined in France). The growth of ads on Internet resembles other media in past decades according to advertising specialists. Thus, the online advertising

will surpass rapidly the existing players like radio and television<sup>5</sup>. The barometer IAB/SRI underlines the positive evolution of Internet that attracts now nearly twice as many advertisers than television and chosen by both renowned click and mortars and new pure players.

## 2.1. Online advertising

Internet offers various possibilities for advertisers: banners, Flash ads, search engines products, e-mailing, affiliation, pop-ups,...

The banner is, the most classic ad, and continues to be the most commonly used. It is followed by sponsored links, e-mail marketing and affiliation. Banners appear on Websites above or on the right of the text and can be animated and include sound or video. The financing of a campaign of banners is close to that of a billboard one. Generally, the cost of such a campaign is a cost per mille or a cost per impression, *i.e.* the firm pays each time the banner is displayed on Internet without any guarantee that it will be noticed by Internet user. The price is calculated for one thousand set by advertizing agencies selling such product on the Web<sup>6</sup>. The efficiency of this type of advertising in terms of, notably, purchase intentions is studied in numerous works like Cho, Lee, and Tharp (2001); Drèze and Hussherr (2003); Manchanda, Dubé, Goh, and Chintagunta (2006); Sherman and Deighton (2001).

E-mailing consists in sending a targeted e-mail to selected Internet users. An e-mail campaign is generally intended to promote a product or service. Its costs are reduced compared to those of a traditional direct mail campaign. It offers responsiveness, flexibility because the campaign is targeted, personalized and sent in a timely manner to each recipient. The efficiency of this marketing strategy is studied notably by Bonfrer and Drèze (2006) or Drèze (2005).

An affiliation program is a set of contractual relationships between a commercial Website

---

<sup>5</sup>Early 2007, in France, advertising investments made on Internet represents 11% and is in the same magnitude than billboard advertising (11%) or radio (15%) but advertisement on paper (32%) and television (30%) still dominate the market (TNS Media Intelligence-IAB).

<sup>6</sup>There is also other types of online advertisements built according to the same principle of financing that banners. On the one hand, we find pop-ups that consist in the display of a new window with the ad which appears during the surf on the Web. But because of a too often display, a large percentage of Internet users are used to close these windows even before the ad can be displayed and Internet browsers include a self-closing feature of these intrusive windows. Consequently, this type of ad is less and less used. On the other hand, there is a new type of advertising that will soon supplant the banner. It appeared with the use of the Flash technology that permits to include advertisings in all parts of the text or by superimposing by transparency on the text of a website.

and a set of varied partners Websites (affiliates). Affiliates generate a stream of visitors and display a link to the commercial Website. Then, they receive a commission depending on, for example, the performance of sales made by the commercial Website.

Concerning the products of search engines, firms seek to get a top position in the results displayed by the search engine after an Internet user's query. As we said before, there are two types of results, the sponsored links for which firms pay to appear at the top or on the side of the page provided by the search engine and organic results. The organic ranking is difficult to change because it is determined by an algorithm defined by the search engine. It usually depends on the relevance of the contents of the Website, its quality and its popularity on the Web (or the "pagerank" developed by the founders of Google). The changes in the algorithm are only known by the search engine (that's why it is called "Google dance" by specialists) and have consequences on the ranking firms can hardly predict. Furthermore, it may be costly to use a Web agency to optimize the content of the Website to be in accordance with the new rules of the search engine. Besides, we need to notice that the proportion of Internet users who visit the pages beyond the second page of results is near 8% (Médiamétrie) which leads only the first twenty slots to give a real visibility. The other possibility offered by search engines lies in the sponsored links or sponsored search advertising. Although sponsored links are costly, the firm can better control its position through them. For that, the search engines offer different tools, to help the firm to manage its keyword strategy: a firm can choose keywords related to its activities, design the weekly budget and determine its willing to pay for a keyword.

Apart from the classic sponsored links, there are contextual sponsored links that appear on a Website depending on the relevance of the keyword with the contents of the Website (newspapers, chat rooms, . . .). Current techniques used in contextual sponsored links campaigns can display keywords in text or in an illustrated way (like banner, . . .). The technical displays are defined by the Website in accordance with the editorial policies of sponsored links providers, *i.e.* Google with the program Google AdSense, Yahoo! with its Content Match, . . .

Concerning the various kinds of online advertising we can compare these in terms of quality and number of visits. Online advertising, excluding search engines products, appear when Internet users are surfing on the Web without necessarily searching for information concerning

a product or service. The efficiency of banners is, for example, studied by Sherman and Deighton (2001). By contrast, the organic links and sponsored links appear in response to a request made by an Internet user. Consumers therefore appeal to a search engine in order to find a product or a service they need, so we may suppose that they are more inclined to purchase the product than Internet users who click on a banner. Consequently, a high rank in the results of search engines can promote efficiently firms website and generate highly qualified visits. According to XiTi, a sponsored search advertising campaign generates twice as many visits than e-advertising (banners, . . .) or an e-mailing campaign. Furthermore, the interest of consumers for the Website when they arrive *via* a sponsored link is 2.5 or 3 times larger than affiliation. 70% of visits from a sponsored search concern, indeed, more than one page against 60% for non-sponsored web search results and 28% for visits from affiliated Websites. Moreover, in terms of the number of pages viewed per visit, sponsored links record an average of 7.6 pages per visit against 2.7 pages for affiliation. Moreover, by paying only when a customer clicks on the sponsored link and visits the Website of the firm, it ensures a high-performance return on investment. That's why the investment in sponsored search advertising is generally considered as an investment much more cost-effective than e-mailing campaigns, banners and other online advertising solutions.

## **2.2. Business models of search engines and slot auction designs**

Search engines offer some relatively similar tools to help firms to choose the keywords related to their activity. These tools consist in a keyword generator, which gives some information about various keywords in terms of audience and number of advertisers who have already chosen the keywords. Once keyword(s) chosen, the firm writes the text to be associated with the sponsored link, define the bid based on its maximum willingness to pay for each contact (the amount of the cost per click) and the budget allocated daily or weekly to the campaign allowing it to control its total expenditures. The sponsored links will be displayed at the top or on the right of the organic results of the search engine when the keyword purchased will be typed by an Internet user. Then, the auction system determines the slot of the sponsored links and we can distinguished two slot auction designs (Lahaie, 2006; Liu and Chen, 2006): "rank by bid" which corresponds to a stylized version of the mechanism currently used by Yahoo! and Microsoft Live

Search and “rank by revenue”, which corresponds to the mechanism currently used by Google.

