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« What counts ? Calculation, Representation, Association »  
Labour Market and HR Network

## INTERNET AND THE LABOR MARKET: TOWARD A PROCEDURAL MODEL OF JOB SEARCH

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*(First draft – Please do not quote)*

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### ABSTRACT

*Since Internet opens an easy and cheap gate to job opportunities, it is supposed to improve the dynamics of information flows on labor markets. This paper aims to explore this hypothesis. In particular, it deals with the following questions: How do job seekers access to labor market information through the Internet? Furthermore, what are the effects of the enlargement of the market induced by the emergence of this new medium?*

*This study relies on an analysis of a database of 30 000 queries made by job searchers on a French Internet search engine (Keljob.com) specialized in employment opportunities.*

*Based on the evidence stemming from these empirical sources I develop a procedural model of job search, which contrasts with the substantive model of the traditional search approach. At a first – say individual – level, these terms explicitly refer to G. Dosi's and M. Egidi's distinction between substantive and procedural uncertainty (1991), which itself refers to H. Simon's distinction between substantive and procedural rationality (1976). Indeed, this distinction expresses the profound changes associated with the Internet: the new technology shifts uncertainty from the lack of available information (substantive one) to the inability to process all the available information (procedural one). Moreover, it gives a realistic framework to describe job search as a problem-solving activity based on cognitive rules or procedures. At a second – say collective – level, the procedural uncertainty refers to the consequences of quality uncertainty on the coordination of suppliers and demanders of work. In an environment replete with quality uncertainty, qualifying work and dynamically positioning oneself inside the market become major concerns for all the agents taking part in the matching process.*

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## Introduction

Since George Stigler's seminal papers (1961; 1962), it is admitted that the dispersion of buyers and sellers, and the information costs these entail, reduce market efficiency. From this point of view, the Internet is a remarkable innovation. New labor market intermediaries, called *job boards*, enable cheap advertising of job offers and costless access to them. Moreover, new businesses, called *job search aggregator sites*, afford the aggregation of information in a decentralized manner: a unique gate opens access to job ads stemming from different sources. For the job seeker, Internet has obviously the power to accelerate the search and to enlarge its scope. A simple query on a search engine potentially affords the instantaneous access to updated and complete labor market information.

Following the traditional economic view – which I shall refer to in the next pages as *the search approach* (Devine and Kiefer, 1991) – the dramatic reduction of search costs enabled by the Internet should move the market closer to its competitive equilibrium. The reduction of search costs in the labor market could produce two kinds of effects: it may either reduce unemployment durations or improve the match quality. However, the first empirical results do not give any evidence for these predictions: when leveling out their observable characteristics, Internet job searchers have longer unemployment durations than other job searchers (Kuhn and Skuterud, 2004); moreover, Internet recruiting is associated with shorter employment durations, thus signaling lower match stability (Hadass, 2004). In order to explain these results, the authors stress the possible negative effects of information asymmetries: the increase in screening costs associated with lowered application costs may counterbalance the positive effect of the Internet on job searchers' costs. Thus, these authors depart from the standard search approach by admitting that the organization and the filtering of information flows are crucial issues on the labor demand side. However, they do not question the benefits associated with the Internet on the supply side of the matching process. This argument is, to say the least, paradoxical: *ceteris paribus*, more information means more search costs for the recruiter and lower search costs for the job seeker.

My aim here is not to find the explanation to this asymmetry of treatment – which probably reveals (without making it explicit) the asymmetric structure of most of the labor markets. It is rather to investigate the implications of the following questions: if recruiters face a risk of overwhelming information flows, why would the job searchers not face the same risk? And, if the latter do, how do they manage uncertainty?

In order to answer these questions, I present the results of an analysis of a sample of more than 33 000 queries made on a French Internet search engine in 2004. These data give an original insight into the Internet job searcher's behavior. Based on the evidence stemming from this empirical source, I develop a procedural model of job search – which contrasts with the substantive model of the traditional search approach. At a first – say individual – level, these terms explicitly refer to G. Dosi's and M. Egidi's distinction between substantive and procedural uncertainty (1991), which itself refers to H. Simon's distinction between substantive and procedural rationality (1976). Indeed, this distinction expresses the profound changes associated with the Internet: the new technology shifts uncertainty from the lack of available information (substantive one) toward the inability to process all the available information (procedural one). Moreover, it gives a realistic framework to describe job search as a problem-solving activity based on cognitive rules or procedures. At a second – say collective – level, the procedural uncertainty refers to the consequences of quality uncertainty on the coordination of suppliers and demanders of work. In an environment replete with quality uncertainty, qualifying work and dynamically positioning oneself inside the market become major concerns for all the agents taking part in the matching process.

The paper is divided into four sections. In Section one, I remind the model of action underlying the job search theory and I present its predictions with regard to the new matching technology. The second Section presents the empirical data and the main results of their analysis. In the third Section I consider the implications of these findings on the cognitive side of job search. The fourth Section discusses socio-economic issues of the job search activity in presence of strong quality uncertainty.

### **1. The predictions of the standard theory: search costs and market competition**

The job search theory was originally introduced in order to deal with the decisive macroeconomic issue of unemployment. However, it indirectly influences our representation of the job searcher's micro-behavior. Indeed, it draws the portrayal of an agent who must acquire information in a frictional environment (Mortensen, 1986). Critical reviews of the job search literature emphasize the lack of realism of some of its assumptions, in particular the focus on wages and the exogenous arrival rate of offers (Granovetter, 1995). Kiefer and Neuman recognize that "these assumptions are obviously unrealistic. The interesting questions are whether they can form the basis of a model that increases our understanding of

the working of the labor market, and whether that model is helpful in organizing and interpreting labor market data" (1989, p 4).

