Linguistic choice and the criterias of efficiency and efficacy in business companies of Catalonia. Implications on inclusion and exclusion of social and linguistic groups.

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The research aims to analyse the rationality of corporate linguistic policies through criteria of communicative efficiency (maximin criteria or maximisation of the minimum communicative competence) and efficacy (minimax criteria or minimisation of maximum communicative loss). The implications of inclusion/exclusion emerging from communication in different linguistic and social groups are examined. Empirical evidence is made up from 22 in-depth interviews with managers and a survey of 228 employees in 26 workplaces affected by the internationalisation of its activity and workforce. The fieldwork has been done in Catalonia. Considering three languages (Spanish, Catalan and English), the results show that communication strategies based on maximin criteria place English as an optimal linguistic choice in contexts of increasing diversity in work and companies, but with an important level of ambiguity and possibility of misunderstandings. Using the criteria of linguistic efficacy (minimax), the result is the choice of Spanish language in a majority of communicative relations. On the question of the inclusion dimension of communication, English is an increasingly advantageous position in comparison with Spanish and Catalan in contexts of high cultural diversity. This publication is part of a wider research that has been made with the support of *Ministerio de Educación y Ciencia* of Spain (grant SEJ2005-03937) and the Institute of Catalan Studies.

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1. Introduction.

In this paper we analyse the choice of a communication language in accordance with two optimisation criteria. The first criterion, which we call efficiency, is defined as the choice of the language that maximises the number of participants in communication. The optimal language is the one that includes more individuals in communication (or which excludes fewer). The second criterion is communicative efficacy, which we define as the choice of the language that maximises quality and equality in communication. The optimal language in communication is one that two individuals speak with the same level of competence. Such an approach allows us to respond to questions of the following type: What capacity of inclusion/exclusion in communication does one language possess compared to another in a specific context? In which language does the communication occur among equals, in other words, between people with the same linguistic competence?

We have applied this type of analysis to the linguistic reality in the business world in Catalonia (Spain). Specifically, the units of analysis are company workplaces and departments. Consequently, the processes of optimisation occur in relation to the communication between departments or workplaces acting as corporate actors to which we attribute relationships with language, for example, a work language, a common language and a corporate language, which are on a different level, although related, to the languages of the speakers. So, which common language is more egalitarian? Which language permits a lower degree of exclusion from the communication? The paper we are presenting aims to formalise methods of analysis that will allow us to respond to these questions.

The indicator we shall use is the linguistic competence of the employees of these workplaces. Using this indicator, we will construct the communicative profiles of the companies for three languages: Catalan, Spanish and English. These communicative profiles allow us to observe the communication possibilities at different levels of linguistic competence and the possibilities of exclusion from communication for each level of competence. We shall operationalise the communication profiles and possibilities through the mathematical theory of fuzzy sets[1]. The formalisation of the decision process on which language to choose in order to maximise communicative efficiency or efficacy will be performed using rational choice theory. We will obtain results that will allow us to discuss some of the theoretical developments relating to choice among languages on the basis of their communicative potential, their communicative loss and the inclusion or exclusion of social groups resulting from such choices.

2. Linguistic efficacy and efficiency. Consequences of exclusion from communication

When deciding to choose a communication language in a company, two major issues can arise. The first of these is linguistic efficiency, a problem that coincides with a central issue in the academic research on linguistic decisions (Van Parijs, 2003, 2004a, 2004b; Grin 2006). The second, linguistic efficacy, serves as a counterpoint to arguments that favour the choice of a language based on the previous criterion. The issue that is resolved by the linguistic efficiency perspective is which language allows a greater number of employees to communication with each other? In other words, how can we guarantee the greatest possible inclusion of the members within a community, in this case a company? By contrast, the second, from the perspective of linguistic efficacy, is which language will guarantee that the economic goals of the company are achieved? In other words, the aim is not to increase the number of participants in communication, but for communication to achieve certain economic goals.

The two questions involve very different reasoning, and have different linguistic aims and consequences. Given that the application of a linguistic efficiency criterion aims to maximise the number of participants in communication, the solution is to choose the language in which the greatest number of participants have linguistic competence, even is this is minimal. By contrast, the efficacy criterion is goal-oriented, given that it seeks to achieve the objectives for which the communication is established. Consequently, it requires a linguistic competence that will guarantee the transfer of information without misunderstandings and without loss of time in translation (costs). Below we explain these two criteria in detail with the aid of some examples.