### 2.2.1. The rank by bid design

The Yahoo!’s service providing sponsored links is called Yahoo! Search Marketing. The business model as we know it today was born of the purchase by Yahoo! of Overture (originally created under the name GoTo.com). Founded in 1997, GoTo.com is the first firm to provide a service to slot advertisements on search engines<sup>7</sup>. GoTo.com offered advertisers the possibility to bid on how much they would be willing to pay to appear at the top of results (following a first-price payment rule) in response to specific searches of Internet users. The bid amount was paid by the advertiser to GoTo.com every time a searcher clicked on a link to the advertiser’s website. In October 2001, GoTo.com, renamed itself Overture Services with the same economic model. In 2003, Overture was acquired by Yahoo!. The current model of Yahoo! is based on a second-price payment rule that is reminiscent of the Vickrey auction rule. Lahaie (2006) shows that with a second-price rule there is no incentive for a bidder to bid higher than his true value per click using either rank by bid or rank by revenue. The economic model of Yahoo is now evolving towards a rank by revenue model similar to the one offered by Google *via* the setting up of its new platform ‘Panama’ operational at the end of 2007 in Europe.

Microsoft has for a long time subcontracted its sponsored links and its organic links to other firms like Yahoo! Search Marketing. To curtail its dependence with its competitors, Microsoft decided in 2005 to create his own program of sponsored links associated with its own search technology for organic links. The development of the program AdCenter and of the search engine Live Search allows Microsoft to become a player in the market of sponsored search advertising. Its current business model is similar to Yahoo!’s one. The ranking of keywords is based on the bid (rank by bid following a second-price rule) with a cost per click payment, the choice of the budget. However, Microsoft introduces some innovation like the ability to target sponsored links by date, location of the Internet user, her age and her gender in exchange of an additional cost.

---

<sup>7</sup>Battelle (2005) describes in details the history of search engines and of auction advertising models. Vise and Malseed (2006) presents the genesis of Google.



### 2.2.2. The rank by revenue design

Founded in 1998, Google is getting involved in online advertising by the end of 1999 to finance its activities of search engine. Initially, Google chose to sell ads in text format with a system of cost per print payment by charging the number of impressions to advertisers. In the end of 2000, Google set up the Google AdWords platform still based on a cost per print principle, and the absence of bidding on keywords, but with the use of a system allowing the independent management of advertising campaigns by firms (as Overture). The evolution of the business model of Google AdWords to the one we know today occurs in early 2002 with the launching of an improved version called AdWords Select. Google introduces a bid payment based on the cost per click rule. Moreover the new platform allows advertisers to choose daily or weekly budget they want to allow to their sponsored link campaign. The auction mechanism that determines the order of the ads is a second price auction rule.

To distinguish its model from Overture ones, the ordering of the sponsored links depends on both other advertisers' bids and a "quality score" of all ads shown for a given search. The quality score is calculated thanks to notably historical click-through rates<sup>8</sup> and the relevance of an advertiser's ad text, keyword, and landing page to the search. The quality score is also used by Google to compute its "rank number" in order to sort the ads, and then charges each advertiser the smallest bid sufficient to exceed the rank number of the next advertiser. This method is also used to choose if the ad will be maintained or not<sup>9</sup>.

## 3. An illustration of firms' choices in keywords

In order to illustrate our analyses, we choose the market of e-tourism which is one of the most dynamic markets on the Web and we will focus on the three major players of the French market of sponsored search (Google, Yahoo! and Microsoft Live Search)<sup>10</sup>. On the French market of e-tourism (including airline or train tickets, trips, and accommodations,...) for the period between December 2006 and May 2007, nearly three Internet users over five purchased, ordered

---

<sup>8</sup>the click-through rate measure is the number of clicks compared to the number of impressions of the ad.

<sup>9</sup>Google sets a bottom threshold of the click-through rate at 0.5%, or at least 5 clicks to 1000 prints for the ad not to be withdrawn.

<sup>10</sup>The French market includes three dominant players and a multitude of smaller players like Miva, Mirago,...

or booked such product or service on Internet. Among the travel-related services available on Internet, ordering tickets ranks to the sale of trips. Nearly 40% of Internet users have, in fact, booked (or bought) a train ticket online in the last six months and almost 30% of Internet users an airline ticket, while only 20% have bought a journey (Médiamétrie//NetRatings/FEVAD).

Furthermore, a lot of purchases are made offline after a preliminary search for information online. So, nearly 45% of Internet users who booked or purchased travel-related services in a travel agency or in the station, have conducted prior research on the Web on price, on the characteristics of the product or on its availability. According to a study conducted by Ad'oc from a representative sample of French internet users, 80% of those who went off on holiday in 2005 have reserved a travel-related services sought through a search engine.

Moreover, we focus our attention on flights, a product that has the greatest growth between 2006 and 2007 compared to the overall products of the e-tourism industry at least for the travel agencies at the top of the French online market<sup>11</sup>. All leaders announced that the sales of flight grew, between 2005 and 2007, significantly faster than the average of other products, with for example an increase of 51% for Promovacances or 23% for Go Travel (Benchmark Group, JDN).

Each advertiser has the choice between using two types of strategy. A first strategy consists in ensuring a presence on keywords that can provide a large number of visits. A second strategy is characterized by the choice of keywords that are more rarely typed by Internet users, but which lead to very qualified visits for a total cost that can be very interesting. For this selective strategy, the volumes generated, however, are lower. Of course, an actor with an extensive strategy may also be interested in the opportunity effects related to keywords that are more rarely used by Internet users.