In this section I remind the model of action that underlies the standard search approach. First, I show that the assumptions of this theory, by enabling a simplification of the context of choice, allow the job searcher to adopt a substantive rationality behavior. Second, I show the predictions of the theory with regard to the new matching technology – and the understanding that it gives of the working of the electronic labor markets.

### *The model of action underlying the job search theory*

In the labor market, the dispersion of suppliers and demanders and the information incompleteness that it entails produce two effects: first, it leads to price dispersion; second, an investment in time is required to acquire information. The returns to this investment, though uncertain in the present, can be rationally anticipated and, thus, structure the actual behavior of the unemployed job seeker. His/her program is the following: “the cost of search, for a job searcher, may be taken as approximately proportional to the number of (identified) sellers approached, for the chief cost is time. ... If the cost of search is equated to its expected marginal return, the optimum amount of search will be found” (Stigler, 1961, p. 216). Though quite simple, this strategy might require extensive calculation capabilities in an uncertain environment.

Nevertheless, the theory of job search assumes that work is an homogeneous good and focuses on the determination of wage rates. The worker receives a job offer that is in fact a wage offer. It is shown that, in such a case, the optimal policy is a reservation wage policy. It is optimal to accept the job (and stop searching) when the highest offered wage is equal or in excess of a critical number called the reservation wage ( $w^*$ ): the first – admittedly the only one – decision consists in the determination of  $w^*$ . One prerequisite to the determination of  $w^*$  is that the job seeker knows the distribution of wage rates; however, he/she does not know which firm offers which wage. The following problem the search approach meets is how to determine the arrival rate of offers. First generation models are non-sequential: facing an “optimal sample size problem”, the worker selects a wage sample of size  $n$  at cost  $c$  per wage in the sample. Second generation models are sequential: the worker receives one offer per period, which he/she rejects or accepts. The optimal strategy is to adopt a dynamic stopping rule: he/she keeps searching until a “good” wage offer arrives – a wage offer higher than or

equal to  $w^*$ . So, it is assumed that the arrival rate is exogenous: it is not determined by the searcher's strategy; on the contrary, it is the outcome of an external random process<sup>1</sup>.

The conjunction of the preceding assumptions – the focus on wages; the known distribution of offers; the random arrival rate – allows the job seeker to adopt an optimizing behavior. In other words, he/she pursues a strict substantive rationality: once he/she knows the probability distributions of events, the decision-maker is able to choose the course of action which maximizes his/her utility. As shown by Simon (1976), once his/her goals defined, the agent's behavior is entirely determined by the characteristics of the environment in which it takes place. Obviously, this environment is simplified. Indeed, the focus on wages contributes to enlighten the cognitive burden borne by the job searcher: qualitative uncertainty is a priori excluded and the calculation consists only in ranking numbers (wages). Furthermore, the searching process remains transparent: since the arrival rate is random, sequential, and external to the agent, only the outcome of the search matters.

#### *The effects of the Internet in the search framework*

Suppose now that a new matching technology, say Internet, is available. The job seeker has the possibility to choose among different matching technologies. Obviously, if the new one is assumed to reduce the costs of search, the job seeker will adopt it. In the substantive rationality framework, the consecutive change in the environment of choice will lead to a modification of the outcomes of the search. The question raised are: how to modelize the search costs reduction? What are the predictions of the theory with regard to the selected model?

Let us first maintain the standard sequential framework in which it is usually assumed that the worker is able to observe one and only one price in the same period. Indeed, the new matching technology may shorten time periods – and thus search costs – between the arrival of two offers. It is supposed that the job seeker still incurs a search cost and receives one offer at a time. In this framework, it has been shown by P. Diamond (1971) that if all workers have positive (even if very small) search costs, the only equilibrium price is the monopoly price. In the labor market, this equilibrium is characterized by frictional unemployment and wages below the marginal product of labor. This is a negative result. Nevertheless, is it realistic to

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<sup>1</sup> In Stigler's model, the wage sample is random.

suppose that offers arrive sequentially, if the searcher is able through the new technology to identify many employers in the same period?

It seems more adequate to assume that with the advent of the Internet multi-applying is made possible in the same period. K. Burdett and K. Judd (1983) have shown in an equilibrium search model that the competitive outcome will be obtained if buyers – here, job seekers – are informed of at least two prices in the same period. As a consequence, a small change in the specifications of the matching technology leads to important differences in the outcomes: we move from a monopoly (search) equilibrium to a competitive (Walrasian) equilibrium. In a more sophisticated model, E. Kandel and A. Simhon (2002) observe a continuum of equilibria between these two extrema. By modifying their search intensity, job seekers are able to receive  $n$  offers in the same period. As  $n$  increases, there is a gradual transition of the equilibrium structure from the search type – frictional unemployment and wages below the marginal product of labor – to the Walrasian type – full employment and equality between wages and the marginal product of labor. The better the job seeker is informed about labor market conditions, the more competitive pressure he/she puts on firms. Since the Internet multiplies the employer-worker meeting rate, this result can be applied to an improvement of the matching technology.