2.1. Linguistic efficiency and the maximin criterion.

Linguistic-communicative efficiency refers to the choice of a language from a repertoire in order to maximise communicative potential. By using a certain number of languages, for example, one single language, communication is established with a greater number of individuals than with any other language. The logic of this criterion responds to rational decisions of a maximin type, which

can be expressed in the following manner: the maximisation of the minimum linguistic competence. The maximin principle of communication[2] was developed by Van Parijs (2003: 3-4) in the following manner:

> "What I shall call the *maximin law of communication* captures another […] mechanism, which can be sketched as follows. Suppose you have to address simultaneously a set of people who each know to various extents a number of languages and by all of whom you want to be understood. When deciding which language among those you know you should pick, the question you will spontaneously tend to ask yourself will not be which is your own best language, or which language is the best language of the majority, or which language is best known on average, but rather which language is best known by the member of your audience who knows it least. In other words, you will systematically tend to ask yourself whether there is any language that is known to some extent by all. If, to the best of your knowledge, there is one and only one, you will choose it. If there is none, you will tend to choose the language which is known to some extent by most. And if there is more than one, you will make a guess for each of them about the level of competence achieved by the person least competent in it, and you will choose the language for which this level of competence is highest. This "maximin" criterion amounts to maximizing the minimum competence. It can also be described as a criterion of minimal exclusion" (Van Parijs, 2003: 3-4)

Thus, the mechanism refers to the choice among the languages known by the audience of the one that everyone shares to the greatest extent. Given that not everybody, and perhaps no one, knows a language perfectly, it introduces the possibility that the members of the audience, despite "not knowing" a language perfectly, can know it to the same extent. Given the different levels of competence among individuals, the chosen language will be the one with the greatest level of shared competence. If it were necessary to give a speech to the entire workforce in one language at one of the workplaces of our sample, based on the above argument, the way of obtaining the communication language that achieves the minimum degree of exclusion could be expressed with the following algorithm

Maximin criterion, seeking the maximisation of communicative minimums

> Step 1. (MIN) Select the communicative minimum of each language in each company, in other words, the individual or individuals with the least competence in each of the languages.
>
> Step 2. (MAX) Select the communicative maximum of the minimums obtained in Step 1.

It is possible to talk about anything in all languages. However, the relevant question is whether, with a very low competence in a language, it is possible to talk about anything in an efficacious manner, in other words, making such communication productive. When the quality reduces, a disutility occurs among all those who have a greater linguistic competence. Therefore, it is not a Pareto-superior selection criterion where the choice of this language at a lower level will not have a negative effect on anyone. Van Parijs does in fact state that in certain circumstances the maximin criteria should not be adopted:

> "On a less massive scale but often in a highly sensitive way, deviation may occur, even in informal contexts, for what could be called expressive reasons [to an extent where it is possible that] each speaks his/her own language [However, the adoption of linguistic should be the prevailing rule]. As soon as efficiency in communication prevails over pedagogical or expressive concerns, perceptible inequalities in the minimum knowledge of the various languages involved will generate a hardly resistible pressure for all to adopt the maximin language. What's the point of uttering beautiful sentences with carefully chosen words if my audience would understand me far better were I to express myself more clumsily in a language far more familiar to them. Hence, although didactic effectiveness and symbolic impact may sometimes strongly constrain language choice, this will not

> prevent the maximin criterion from running the show whenever communication is the prime concern, i.e. in the bulk of spoken and written language use" (Van Parijs, 2003: 3-4).

In our opinion, determining who is least familiar with a language in order to satisfy the ultimate aim of inclusion in communication suffers from the drawback that we are only considering the cohesive properties of languages and not the instrumental ones aimed at other objectives. Furthermore, the maximin solution has perverse effects in relations between regional majorities and minorities (regional diversity) and local minorities (new migration). For example, international migrations that arrive in Catalonia without knowing Catalan often have a certain knowledge of English and no knowledge of Catalan. This places English in an better position than Catalan according to the maximin criterion.