Using the keyword generators of Google and Yahoo! we chose early February two keywords. On the one hand, we select "airline ticket" (*billet avion*) which refers to the first type of strategy. The search volume of this keyword compared to the search volume received by various keywords during the last 12 months is maximal<sup>12</sup>. As the search volume is high, the number of competitors on the keyword is also high<sup>13</sup>. Concerning the cost per click, the estimates of Yahoo! with a

---

<sup>11</sup>The travel agencies with the highest turnovers on the French market are Go Voyages, Lastminute, Promovacances, Voyages-sncf, Expedia and Opodo.

<sup>12</sup>If we look at the scale provided by Google (in February 2007), the search volume obtain a mark of 4/5.

<sup>13</sup>If we look at the competition estimation provided by Google (in February 2007), the degree of competition

rank by bid rule is 0.15 euros for the lowest bid and 0.42 for the first slot. The estimates of Google cost per click with a rank by revenue rule, is 0.09 euros to have a slot between the fifteenth and the eleventh ranks, 0.28 euros for the slots between the tenth and the seventh ranks, 0.46 euros for the slots between the sixth and the fourth ranks and 1 euros to obtain one of the slots over the organic results.

On the other hand, we select “find a flight” (*trouver un vol*) which refers to the second type strategy. The search volume of this keyword compared to the search volume received by various keywords during the last 12 months is low<sup>14</sup>. As the search volume is low, the number of competitors on the keyword is low<sup>15</sup>. Concerning the cost per click, the estimates of Yahoo! with a rank by bid rule is 0.15 euros for the lowest bid and lower than 0.4 for the first slot. The estimates of Google cost per click with a rank by revenue rule, is 0.05 euros to obtain one of the slots over the organic results.

Data collection began on 9 February 2007, when we began physically downloading screenshots for the three most popular search engines in France (Google, Yahoo! and Live Search). This process continued for each morning until 9 November 2007. The online sector of flights includes travel agencies, airline companies, shopbots and affiliates Websites. As shopbots and affiliates simply transfer Internet users to travel agencies, we choose to limit our analysis to the most popular travel agencies and airline companies that remain in the sample for the duration of our study<sup>16</sup> and we analyse the relative ranking of these firms each day. Over the nine months period we have the ranking of advertisers for 274 days<sup>17</sup>.

### 3.1. Time series variation in rankings

Following the methodology used in the analyses of firms’ position on price comparison sites (Baye et al., 2004), we seek to analyse if the identity of the firm obtaining higher slots change probabilistically from day to day. For this purpose, we use a non parametric runs test developed

---

is 5 on a five stages scale.

<sup>14</sup>If we look at the scale provided by Google, the search volume obtain a mark of 2/5.

<sup>15</sup>If we look at the competition estimation provided by Google, the degree of competition is 1 on a five stages scale.

<sup>16</sup>For example, for Google, we can follow fifteen firms: Airfrance, Bravofly, Ebookers, EDreams, Expedia, Govoyages, Lastminute, Lookvoyages, Méridiana, Nouvelles-frontières, Opodo, Promovacances, Promovols, TerminalA and Voyages-sncf.

<sup>17</sup>Appendix A offers a full description of the data collected.

by Swed and Eisenhart (1943). Considering time series variation at highest slot levels, we perform a series of tests for randomness of groupings of the identity of the first firm (as far as the third slot).

The null hypothesis is that the identity of the first firm is random over time<sup>18</sup>. The alternative hypothesis is that some firms consistently charge high bids to obtain the first slot.

**Box 1. The runs test methodology**

To perform the runs test we sorted the firm by alphabetical order and calculate the number of observations below the threshold defined by the median firm ( $n_0$ ), the number of observations above the threshold ( $n_1$ ) and the number of runs ( $r$ ) above and below the threshold.

The expected number of runs under the null hypothesis is:

$$\mu_r = \frac{2n_0n_1}{N} + 1$$

where  $N = n_0 + n_1$

The variance is:

$$\sigma_r^2 = \frac{2n_0n_1(2n_0n_1 - N)}{N^2(N - 1)}$$

And the normal approximation test statistic is:

$$\hat{z} = \frac{r - \mu_r}{\sigma_r}$$

Tables 1 and 2 display the results of runs tests for changes in the identities of the firm obtaining the first slot, the second one and the third one both for the different search engine and for the two keywords. The first column of figures gives the total number of observations over the nine months period. Apart from the low typed keyword on Google for which we have few observations because this keyword is rarely selected by the firms surveyed, we have observations for the different position of firms for all days of the period. The second column display the number of runs, that is to say the number changes in the identity of the firm on the slot considered<sup>19</sup>. The last two columns are relative to the runs test. Thus, for example, for the first position on Google for the high typed keyword, there are 71 runs in the 274 observations. Using the normal approximation to the true distribution of the number of runs, the 71 runs in

<sup>18</sup>It corresponds to a situation in which the top firm is generated each day from a fair coin flip.

<sup>19</sup>In practice, we count how many runs there are above and below a threshold. Moreover, we need to notice that even if we change the definition of the threshold (for example the mean firm instead of the median one) the results are unchanged.

this series are fewer than would be expected if the observations were serially independent<sup>20</sup>.

Table 1: Runs tests of the identity of first three firms for the popular keyword

	<b>Rank</b>	<b>Observations</b>	<b>Number of runs</b>	<b>z-statistic</b>	<b>p-value</b>
<b>Google</b>	First	274	71	-6.26	0.00***
	Second	274	98	-3.75	0.00***
	Third	274	80	-4.25	0.00***
<b>Yahoo!</b>	First	274	13	-15.05	0.00***
	Second	274	52	-10.35	0.00***
	Third	274	56	-9.92	0.00***
<b>Live Search</b>	First	274	14	-14.73	0.00***
	Second	274	33	-11.07	0.00***
	Third	274	37	-12.05	0.00***

\*\*\* significant at the 1-percent level

Table 2: Runs tests of the identity of first three firms for the low typed keyword

	<b>Rank</b>	<b>Observations</b>	<b>Number of runs</b>	<b>z-statistic</b>	<b>p-value</b>
<b>Google</b>	First	188	40	-8.03	0.00***
	Second	111	24	-6.12	0.00***
	Third	38	20	0.69	0.49
<b>Yahoo!</b>	First	274	17	-13.71	0.00***
	Second	274	11	-2.56	0.01**
	Third	274	33	-12.69	0.00***
<b>Live Search</b>	First	274	43	-7.81	0.00***
	Second	274	51	-10.43	0.00***
	Third	274	85	-6.42	0.00***

\*\*\* significant at the 1-percent level

\*\* significant at the 5-percent level

Tables 1 and 2 show that we can reject the null hypothesis (that the identity of the firm in top positions is random over time) at the 1% significance level for all first positions, at the 1% or the 5% significance level for the second positions and at the 1% significance level for the third one except for the low typed keyword on Google which is non significant. Consequently, there is some persistence in the firms that charge high bids to obtain the first slot.