Consequently, a higher level of information should make labor markets more competitive. Of course, this is a very stylized result. In fact, the increase in competition due to technical advances in matching does not lead to perfectly competitive markets. As shown by B. Petrongolo and C. Pissarides (2001), not only other types of frictions remain (such as skill mismatch or limited mobility), but complete information can be associated with frictional unemployment (as modeled in the stock-flow matching models). However, the traditional search approach necessarily leads to a unilateral representation of the changes associated with the Internet. Central though implicit to this framework, is the "substantive" assumption that the job seekers are able to compute all the information that the world delivers.

## **2. Sample analysis of the search queries**

Concretely, how do job seekers access to labor market information? Though unquestioned by the search approach, this issue becomes crucial with the advent of the Internet. This section presents the results of an analysis of a sample of queries made on a French Internet based platform, *Keljob.com*. This job search aggregator site enables a very

extensive search: in february 2004, when the data were gathered, 150 000 ads were accessible from one unique virtual gate. First I present the functioning of this site. Second I highlight the main results of the statistical analysis of queries.

### *Keljob.com: an employment cyber-market place?*

Though large volumes of job advertisements are accessible on the Internet, the new communication channel does not *a priori* look like a unified market. These ads are displayed by labor market intermediaries with quite different statuses: former print advertisers; Internet pure players; recruiting agencies; temporary employment agencies; public employment services; companies. These many actors compete with each others to attract employers and job seekers. For the latter, the access to scattered information involves time resources to the point that the expected benefits of the Internet could be eaten up.

Similar to price comparison sites or search engines, *Keljob.com* enables the access to job ads stemming from different distant sources: it is a job search aggregator site<sup>2</sup>. It is a mediaplayer whose customers are advertisers that want to "push" their job ads to a larger audience. Technically, this implies that *Keljob* daily indexes many databases and enables a unique query to search into these databases. As an early mover in the Internet, it has benefited from important network externalities and attracts large numbers of job seekers and advertisers. 150 000 ads<sup>3</sup> were displayed daily. By comparison, about 100 000 job offers were, on average, accessible on the public employment service's job board – the PES pretends to hold between 30 and 35 % of market shares in job advertising. In addition, *Keljob.com* has recorded in april 2004 554 000 unique visitors for 1 800 000 visits. These numbers make *Keljob* a sort of supermarket<sup>4</sup> for the employment opportunity.

It is therefore tempting to compare this virtual marketplace with a sort of walrasian auctioneer. Both aggregate many offers and demands; both operate as clearing houses. However, the comparison may be misleading. Indeed, the walrasian auctioneer aggregates offers and demands in order to determine the optimal transaction price. *Keljob* does not intervene in the determination of the wages rates. It is only a matchmaker: it facilitates the encounter between potential partners searching for each other. Nevertheless, through its

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<sup>2</sup> This business model is not a French specificity. By way of comparison, the Canadian web site *Simplyhired.com* aggregates more than 3 900 000 job offers stemming from different North American job boards (june, 2005).

<sup>3</sup> Since the same ad can be displayed on several sites, some of the sample ads are counted several times.

<sup>4</sup> It is however not representative of the domestic labor market. On the demand side, job seekers are more similar to Internet users than to unemployed persons (on average, *Keljob* users are young, urban, white-collar and have a higher educational degree). On the supply side, tertiary, and especially IT and commercial positions are over-represented.

ingenious two-sided structure, it may potentially drastically reduce search costs for potential trading partners. It is therefore a key issue to understand the process by which job seekers get connected to ads through this medium.

### *An insight into the Internet search process*

I now highlight the results stemming from a survey conducted on a sample of queries made on the search engine *Keljob.com* web site. These queries enable connected job seekers to reach job ads displayed by *Keljob.com's* customers. Once connected to Keljob, the job seeker enters his/her search criteria (see Figure 1). Once the query is launched, the searching agent scrutinizes the indexed database and catches the offers that match with the searching criteria. A new window appears, which displays a list of the matched ads. These summarized ads are displayed at a rate of 25 per web page, with a technical limitation to 250 ads (cf infra). Once the Internet job seeker clicks on a specific ad, he/she leaves Keljob: he/she is automatically directed to the advertiser's web site.

**Figure 1: Keljob's multi-criteria search engine**

Jeudi 19 août 2004  
**149 074** offres d'emploi, **356** sites

accueil recherche multicritère espace candidats espace formation espace recruteurs

Aide à la recherche ?

Votre lieu de travail :  
EUROPE FRANCE Toutes les Régions

Intitulé du poste / Mot Clés :  
\_\_\_\_\_

Secteur d'activité / Métier : (Indifférent)  
Société (Raison sociale) : \_\_\_\_\_

Type de Contrat :  
 CDI  CDD  Intérim  Stage  
Expérience : (Indifférent)

Effectuez maintenant la recherche  
 Recevez quotidiennement toutes les nouvelles offres par mail

Go!