2.2. Linguistic efficacy and the minimax criterion

We referred to a principal problem in the previous section. The maximin criterion resolves the problem of inclusion at the expense of reducing the efficacy of communication, giving rise to impoverishment in the use of language and the disutility of those with greater linguistic competence. In addition, adopting a rich and complex version of the language leads to the appearance of errors and misunderstandings in communication when the messages are addressed to those with lower competence. If we consider not only the expressiveness of the language, but the fact that a series of jobs and professions increasingly have greater linguistic intensity –the importance of language in the production and management of information and knowledge–, then the maximin criterion is inefficient.

An alternative solution with repercussions on inclusion is the minimax criterion, which responds to communicative efficacy criteria. Communicative efficacy refers to the choice of a language from a repertoire in order to minimise communicative loss between the speakers. The algorithm of the minimax strategy is as follows:

> **Minimax criterion, seeking the minimisation of maximum communicative loss**
>
> 1. (MAX) Select the maximum loss that occurs with the use of each language in each company. We can use a corrective index, so that the lower the level of competence of an individual, the greater the communicative loss.
>
> 2. (MIN) Choose a language in which there is less communicative loss.

Under this criterion, the aim is to select the language that produces the highest quality communication, so that, within the context of the internal organisation of the company or between

commercial partners, orders are executed without linguistic errors or misunderstandings. With a high degree of linguistic intensity, a minimax strategy (efficacy) is advisable, in other words, to opt for the recruitment of linguistically specialised employees aimed at markets that offer their principal languages a high use value (Kingscott, 1990; Harris, 1998). The importance of what it wishes to communicate and that fact that it is able to guarantee communication without errors allows it to pursue maximum communicative efficacy, in spite of excluding a large number of individuals. From the perspective of communicative efficacy, the choice of languages in companies is not necessarily regulated by maximin criteria due to the high linguistic specificity and intensity of goods and services characteristic of the information and knowledge society. This approach involves non-adaptive strategies (Colomer, 1996) that grant certain languages, in particular mother tongues, a greater use and prefers to establish the communication in these languages, in spite of individuals having competence in other ones.

3. Language as a question of degree and the Theory of Fuzzy Sets.

Zadeh (1965) first developed fuzzy theory in 1965 based on Cantor's theory of sets. With this theory based on fuzzy logic, Zadeh basically contributed to the representation of knowledge and human reasoning that is always imprecise or approximate. Unlike classical logic, in fuzzy logic precise reasoning is only a limit of approximate reasoning; in it everything is a question of degree. This rejects the static and abstract notion of 'true' or 'false' in favour of degrees 'of truth'.

The treatment carried out in the modelling of communicative efficiency and efficacy is based on the construction of their indicators and the subsequent treatment in which linguistic competence is a question of degree. This assumption makes it necessary for their treatment to be based on fuzzy set theory, a mathematical theory based on the notion that propositions such as *x is competent in language y* are not necessarily and exclusively true or false, instead their degree of truth may vary in a broad grey-scale. The evidence of competence as a degree is a constant throughout our research work. By way of illustration, we have observed the following extract from an interview with a Catalan manager in a Japanese-owned company.

> "If I have to do it in Catalan, I will do it as well as I can"
>
> "Those who do logistics and speak English end up doing it with a certain degree of fluency, because it is always about the same thing"
>
> "If you get out and speak to people, you improve your English much more"
>
> "Because you can be very adept and be familiar with the 100 words in your business, but you have to have relations with the outside […] You have to maintain your long-lasting contacts on the basis of relationships; this is not done on the basis of invoices, but inquiring about children, telling jokes"
>
> "The conferences I told you about on the phone are very difficult and there is a high level of English, there are the Scandinavians and the English, who are like machines, and then there are the Spanish, Portuguese, Italians, Greeks, etc., who are not as good as them, because we understand 60, 70%; 100% is very difficult, we are not so fluent"
>
> "Not everyone understands as well what is being said, because there are many levels of English […] And sometimes in serious meetings, and taking quick decisions on the phone without having understood 100% is complicated […] somebody rings you, with a higher or lower level of English, and could be speaking really fast, and at some point you tell him that you don't understand and ask him to repeat everything. In the end, 50% is always understood".