There exists asymmetric equilibrium that implies persistence in the identity of firms placed

<sup>20</sup>The p-value is 0.00 indicating a significant result at the 1% level.

at the top of the sponsored links. Consequently, rivals can exploit the predictability of the bid strategy of other firms to adapt their own strategy.

### 3.2. Dynamics of positions

To go deeper in the analysis of the time evolution of firms' positions in sponsored search results on the market of flights, we use a method for studying the intra-distribution movements of firms in their relative ranking. This method is initially employed to assess cross-country convergence of per capita income (Quah, 1993; Kangasharju, 1999).

#### Box 2. Markov Chain matrices

Let  $X_t$  the variable of interest at time  $t$  and assume it can take values in a certain set  $E$ . In the present framework, the variable of interest is the relative rank of the fifteen firms studied<sup>a</sup>. Let  $F_t$  represent the distribution of that variable at time  $t$ , the law of motion can be described by a first order autoregressive process (Quah, 1997):

$$\phi_{t+1} = T^*(\phi_t)$$

Where the operator  $T^*$  describes how the cross-section distribution ( $\phi$ ) transits from one state to another.

If  $X_t$  is discrete, with the set  $E$  assumed to be finite or countably infinite, the operator  $T^*$  can be interpreted as the transition probability matrix  $M$  of a Markov process:

$$F_{t+1} = M.F_t$$

Operator  $M$  is approximated by discretising the set of possible ranks<sup>b</sup> into intervals. For Google and Yahoo!, we construct five intervals: one when the rank of the firm is between 1 and 3, one when the rank is between 4 and 6, one when the position is between 7 and 9, another when the relative position of the firm is between 10 and 15 and finally one when the firm has no bid on the keyword a particular day. This choice attempts to divide all the observed data points into roughly equal sized categories for at least the high typed keyword on Google.

All relevant properties of  $M$  are then described by a  $5 \times 5$  Markov chain transition matrix (for Google and Yahoo! and  $4 \times 4$  for Live Search) where the entry  $(j; k)$  is the probability that a firm in the position  $j$  transits to position  $k$ .

<sup>a</sup>Twelve in the case of Live Search.

<sup>b</sup>We take each firm's relative rank to other firms.

The Markov transition matrices for firms' relative position for the two keywords and on the three search engines are presented in Table 3 for Google, in Table 4 for Yahoo! and in Table 5 for Live Search.

Table 3 contains the one-step day transition matrix estimated by averaging the observed one-day transition over every day of firms' position on the sponsored links displayed by Google.

Table 3: Markov Chain Matrix of positions on Google<sup>a</sup>

		<b>High typed keyword</b>				
		Interval in t+1				
		Ranks 1-3	Ranks 4-6	Ranks 7-9	Ranks 10-15	No bid
Interval in t	Observations (t)	1	2	3	4	5
1	819	<b>0.68</b>	0.18	0.04	0.04	0.06
2	818	0.17	<b>0.54</b>	0.16	0.06	0.07
3	814	0.05	0.16	<b>0.50</b>	0.17	0.12
4	925	0.04	0.04	0.16	<b>0.63</b>	0.13
5	719	0.07	0.08	0.13	0.18	<b>0.54</b>

  

		<b>Low typed keyword</b>				
		Interval in t+1				
		Ranks 1-3	Ranks 4-6	Ranks 7-9	Ranks 10-15	No bid
Interval in t	Observations (t)	1	2	3	4	5
1	335	<b>0.64</b>	0.02	0.00	0.00	0.34
2	28	0.11	<b>0.11</b>	0.00	0.00	0.78
3	4	0.25	0.00	<b>0.00</b>	0.00	0.75
4	0	0.00	0.00	0.00	<b>0.00</b>	0.00
5	3728	0.03	0.01	0.00	0.00	<b>0.96</b>

<sup>a</sup> Intervals depict the rank of firms in each state, from highest to lowest position or absence. The diagonal represents the probability of a firm remaining in its original group. The off-diagonals show the probabilities of firms to move into another state. The first column gives the total number of transitions with starting points in that state.

The first column gives the total number of transition with a starting point in the quantile considered. Thus, for example, the first row shows that over the entire sample (across 15 firms and 273 days in t, that is to say 4095 observations) 819 observations fall in the state 1 in t, *i.e.* has a rank between the first slot and the third one included for the high typed keyword. Of these, 68% remains in that same state in the following day. Over this one-day horizon the predominant feature is a persistence of positions. All diagonal entries, indeed, exceed 50%. Concerning transitions, 4% of firms originally at state 4 (a slot between 10 and 15) transited into state 1 over this nine month transition against 13% which chose to no bid in t+1. 7%

of firms originally not present on the high typed keyword transited to slots in the top state, over the horizon. Looking down a neighbourhood of the diagonal suggests that at low state the greater tendency is that upward and downward motilities in the state nearest is just about balance. The highest quantile appears more persistent than others. The probability of the highest firm remaining highest is, indeed, by far the largest entry in the transition matrix.

Concerning the low typed keyword on Google, there are few observations for firms present in  $t$  (less than 400 for the third first state against 3700 for no bid). There is still persistence of highest positions and also persistence in the choice of no bid.

Table 4 displays the one-step day transition matrix on the sponsored links observed on Yahoo!<sup>21</sup>.

Table 4: Markov Chain Matrix of positions on Yahoo!