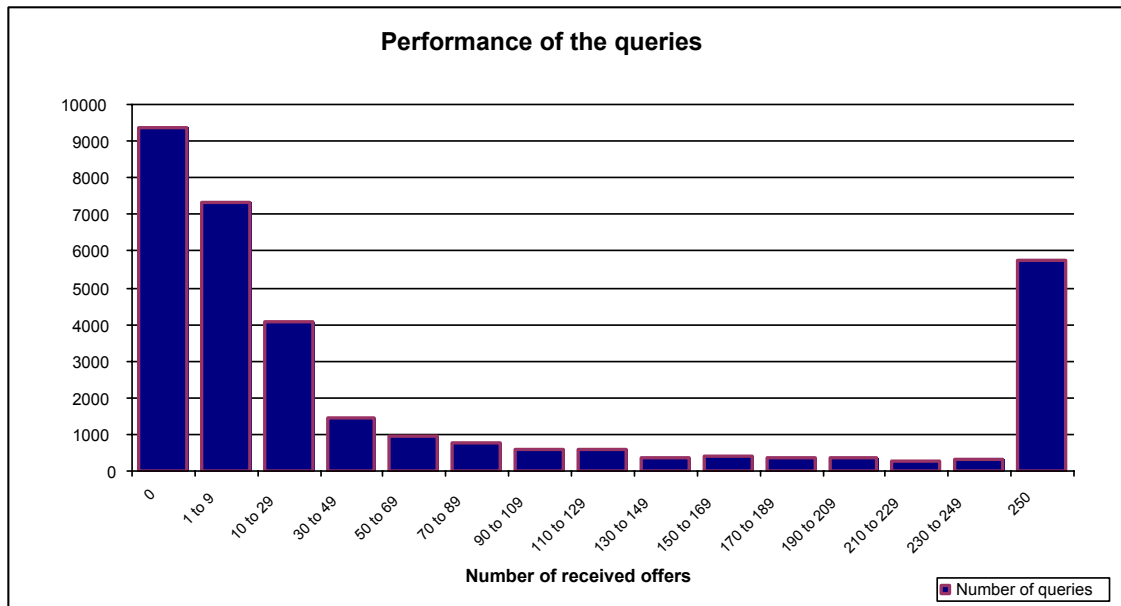
The empirical material is an Excel file that contains a recording of all queries made on 28 and 29 february 2004, that is 33 044 queries<sup>5</sup>. Though I did not have any information on the job seekers' identity, and though I did not have access to the contents of the offers reached by the queries, I am able to present results concerning not only the individual searching strategies but also the performance of the queries in terms of matching. Indeed, for each query, I have a specific information, the number of received offers, which I shall use as a proxy for the queries' performance. With evidence stemming from these empirical sources, I consecutively consider the arrival process of offers and the searching strategies implemented by the connected job seekers.

Let us first consider the arrival rate of offers. It is possibly determined by factors that are unrelated to individual search decisions: a coordination failure results then from the absence of offer in a particular market segment. But it is not enough to explain that almost one third of all queries don't match any job offer - the Table 1 shows the distribution of the number of received offers. Since they are the result of inadequate queries, many coordination failures can be attributed to the job searcher's action: spelling mistakes, inconsistant queries or too accurate demands lead to bad results. Symmetrically, high returns are not synonymous with successful queries: 17 % of all queries reach more than 250 offers. It means that 17 % of all queries reach between 250 and 150 000 offers, but that, for each query, only 250 offers are randomly choosen by the search engine – the number "250" is a technical limitation embodied in the search algorithm. Then, the offers are displayed at a rate of 25 offers per pages. Screening a large sample of datas requires time: web searching studies show that search engines' users rarely go beyond viewing one or two pages (Jansen and ali., 2000). Clearly, the connected job seeker has the power to modify through his/her search criteria the size of the market he/she explores. Not only this power leads to misuses of the search engine, but it is also restricted by the limited rationality of the job applicant. His/her strategy is governed by one question: how to manage uncertainty if a too selective search drains the market and a too unselective search floods the market?

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<sup>5</sup> This empirical material might not seem familiar to an economist or to a sociologist. However, it is part of a growing litterature: the web searching studies (Jansen and Pooch, 2000).

**Table 1**

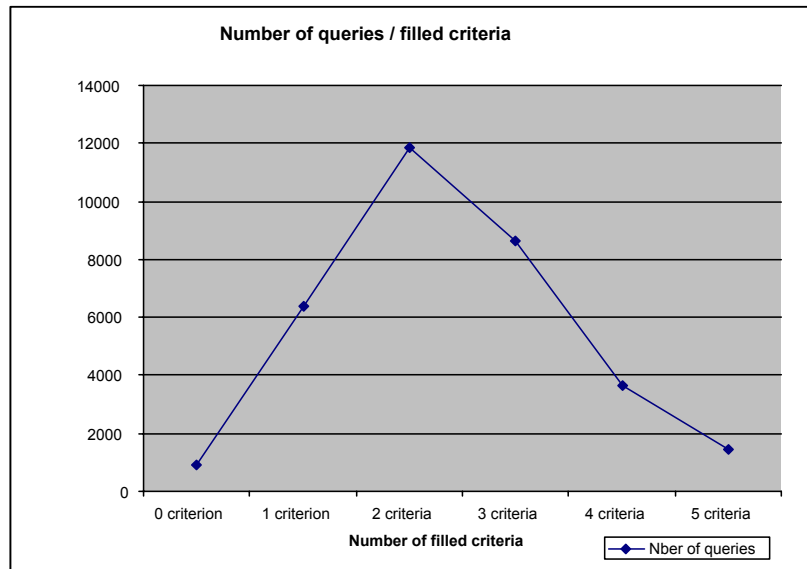


Obviously, the arrival rate of offers is not the result of a random procedure, and it is greatly determined by the job searcher's behavior. In order to explain what an effective cognitive strategy is, we need to know how he/she parametrizes the search engine<sup>6</sup>. The web site enables two types of queries: the simple 'key word' query<sup>7</sup>, and the multi-criteria query – with up to five commonly used criteria (key word; location; domain; experience level; type of contract). Table 2 – which represents the level of complexity of the queries – shows that most queries (77 %) are combinations of several criteria. More precisely, 62 % of all queries are reasonably complex, using two or three criteria. It's quite logical, since all "zero criterion" queries reach all the market (empty search) and 80 % of "five criteria" queries don't match any offer.

<sup>6</sup> In fact, the most relevant unit of analysis is the "web session", which is made up of several successive queries by the same user. Indeed, an inadequate query can be marginally modified in order to enlarge or to restrict the search. Unfortunately, it was not possible to piece together individual sessions from the queries' database.

<sup>7</sup> In an empty field, the job seeker writes the word(s). For example, key words may refer to occupations (florist; butcher; financial analyst; ...), to skills and tasks (german; computer maintenance; inventory control; ...) or to products (Oracle; networks; polymers; waste; ...).

**Table 2**



But this simple quantitative result is not sufficient to assess what is an effective cognitive strategy. Is there an optimal combination of criteria? It seems possible to hierarchise them. Criteria such as the job location, the type of contract or the level of experience do not suffice to calibrate the search engine in order to match relevant ads. Since they explicitly qualify the work, the two other criteria rule the search: employment domain<sup>8</sup> and key word. Table 3 shows the performance of queries – that is the number of received ads – depending on whether they incorporate one, both or none of those two dominant criteria. First, the results confirm that these criteria are a necessary condition of an effective search: 67 % of the queries using neither of them match 250 offers or more. Second, these criteria are mutually exclusive: 64 % of the queries using simultaneously the "domain" and "key word" criteria don't reach any offer. Finally, each dominant criterion can be associated with a different market size: key word searches reach a tighter market than domain searches. It's quite understandable since the employment domain is an enlarged cutting-out of the labor market, while the key word enables a more targeted search. The best strategy might differ, depending on the market scope the job seeker's is targeting.

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<sup>8</sup> The "domain" criterion is an hybrid and finite list of 30 "job categories", such as: marketing; automobile industry; finance; tourism; healthcare; executive; etc.

**Table 4: performance of different combinations of criteria**

	"Domain" queries (D)	"key word" queries (KW)	D + KW	neither D nor KW
<b>Performance</b>	%	%	%	%
<b>0 offer</b>	6	31	64	4
<b>1 to 19 offers</b>	30	37	26	11
<b>20 to 249 offers</b>	42	25	9	18
<b>250and more offers</b>	22	7	1	67
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

Therefore, different searching strategies are implemented by the connected candidates that make an efficient use of the search engine. As a consequence, it appears that the central issue of the online job search is the discovery and selection of efficient search rules. These rules are implemented in order to find a path between situations characterized by a deficit of information and situations characterized by an excess of information.

### **3. Implications (I): the cognitive dimension of job search**

A job seeker entering *Keljob.com* faces 150 000 alternatives. The reduction of search costs critically depends on his/her ability to select effective procedures of search. Understanding the potential effect of the Internet on search costs implies therefore that we move to a framework which gives way to procedural rationality, defined by H. Simon as "the effectiveness, in light of human cognitive powers and limitations, of the procedures used to choose actions" (1978, p. 8).

In this section I move a step forward and introduce the cognitive aspect of the procedural model of job search. First, I show that an effective search requires specific cognitive skills. Second, I consider the role of cognitive artifacts that serve as a decision aid and lead to a distribution of the cognition.

#### *From procedural uncertainty to cognitive skills*

Procedural uncertainty characterizes "circumstances whereby the solution of choice problems is constrained by the computational and cognitive abilities of the agents" (Dosi and Egidi, 1991, p. 150). Strong procedural uncertainty implies that the main activity is not the choice itself but the problem-solving process. In other words, the agent must develop a

procedure to proceed from a large number of alternatives; and the development of an adequate procedure is a central issue of the decision-process. In order to explain this issue, Dosi and Egidi consider the case of an agent who is given a Rubik cube. They show that he/she can follow three different procedures. The first one consists in exploring extensively the game-tree according to a general search algorithm. The "orthodox player" thus explores, one after the other, all possible sequencies. When considering the arrival rate of offers in the search approach, it is explicitly this kind of procedure that is modelized. This procedure requires a high cognitive effort in a complex environment. The "satisficing player" follows a different procedure: he/she examines sub-trees and uses local algorithms (or routines). This procedure typically results from the agents' bounded rationality. The third procedure, which characterizes the "innovative player", consists in finding a new problem-specific algorithm. This procedure implies that the player moves from the problem-space to the sub-problem space, where he/she can create new representations of the problem. The innovative behavior requires a higher level of abstraction.

Let us now consider the job seeker connected to *Keljob.com*. Suppose now that he/she does not hierarchize his/her search. Even if he/she precisely knows what he/she is looking for, a linear item-by-item random search might take time and be very costly: this basic procedure leads to linear computational complexity (Norman and al., 2004). Furthermore, such a procedure is made impossible by the technical constraints of the search engine. Obviously, Keljob's job seeker is not an orthodox job seeker. He/she will more probably adopt a satisficing behavior, by using search rules that have already shown a certain degree of effectivity. The job ads are daily actualized; but the job seeker does not daily actualizes his/her search rules. The use of repeated combinations of criteria and key words characterizes a routinely job seeker. Moreover, it is possible to register for a daily (or weekly) mail alert by pre-recording some specific search features: the routine is automated. However, where do the performant search rules come from? In fact, the search rules revealed in the former section are not codified or made explicit anywhere. They are the outcome of a trial-error process carried on by the job seeker. The job searcher learns by using insofar as he/she tries new combinations. He/she progressively drops inefficient search routines, and keeps the efficient ones. The Internet job seeker is both – though not simultaneously – a satisficing and an innovative searcher.