<b>High typed keyword</b>						
		Interval in $t+1$				
		Ranks 1-3	Ranks 4-6	Ranks 7-9	Ranks 10-15	No bid
Interval in $t$	Observations ( $t$ )	1	2	3	4	5
1	820	<b>0.85</b>	0.08	0.00	0.01	0.06
2	804	0.08	<b>0.70</b>	0.14	0.03	0.05
3	751	0.00	0.16	<b>0.63</b>	0.17	0.05
4	424	0.01	0.06	0.28	<b>0.57</b>	0.08
5	1296	0.04	0.03	0.03	0.02	<b>0.88</b>

  

<b>Low typed keyword</b>						
		Interval in $t+1$				
		Ranks 1-3	Ranks 4-6	Ranks 7-9	Ranks 10-15	No bid
Interval in $t$	Observations ( $t$ )	1	2	3	4	5
1	822	<b>0.88</b>	0.07	0.01	0.00	0.04
2	794	0.07	<b>0.71</b>	0.13	0.01	0.08
3	674	0.01	0.15	<b>0.70</b>	0.11	0.03
4	215	0.01	0.04	0.34	<b>0.55</b>	0.06
5	1590	0.02	0.03	0.02	0.01	<b>0.92</b>

The strategy which consists in choosing the low typed keyword is less neglected than on Google. There is more absence in  $t$  than on other search engine<sup>22</sup>. The persistence of positions in the same state is higher than on Google. More than 80% of firms originally in the first

<sup>21</sup>We need to notice that we follow the same firms except TerminalA which never choose one of the keywords we have selected and which is replaced by jereserve to keep fifteen firm to analysed.

<sup>22</sup>This can largely be explained by periods of hesitation for firms because of changes on the Yahoo!'s bid platform.



three slots above organic results (state 1) remains in this same state in the following day. The 28% probability of the fourth state obtaining a slot in the third state is greater than the 8% probability of going out the following time. Moreover, there is more upward mobility from the fourth state than from highest original states (probability of 28% to transit from the state 4 to the state above, 16% from the state 3 and 8% from the state 2).

Table 5 shows the transition matrix concerning the sponsored links sold by Live Search during the nine-month horizon<sup>23</sup>.

Table 5: Markov Chain Matrix of positions on Live Search

<b>High typed keyword</b>					
		Interval in t+1			
		Ranks 1-3	Ranks 4-6	Ranks 7-12	No bid
Interval in t	Observations (t)	1	2	3	4
1	818	<b>0.85</b>	0.11	0.01	0.03
2	816	0.11	<b>0.75</b>	0.08	0.06
3	938	0.01	0.07	<b>0.86</b>	0.06
4	704	0.03	0.06	0.09	<b>0.82</b>

  

<b>Low typed keyword</b>					
		Interval in t+1			
		Ranks 1-3	Ranks 4-6	Ranks 7-12	No bid
Interval in t	Observations (t)	1	2	3	4
1	819	<b>0.89</b>	0.08	0.00	0.03
2	816	0.08	<b>0.73</b>	0.12	0.07
3	610	0.00	0.15	<b>0.75</b>	0.10
4	1031	0.02	0.06	0.06	<b>0.86</b>

Here again, we see persistence. For example, 85% probability of firms originally obtaining one of the slots above organic results remaining in those positions a day after.

## 4. The model

We consider two Web-based firms A and B competing in price to attract Internet users. At the competitive equilibrium, the market price is identical for both firms and equal to  $p$ . But market shares can be asymmetric, due to some heterogeneity (reputation, location, ...). Let

<sup>23</sup>We need to notice that, because of less advertisers on this search engine, we retain only twelve of the fifteen firms observed on Google and Yahoo!.

$\lambda_A \geq 0.5$  be A's "organic" market share when Internet users only rely on their experience and the organic links on search engines to choose the seller. The profit of firm A is defined by

$$\pi_A = p\lambda_A$$

and the profit of B by

$$\pi_B = p(1 - \lambda_A)$$

Each firm can increase its visibility and gain market shares by paying for commercial or sponsored links on search engines. Commercial links are obtained by advertising one or several keywords. We only consider two keywords: a popular keyword, that is frequently asked on search engines by the Internet users and a niche keyword, rarely typed by Internet users. If a firm is the only one to bid on a keyword, it will pay the minimum price per click  $\underline{v}$  (reservation price) set by the search engine. Here, we implicitly assume that the bidder knows exactly how many firms wish to bid for the same keyword<sup>24</sup>.

If two firms want to advertise the same keyword, the best position will be attributed to the firm who sets the highest bid. The second-ranked firm will be less visible on the search result page, but will pay less than the first-ranked firm. Here, we assume that the bids are posted simultaneously and the price that the top-ranked firm faces is the bid posted by the second-ranked firm (second price auction) and the second-ranked firm pays the minimum price per click  $\underline{v}$ .

What is the impact of search advertising on market competition? By advertising a keyword, a firm can poach rival's buyers and increase its market share. We consider that it exists two kinds of buyers: loyal buyers versus shoppers. The loyal buyers are not influenced by paid links and continue buying to the same seller (they only consider organic links on search result pages). The shoppers rely on sponsored links to choose between the two sellers. By advertising the popular keyword, a firm can expect to attract a proportion  $\gamma$  of online purchasers through the sponsored link. For example, if firm A is the only one to have a sponsored link on the popular keyword, then the loyal customers (not influenced by the sponsored links) are  $(1 - \gamma)$  and firms

---

<sup>24</sup>Google provides this information to the advertisers.

A and B obtain respectively market shares  $\lambda_A$  and  $(1 - \lambda_A)$  on the loyal segment. But firm A will also attract all the shoppers ( $\gamma$ ) and its profit becomes

$$\pi_A = p(1 - \gamma)\lambda_A + (p - \underline{v})\gamma$$

Whereas B has a profit of

$$\pi_B = p(1 - \gamma)(1 - \lambda_A)$$

For the niche keyword, the proportion of Internet users influenced by the sponsored links is  $\mu$ , with  $\mu < \gamma$  (because this keyword is rarely typed). For example, if firm B is the only firm to bid this keyword, it will attract  $(1 - \mu)(1 - \lambda_A) + \mu$  customers and firm A  $(1 - \mu)\lambda_A$  (and their profit will be  $\pi_A = p(1 - \mu)\lambda_A$  and  $\pi_B = p(1 - \mu)(1 - \lambda_A) + (p - \underline{v})\mu$ ).

When both firms bid for the same keyword, they have to share the shoppers. The top-ranked firm obtains a share  $\alpha$ , with  $\alpha > 0.5$  and the second ranked  $(1 - \alpha)$ . The global distribution of market shares is  $(1 - \gamma)\lambda_A + \gamma\alpha$  for firm A and  $(1 - \gamma)(1 - \lambda_A) + \gamma(1 - \alpha)$  for firm B when they compete on the popular keyword (respectively  $(1 - \mu)\lambda_A + \mu\alpha$  for firm A and  $(1 - \mu)(1 - \lambda_A) + \mu(1 - \alpha)$  for firm B when they compete on the niche keyword).

#### 4.0.1. the bidding strategies

Now we consider the optimal bidding strategies for the frequent keyword.

We assume that the search engine sets a minimum price per click (or per buyer)  $\underline{v}$  that the advertisers will at least pay. If a firm expects to be the only one to bid, it is in its interest to bid  $\underline{v}$  or less. But if both firms compete for the same keyword, they will have to adopt mixed bidding strategies. Each firm will be characterized by a probabilistic distribution of bids on the interval  $[\underline{v}, \bar{v}]$ , where the lowest bid  $\underline{v}$  is a strategic variable set by the search engine and the highest possible bid  $\bar{v}$  is endogeneously determined by the bidders. What is the maximum bid that firm can announced?

Let  $v_A$  and  $v_B$  be the bids simultaneously posted by the two firms. If  $v_A > v_B$ , then the profits are

$$\pi_A = p(1 - \gamma)\lambda_A + (p - v_B)\gamma\alpha$$

and

$$\pi_B = p(1 - \gamma)(1 - \lambda_A) + (p - \underline{v})\gamma(1 - \alpha)$$

If  $v_A < v_B$ , then the profits are

$$\pi_A = p(1 - \gamma)\lambda_A + (p - \underline{v})\gamma(1 - \alpha)$$

and

$$\pi_B = p(1 - \gamma)(1 - \lambda_A) + (p - v_A)\gamma\alpha$$

At the equilibrium, a mixed strategy can yield the same profit and the firm should be indifferent between posting the lowest price  $\underline{v}$  (the firm is certain to be last-ranked) and posting the highest price  $\bar{v}$  (the firm is certain to be top-ranked). For firm A, it means that

$$p(1 - \gamma)\lambda_A + (p - \bar{v})\gamma\alpha = p(1 - \gamma)\lambda_A + (p - \underline{v})\gamma(1 - \alpha)$$

As the profit is unchanged for loyal customers, we just have to compare the gains from the shoppers (the non loyal customers). Then, we obtain

$$\bar{v} = \frac{1 - \alpha}{\alpha}\underline{v} + \left(1 - \frac{1 - \alpha}{\alpha}\right)p$$

The maximal price increases with the reservation price set by the search engine and with  $p$  (i.e. decreases with the intensity of price competition).

Let  $F(v)$  be the cumulative distribution function. Then the expected profit for the firm A

when bidding  $v$  is given by

$$E\pi_A(v) = p(1 - \gamma)\lambda_A + F(v)(p - v)\gamma\alpha + (1 - F(v))(p - v)(1 - \alpha)$$

This expected profit must be equal to the profit when bidding the reservation price  $p(1 - \gamma)\lambda_A + (p - \underline{v})\gamma(1 - \alpha)$ . After rearrangement, we find

$$F(v) = \frac{(v - \underline{v})(1 - \alpha)}{(p - v)(2\alpha - 1)}$$

$F(v)$  characterizes the mixed strategy of firm A and firm B.

#### 4.0.2. The keyword strategies

Now, let consider the existence of an equilibrium without sponsored links. The conditions are given by

$$p\lambda_A > p(1 - \gamma)\lambda_A + (p - \underline{v})\gamma$$

and

$$p(1 - \lambda_A) > p(1 - \gamma)(1 - \lambda_A) + (p - \underline{v})\gamma$$

The condition for not bidding for any keyword is

$$\underline{v} > p\lambda_A$$

This condition holds when the reservation price is excessive compared to the expected gains from additionnal market share.

Now, let consider the existence of an equilibrium with sponsored links.

If A chooses to advertise the frequent keyword, then B will always prefer to advertise one of the two keywords and its best reaction will be to advertise the same keyword if and only if:

$$p(1 - \gamma)(1 - \lambda_A) + (p - \underline{v})\gamma(1 - \alpha) > p(1 - \gamma - \mu)(1 - \lambda_A) + (p - \underline{v})\mu$$

Then

$$(p - \underline{v})\gamma(1 - \alpha) > \mu(p\lambda_A - \underline{v}) \quad (1)$$

And if B chooses to advertise the frequent keyword, then it is also in the interest of A to advertise the frequent keyword if :

$$p(1 - \gamma)\lambda_A + (p - \underline{v})\gamma(1 - \alpha) > p(1 - \gamma - \mu)\lambda_A + (p - \underline{v})\mu$$

Then

$$(p - \underline{v})\gamma(1 - \alpha) > \mu(p(1 - \lambda_A) - \underline{v}) \quad (2)$$

As  $\lambda_A > 1 - \lambda_A$ , then if the condition 1 holds, then 2 also is satisfied. This can be rewritten as

$$\underline{v} < p \left( \frac{\gamma(1 - \alpha) - \mu\lambda_A}{\gamma(1 - \alpha) - \mu} \right)$$

This condition is satisfied if the price of product is high compared to the minimum bid for the keyword.