The ability to find and to follow performant search rules is a prerequisite for an efficient – that is quick and cheap – job search. Obviously, the discovery and the

implementation of search procedures require cognitive skills. However, the high number of unsuccessful queries – almost one half – tends to show that these procedures have not become more commonplace. The distribution of the results (table 2) can be explained by the simultaneous coexistence of expert and novice users of the search engine. Nevertheless, this may tell us that the capacities of innovation – exploring new combinations – and of learning – selecting the good routines – are not equally distributed among job applicants. Yet, it is not possible to isolate and measure these two factors.

### *Selection procedures and the role of cognitive artifacts*

I consider now the nature of the procedures implemented by job seekers. I adapt here the results from A. Norman and al. (2004) whose work lays the foundations of a procedural model of the consumer. They focus on consumers who face markets with heterogeneous goods, such as high tech products. Basically, consumers use an elimination-by-aspect rule (EBA), as defined by Tversky (1972): the decision maker chooses an aspect and then eliminates all items which do not possess the aspect. The aspect refers to the characteristics that are or not attributable to the good. However, since it is a linear rule – this is an item-by-item search – the EBA rule might require important cognitive resources, in particular when there are many alternatives. It might therefore be efficient to use a sublinear rule, such as the set-selection-by-aspect rule (SSBA): only one aspect is required to determine the subset of items in the original set that possesses the aspect. The SSBA rule acts as a powerful filter that retains the relevant subset. However, it depends crucially on how the original set is organized: "when stores organize goods in a nested structure by attributes, they make SSBA steps feasible. ... This organization enables buyers to use many selection-by-aspect steps on aspects defined over the attributes because sellers provide customers with labels to recognize sets, organize goods in patterned displays which customers learn to recognize, organize goods in catalogues hierarchically through indices, and on web sites, provide search algorithms that return the set with the specified characteristics" (Norman and al., 2004, p. 185).

Identification of search rules provides an explanation of the functioning of *Keljob's* search engine. Indeed, the problem the job searcher faces is similar to the consumer's problem: how to discriminate among goods with heterogeneous characteristics? Since the job ads are stored in hidden databases, search algorithms are required to reach them. This has two consequences on the searching process. First, *Keljob's* search algorithm implements several

SSBA rules. Indeed, each query is a combination of criteria. Each criterion is an SSBA rule which enables to select an aspect. This means that a query is a multi-SSBA rule. However, and contrary to the canadian web search engine *Simplyhired.com*, it is not possible to proceed by sequencies, or steps. The difficulty for the job seeker connected to *Keljob* is to find the proper parametrization of different SSBA rules. Once the first search is performed by the algorithm, the job seeker can use a basic EBA rule to compare the subset of matched job ads. Second, the job seeker must define a set of aspects that is consistent with the informations' organization. In fact, he/she is constrained by the matching device that is implemented by the web site's developers. This matching device also serves as a resource since it improves the performance of the search. As a consequence, this search configuration distributes the cognition: as shown by E. Hutchins (1995), the search process is the produce of the interaction between the agent (the human individual) and the cognitive artifact that is part of the environment. Moreover, since the technical artifact is implemented by the labor market intermediary, the selection of the "matching markers" (the advanced aspects) greatly relies on its intervention. Consequently, the diversity of search engines implemented by Internet based labor market intermediaries leads to a plurality of search procedures (Marchal and al., 2005). However, the relationship between the technical artifact and the procedures of search is not deterministic. Indeed, *Keljob.com*'s developers expected job seeker's to use simultaneous combinations of three criteria: the job location, the employment domain and the key word area. However, as shown before (cf Table 3), queries using simultaneously the "domain" and "key word" criteria are very uneffective.

To sum up, it appears that the implementation of searching strategies requires computation. This computation admittedly relies on the job seeker's ability to find effective search procedures. But it also relies on the organization of informations and on the choice of search algorithm: these activities are on the behalf of the web site's developers. Under these conditions, the Internet job search should become an effective, cost reducing activity.

Nevertheless, these findings on the cognitive dimension of search raise a typical "orthodox" question: is it possible to integrate this cognitive part of search in the cost function of the job seeker? After all, the search for effective search rules is part of the search process and could be expressed in a cost. However, as shown by Dosi and Egidi, "it is in principle impossible to establish ex-ante whether a procedural choice is better than another one, e.g., in terms of time and costs of search" (1991, p. 156). Indeed, it is not possible to assess the

rationality of a procedural operation on the basis of its result: the assessment concerns the elaboration's process of the result. In the second section I used the number of matched ads as a search performance clue. Though it helps pointing out the effective search procedures used by job seekers, it is quite an arbitrary and unsatisfactory proxy. Not only it ignores the real contents – and thus the value – of the ads but it also neglects external labor market conditions. To assess the job seeker's rationality implies to concentrate on the search procedures.

#### **4. Implications (II): the socio-economic dimension of job search**

In the preceding Section, I have described the change associated with the Internet by a move from substantive to procedural uncertainty. My aim in the following section is to identify the implication of the Internet from another point of view: quality uncertainty<sup>9</sup> and the market clearing process. As seen before, the search approach associates the reduction in search costs with more competitive markets (in a walrasian way). I shall departure from this view. First, I investigate at a theoretical level the implications of the relaxing of the "nomenclature-hypothesis" in presence of quality uncertainty. Second, I introduce the two-sided search problem as a coordination game. Third, I give an empirical description of *Keljob's* coordinating activity.

##### *The "nomenclature-hypothesis"*

The traditional job search models rely on the assumption that work is an homogeneous good, and thus define a job offer as a wage offer. Stigler's argument on this assumption is the following: "No worker, unless his degree of **specialization** is pathological will ever be able to become informed on the prospective earnings which would be obtained from everyone of the potential employers at any given time, let alone keep this information up to date" (1962, p. 94; I stress). The implicit underlying idee is that if a worker is very specialized, he/she will be able to go round the market to meet all his/her (few) potential employers. On the contrary, a worker with standardized skills will not be able to contact all his/her (numerous) potential employers. Only the latter will truly be confronted to substantive uncertainty – defined as a lack of information about environmental events. Let us now consider this problem in the Internet age. Suppose that workers are standardized to the point that work can be likened to an homogeneous good. If employers post their job offers on the same web site, and if an

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<sup>9</sup> In fact, as I will show, procedural and quality uncertainties are the two sides of the same coin.

algorithm enables the ranking of the wage rates, then the market place will approach its walrasian ideal-type. On retail and financial markets, web based algorithms enable the immediate comparison between hundreds of vendors, with important (though not decisive) effects on price rates and price dispersion (Brown and Goolsbee, 2002). The more the products are homogenized, the closer benefits associated with the Internet are to competitive markets outcomes.

However, quality uncertainty is a central feature of the search process I investigate. As shown by C. Benetti and J. Cartelier (1980), the walrasian market clearing process, which supposes an adjustment of quantities through flexible prices, relies on the so called "nomenclature-hypothesis": for each good, there is a complete list of characteristics (or qualities) of the good; this list is common knowledge. Quality uncertainty results from the relaxing of this assumption. G. Akerlof (1970) shows that, in the presence of quality uncertainty, price mechanisms do not suffice to guarantee an efficient clearing of offers and demands. In the labor market, frictions result not only from agents and prices dispersion, which is the working hypothesis of the job search theory, but also from the incomplete information about the attributes of the goods. This claim becomes more relevant with the advent of the Internet as a communication medium. Indeed, physical distance is abolished on the informational side of the matching process, while organization and filtering of informations are particularly crucial issues. These issues concur to the characterization of two-sided search as a coordination game.

#### *Two-sided search as a coordination game*

Job seekers search for hiring firms while recruiters search for job applicants. Obviously, both face a cooperative-game issue: their interests converge. Nevertheless, if not organized, the bilateral search process might be very ineffective: there is no reason that each side's searchers converge on the other side's searchers (and reciprocally). Consequently there is room for a third party – the matchmaker – to emerge: his/her activity consists in facilitating the encounters. More precisely, the search process will be effective if the matchmaker is able to facilitate "good" encounters, while preventing "bad" encounters<sup>10</sup>. Note that this problem is

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<sup>10</sup> The mainstream literature focuses on the existence and stability of market structures including intermediaries. Since it does not modify the nature of the transacted good, the intermediary is usually assumed to be neutral: it only reaps the surplus associated with gains in search costs (Rubinstein and Wolinski, 1987). Moreover, the two-sided architecture of matchmakers generates network externalities – job ads attract applicants which attract more announcers, etc –, thus favoring first movers that become monopolies (Caillaud and Jullien, 2003).

irrelevant in the substantive rationality framework, while it becomes critical in the procedural one. Indeed, the effectivity of the search process depends dramatically on the matchmaker's ability to regulate and filter the information flows.

D. Lewis (1969) develops a game-theoretic model which he calls the pure coordination game. Consider two players who must decide to drive either on the left or on the right. There are two equilibria that are individually and collectively equivalent. Moreover, the player's interests converge. Their problem is to coordinate their behaviours. Lewis' well-known solution is that both players will follow the same convention. F. Eymard-Duvernay (1989) extends this coordination problem to markets and organizations by assuming that the product's quality has a conventional nature. Indeed, several quality conventions – which he calls the "merchant", the "industrial" and the "domestic" ones – are the basis, in different contexts, of the interactions between individuals.

Let us now reconsider the problem the agents face on the Internet based labor market. At a first level, suppliers and demanders of work have to coordinate their behaviors. The solution is to meet at the same place: that is, the web site. At a second level, they have to coordinate their representations of each others in order to discriminate among each others. This means that they have to use the same language to qualify each others and to match these qualities. As seen in the preceding section, the intermediary contributes, by highlighting "coordination markers" – the aspects – to the use of this common language. However, these markers are neither arbitrary, nor pure creations of the matchmaker<sup>11</sup>. They relate to categorizations that are shared and used by many other agents – other intermediaries, but also employers, public services, unions, statistical agencies, etc. I will show now that *Keljob.com* original coordination architecture may affect these common categorizations.