For a symmetric equilibrium on the rare keyword, the conditions are given by

$$p(1 - \mu)\lambda_A + (p - \underline{v})\mu(1 - \alpha) > p(1 - \gamma - \mu)\lambda_A + (p - \underline{v})\gamma$$

and

$$p(1 - \mu)(1 - \lambda_A) + (p - \underline{v})\mu(1 - \alpha) > p(1 - \gamma - \mu)(1 - \lambda_A) + (p - \underline{v})\gamma$$

Then

$$(p - \underline{v})\mu(1 - \alpha) > \text{Max} \{ \gamma(p\lambda_A - \underline{v}), \gamma(p(1 - \lambda_A) - \underline{v}) \} \quad (3)$$

This equilibrium appears when

$$\underline{v} > p \left( \frac{\gamma\lambda_A - \mu(1 - \alpha)}{\gamma - \mu(1 - \alpha)} \right)$$

If the minimum cost per click is too important compared with the expected gain, then the firms can choose to bid the rare keyword to limit their advertising cost. Moreover when  $\underline{v} > \text{Max} p \left\{ \lambda_A, \frac{\gamma\lambda_A - \mu(1 - \alpha)}{\gamma - \mu(1 - \alpha)} \right\}$ , two equilibria coexist: one without advertisement and a second with competition on the niche keyword.

Is it possible to have an asymmetric equilibrium with one firm advertising the frequent keyword and the second firm the rare keyword?

If A chooses the frequent keyword, then B will prefer the rare keyword if

$$(p - \underline{v})\gamma(1 - \alpha) < \mu(p\lambda_A - \underline{v}) \quad (4)$$

and if B chooses the rare keyword, A will choose the frequent keyword if

$$(p - \underline{v})\mu(1 - \alpha) < (\gamma(p(1 - \lambda_A) - \underline{v})) \quad (5)$$

# Appendix

## A. Descriptive statistics

Table 6: Data description for the high typed keyword

Search engine	Firm identity	Obs.	Mean	Std. Dev.	Freq. 1st rank	Freq. 2nd rank	Freq. 3rd rank
Google	airfrance.fr	197	6.4	2.8	4.06	1.02	2.03
	bravofly.fr	177	8.7	2.3	1.13	0.00	1.69
	ebookers.fr	254	10.2	2.6	0.79	0.00	0.00
	edreams.fr	256	9.3	2.4	0.00	0.39	0.00
	expedia.fr	131	4.6	2.3	0.00	2.29	15.27
	govoyages.com	211	5.8	3.0	6.64	14.22	6.16
	lastminute.com	254	6.5	3.1	5.51	1.57	6.69
	lookvoyages.fr	213	9.4	2.4	0.47	0.94	1.88
	meridiana.fr	233	11.2	2.5	0.00	0.00	0.00
	nouvelles-frontieres.fr	225	5.4	3.6	15.56	14.22	8.89
	opodo.fr	270	2.8	2.6	44.07	19.63	8.15
	promovacances.com	268	3.8	2.2	5.60	18.66	36.94
	promovols.com	243	7.8	3.0	1.65	2.88	7.41
	terminala.fr	201	5.9	3.1	5.47	11.94	9.95
voyages-sncf.com	256	4.3	3.3	19.14	25.78	13.28	
Yahoo!	airfrance.fr	209	3.7	2.2	5.26	24.88	31.58
	bravofly.fr	258	7.6	1.7	0.00	0.78	1.55
	ebookers.fr	129	6.9	2.3	0.00	0.00	1.55
	edreams.fr	196	9.1	1.7	0.00	0.00	0.00
	expedia.fr	242	6.5	3.0	8.26	3.31	10.33
	govoyages.com	240	1.5	0.6	57.50	36.67	5.83
	jerreserve.com	41	9.8	2.1	0.00	2.44	2.44
	lastminute.com	251	6.4	1.4	0.00	0.40	0.40
	lookvoyages.fr	211	9.8	2.0	0.00	0.00	0.00
	meridiana.fr	225	8.3	2.1	0.00	0.89	1.33
	nouvelles-frontieres.fr	11	6.2	3.6	0.00	0.00	45.45
	opodo.fr	191	1.8	1.2	54.45	26.70	11.52
	promovacances.com	251	4.8	1.3	0.00	0.00	11.95
	promovols.com	115	3.8	2.5	0.87	42.61	24.35
voyages-sncf.com	238	3.9	1.5	0.00	8.40	31.09	
Live Search	airfrance.fr	234	5.0	2.4	3.85	12.82	13.25
	ebookers.fr	268	6.4	2.9	1.49	15.30	8.21
	edreams.fr	237	5.2	1.2	0.00	0.00	6.33
	expedia.fr	110	6.9	3.1	13.64	0.91	0.00
	govoyages.com	147	5.7	1.9	4.08	2.04	13.61
	lastminute.com	269	7.9	1.1	0.00	0.37	0.00
	lookvoyages.fr	253	8.9	1.6	0.00	0.79	1.58



Search engine	Firm identity	Obs.	Mean	Std. Dev.	Freq. 1st rank	Freq. 2nd rank	Freq. 3rd rank
	nouvelles-frontieres.fr	22	9.6	1.0	0.00	0.00	0.00
	opodo.fr	269	2.2	1.7	58.36	8.18	8.55
	promovacances.com	264	4.5	1.6	0.00	13.64	18.18
	promovols.com	270	3.1	2.3	26.67	28.15	15.93
	voyages-sncf.com	239	3.3	1.3	4.60	25.94	28.03