### *(Kel)job matching as an (im)pure coordination game*

*Keljob.com* managers are obviously concerned about the effectivity of the encounters that their site contributes to arrange. However, they are seriously constrained in their intervention by *Keljob's* specificity as an aggregator site. I will consider this issue by answering the following question: how does *Keljob* help reducing quality uncertainty?

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<sup>11</sup> A counter-example is given by the french public employment service which has developed an original and finite nomenclature of occupations (the ROME). This nomenclature serves as the spinal column of its employment web site, *Anpe.fr* (Marchal and al., 2005).

First, the web site enables the use of search criteria that are displayed in the form of finite lists and pull-down menus. The use of categorizations that cover the labor market and cut it into segments is thus made explicit. Not only such criterion qualifies both the job ad and the job seeker, but its salience is incitative: on the one hand, each job ad belongs to one segment; on the other hand, the job seeker easily chooses a preferred segment through the pull-down menu. Such an organization concerns all search criteria – location; nature of the contract; level of experience; employment domain – except the "key word" one. The intersection of these criteria will define the matching area. For example, the query "Provence Region + Long Term Contract + Communication/Media Domain" matches 13 job ads. This example does not show major ambiguity. Obviously, the physical location is an unproblematic cutting-out of the labor market. It is common knowledge, and there is no competing representation of the physical location. Moreover, it is not ambiguous insofar as it is clear-cut: this information circulates very well. As a consequence, the location criterion is the most popular among Keljob's job seekers: less than 10 % of all queries do not mention it. The nature of the employment contract also relates to a representation – this one is legal – that is firmly established. The experience level criterion divides the labor market into two classes: debutants and experienced job seekers. Though basic, this division raises interpretive difficulties: the boundary is fluctuating and uncodified. As a consequence, 78 % of the queries do not use this criterion. Finally, the employment domain criterion raises a specific problem. This "homemade" list of 30 qualities is an hybrid between industrial sectors and occupations. Many job ads (and job seekers) may be put into several domains. This uncertainty leads to coordination failures. However, to change this list would be very costly: technical investments are required to modify the search algorithm and the compatibility with customer sites' classifications; announcers and job seekers should also change their routines. For *Keljob.com*, the use of listed search criteria greatly (though not completely) reduces quality uncertainty; however it turns out *ex post* to be a quasi non-reversible investment.

Since *Keljob.com* is a non-specialized job board, its scope is the whole labor market. Since it is an aggregator site, it can not impose a unique format of information to customers that display the job ads on their own web pages. These two reasons justify the use of key words as the main search criterion – it concerns 70 % of the queries. This mode of search modifies the nature of the coordination between both sides of the market. Note that the key word search isn't a full text search: indeed, the announcer has to mention for each ad the sample of "matchable" key words. The job searcher has to guess, in a myopic way, the sample

of words chosen by the advertisers. And the web site is of no help: it stays in the background of the matching process. For him/her, the question raised is: "which words connect me to jobs I'm looking for?" The effectivity of the "key word" search hardly depends on the possibility to summarize the searched position in one or a few words. Different alternative categorizations concur to the representation of the labor market: sectors, occupations, skills, products, etc. By opening the search to the whole language, the "key word" search leaves the job seeker free to choose among these competing representations. This could be an advantage, under the condition that the isolated *Keljob's* user is able to manage the induced procedural uncertainty. Like Dosi's and Egidi's innovative player, he/she has to move from the basic search space (the problem-space) to the qualification space (the sub-problem space). However, he/she is not a pure innovator: he/she is not creating new words. He/she pursues a more social activity, which consists in getting up to date information about recruiters' habits and interests. Since the relevant matching markers are not immediately available, they have to be found in other social worlds, such as professional communities. Indeed, only such "hot" intermediary social worlds link up local tacit skills and commonly recognized matching standards that are put into circulation (Benner, 2002).

As a consequence, it seems necessary to reformulate Stigler's problem to adapt it to the Internet job search: no worker, unless his degree of **standardization** – which literally means "put into standards" – is pathological will ever be able to become informed on the prospective earnings which would be obtained from everyone of the potential employers at any given time, let alone keep this information up to date. The coexistence of a plurality of categorizations, the incompleteness of these categorizations and the resulting quality uncertainty obviously contribute to the persistence of frictions in contemporary labor markets.

## **Conclusion**

E. Brynjolfsson and L. Hitt consider that "the fundamental economic role of computers becomes clearer if one thinks about organizations and markets as information processors" (2000, p 24). Following Simon's works, this view clearly departs from the orthodox probabilistic treatment of uncertainty.

By focusing on the changes associated with the Internet on the job search activity, I have shown some implications of this perspective. On the critical side, the standard job search theory clearly shows its limitations: it gives an unsatisfactory view of the dynamics of these

changes. On the positive side, I present some basic features of a procedural model of job search. First, I show that the efficiency of the search depends on the effectivity of searching strategies. These strategies admittedly rely on the job seeker's ability to find effective search procedures. But they also depend on the web site's organization of informations and choice of search algorithm. Second, I consider the coordinative role of qualifications. I show that, if the Internet is assumed to abolish distance, it also probably intensifies the quality uncertainty.

Further research should first include the "digital divide" implications of the procedural nature of search. Indeed, the search activity requires computational, and innovative capabilities. This work should also be symmetrized by the study of the procedures of search and screening used by the recruiters. Finally, I have shown that intermediaries intervene in the coordination process. Comparative studies of these intermediaries should be pursued (Marchal and al., 2005; Mellet, 2005).

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