Table 7: Data description for the low typed keyword

Search engine	Firm identity	Obs.	Mean	Std. Dev.	Freq. 1st rank	Freq. 2nd rank	Freq. 3rd rank
Google	airfrance.fr	4	5.5	1.0	0.00	0.00	0.00
	bravofly.fr	44	1.8	1.3	45.45	43.18	4.55
	ebookers.fr	15	3.7	2.3	13.33	33.33	13.33
	edreams.fr	29	2.6	0.8	6.90	37.93	41.38
	expedia.fr	1	2.0	...	0.00	100.00	0.00
	govoyages.com	46	1.2	0.7	89.13	6.52	2.17
	lastminute.com	2	1.5	0.7	50.00	50.00	0.00
	lookvoyages.fr	66	1.7	0.9	48.48	34.85	12.12
	meridiana.fr	35	1.7	0.7	42.86	45.71	11.43
	nouvelles-frontieres.fr	0	...	...	...	...	...
	opodo.fr	4	1.3	0.5	75.00	25.00	0.00
	promovacances.com	17	1.3	0.6	76.47	17.65	5.88
	promovols.com	58	1.5	1.0	68.97	24.14	0.00
	terminala.fr	32	2.6	1.2	18.75	34.38	25.00
voyages-sncf.com	16	1.2	0.4	81.25	18.75	0.00	
Yahoo!	airfrance.fr	209	3.9	2.5	15.79	23.44	15.79
	bravofly.fr	193	7.8	2.1	0.00	2.07	2.07
	ebookers.fr	248	7.7	1.8	1.21	0.00	2.02
	edreams.fr	201	5.4	1.2	0.00	0.00	2.99
	expedia.fr	242	6.5	2.9	11.16	5.79	2.48
	govoyages.com	241	1.5	0.8	63.49	24.07	10.37
	jerreserve.com	78	10.5	0.9	0.00	0.00	0.00
	lastminute.com	249	6.7	1.5	0.00	0.00	0.80
	lookvoyages.fr	92	7.5	2.0	0.00	0.00	0.00
	meridiana.fr	3	10.7	0.6	0.00	0.00	0.00
	nouvelles-frontieres.fr	9	4.6	3.4	0.00	55.56	0.00
	opodo.fr	274	2.2	0.9	19.34	50.36	24.45
	promovacances.com	248	4.7	1.5	0.00	0.40	11.29
	promovols.com	118	4.2	2.1	2.54	1.69	50.85
voyages-sncf.com	110	4.2	1.8	1.82	2.73	37.27	
	airfrance.fr	209	3.7	1.7	4.31	19.14	35.41
	ebookers.fr	154	7.6	1.2	0.00	0.00	0.00
	edreams.fr	229	5.8	1.1	0.00	0.00	0.00

Search engine	Firm identity	Obs.	Mean	Std. Dev.	Freq. 1st rank	Freq. 2nd rank	Freq. 3rd rank
	expedia.fr	103	2.7	0.8	5.83	33.98	47.57
	govoyages.com	136	5.5	1.2	0.00	0.00	4.41
Live Search	lastminute.com	243	8.1	1.2	0.00	0.00	0.00
	lookvoyages.fr	121	7.6	1.0	0.00	0.00	0.00
	nouvelles-frontieres.fr	27	2.9	1.8	14.81	37.04	29.63
	opodo.fr	268	3.1	1.1	7.84	26.12	22.76
	promovacances.com	252	5.6	1.1	0.00	0.40	3.17
	promovols.com	270	3.0	1.1	2.96	39.63	23.70
	voyages-sncf.com	242	1.1	0.4	93.39	4.55	1.65

## References

- AGGARWAL, G., A. GOEL, AND R. MOTWANI (2006): “Truthful Auctions for Pricing Search Keywords,” in *ACM conference on electronic commerce*.
- BATTELLE, J. (2005): *The search*, Portfolio Hardcover.
- BAYE, M. R., J. MORGAN, AND P. SCHOLTEN (2004): “Temporal price dispersion: Evidence from an online consumer electronics market,” *Journal of Interactive Marketing*, 18, 101–115.
- BONFRER, A. AND X. DRÈZE (2006): “Real-Time Evaluation of Email Campaign Performance,” Working paper.
- BU, T.-M., X. DENG, AND Q. QI (2007): “Dynamics of Strategic Manipulation in Ad-Words Auction,” 16th international world wide web conference.
- CHEN, Y. AND C. HE (2006): “Paid Placement: Advertising and Search on the Internet,” Working Paper 06-02, NET Institute.
- CHO, C., J.-G. LEE, AND M. THARP (2001): “Different Forced-Exposure Levels to Banner Advertisements,” *Journal of Advertising Research*, 41, 45–56.
- DRÈZE, X. (2005): “Lessons from the front line: two key ways in which the internet has changed marketing forever,” *Applied Stochastic Models in Business and Industry*, 21, 443–448.

- DRÈZE, X. AND F.-X. HUSSHERR (2003): “Internet Advertising: Is Anybody Watching?” *Journal of Interactive Marketing*, 17, 8–23.
- EDELMAN, B. AND M. OSTROVSKY (2007): “Strategic Bidder Behavior in Sponsored Search Auctions,” *Decision Support Systems*, 43, 192–198.
- EDELMAN, B., M. OSTROVSKY, AND M. SCHWARZ (2007): “Internet Advertising and the Generalized Second-Price Auction: Selling Billions of Dollars Worth of Keywords,” *American Economic Review*, 97, 242–259.
- GHOSE, A. AND S. YANG (2007): “An Empirical Analysis of Search Engine Advertising: Sponsored Search and Cross-Selling in Electronic Markets,” Working paper 07-35, NET Institute.
- KANGASHARJU, A. (1999): “Relative Economic Performance in Finland: Regional Convergence, 1934-1993,” *Regional Studies*, 33, 207–217.
- LAHAIE, S. (2006): “An Analysis of Alternative Slot Auction Designs for Sponsored Search,” Tech. rep., ACM EC’06, June 11-15, 2006, Ann Arbor, Michigan, USA.
- LIU, D. AND J. CHEN (2006): “Designing online auctions with past performance information,” *Decision Support Systems*, 42, 1307–1320.
- MANCHANDA, P., J.-P. DUBÉ, K. Y. GOH, AND P. CHINTAGUNTA (2006): “The effect of banner advertising on Internet purchasing,” *Journal of Marketing Research*, 43, 98–108.
- QUAH, D. (1993): “Empirical cross-section dynamics in economic growth,” *European Economic Review*, 37, 426–434.
- (1997): “Empirics for growth and distribution: polarization, stratification, and convergence clubs,” *Journal of Economic Growth*, 2, 27–59.
- RUTZ, O. J. AND R. E. BUCKLIN (2007): “A Model of Individual Keyword Performance in Paid Search Advertising,” Working paper, Yale University,.
- SHERMAN, L. AND J. DEIGHTON (2001): “Banner advertising: Measuring effectiveness and optimizing placement,” *Journal of Interactive Marketing*, 15, 60–64.

SWED, F. AND C. EISENHART (1943): “Tables for testing randomness of grouping in a sequence of alternatives.” *The Annals of Mathematical Statistics*, 14, 66–87.

VARIAN, H. R. (2007): “Position Auctions,” *International Journal of Industrial Organization*, 25, 1163–1178.

WISE, D. A. AND M. MALSEED (2006): *The Google Story*, Batam Dell Publishing Group, Random House Inc., New York.