"They come when there is a vacancy, having just graduated, and can't cope because of the English… and they acknowledge this. You ask them, "do you have an intermediate level?" "Yes" "Could you maintain a conversation on the phone?" "I think so" OK, then ring up so-and-so of somewhere and ask him... and they *[are afraid]. They [are afraid]. […]* Sometimes they are very cocky with their *First Certificate*... but English is just a question of fluency.[…] The level here in Spain is very poor, awful, lots of people come with an intermediate level, *First Certificate*, yet they've never been out of the country. And since they've never been out of the country, they know a lot of grammar but in face to face conversation, there is something more, things that you see, which they miss. You need to gain fluency"

"If we have a legal problem it has to be written down by a lawyer so it can be understood perfectly in England... […] Because those who sign the document have to know what they are signing, the English manager signs the English part and the Spanish one the Spanish part"

"If you only know English, they won't take you on however much English you know […] all the users know how to read it, and at least how to express themselves writing (e-mail). The most difficult thing is speaking it"

"We took him on…and he didn't know any English, but he's a very good boy and there was nobody else so we took him on, and he's very happy because he has the opportunity to write e-mails in English. And they reply to him.. well, when they reply to him, because in the beginning they couldn't understand him, but gradually he's becoming more confident and starting to have small conversations on the phone..."

[Extracts from an interview with a Spanish manager in a Japanese company]

Languages, according to the respondent, are spoken "*as well as you can*", "*with a certain degree of fluency*" and the message is received "*having understood everything*" or "*in the end, 50% is always understood*". The allusions made by the respondent to the necessary degree of competence of a language are not always related to the scale of the communication. They refer to the degree of technical competence or to the degree of involvement of the language in the social context of the company. They are also related to the degree of linguistic division of the job, which make it necessary for the linguistic shortcomings of a significant part of the workforce to be resolved through the linguistic specialisation of the workforce. On a written level, the competence required to do a sworn translation of a contract is quite different to the competence required to write a simple e-mail. On a spoken level, it is quite different receiving and transferring calls from a switchboard than closing a commercial agreement. Having expressed this necessary distinction, the key point is that we have observed that the degree of linguistic competence varies considerably and has repercussions on both efficiency (who is able to participate in communication) and on efficacy (achieving the goals of the organisation through high quality communication).

The aim of fuzzy set theory is the formal treatment of ambiguity and vagueness with regard to propositions which, owing to their nature, do not fit an exclusive attribution of a true or false value and are better represented if we attribute them a certain degree of truth. This is our option when analysing the linguistic competence and communicative profile of companies. Companies have certain degrees of linguistic competence and certain opportunities to communicate with each other. Linguistic competence will be considered as a fuzzy set. Thus, the attribution of an employee or a company to a predicate of the type *x knows language y* is characterised as a vague predicate, in that, to a certain degree, in a company people know and do not know a certain language or, at least, such knowledge has nuances and contradictions. We speak of the level of pertinence to competence in a language insofar as, despite the lack of definition, companies display a certain aptitude to communicate in this language. Therefore, it could be said that it is more likely that said company will communicate in said language in order to improve its communication. The notion of possibility is based on subjective evaluations contributed by company employees. The fuzzy representation of linguistic competence allows us to speak of linguistic skills in a company based in the frequency

distribution of the linguistic skills of the individuals. This is a form of aggregation that will subsequently allow us to analyse the possible linguistic interaction between workplaces.

We need to normalise, on the basis of 1, the frequencies of linguistic competence observed in each workplace. To do this, we take the mode of each of the values attributed to the reference values for each company and for each language. We should point out here that the different degrees of competence have been grouped into five possible reference values or categories. Their semantic references can be observed below:

> Reference value: {1:[Do not know]; 2:[Know very little]; 3: [Neither know, nor do not know]; 4:[Know quite well; 5:[Know]}

We obtain the normalised frequency by dividing each reference value by the mode of the reference value. For example, in the case of the Latin American restaurants in our sample, the distribution of competence in Catalan language is as follows:

[Table 1 about here]

[Table 2 about here]

The cardinality, in the final column, is the sum of the values of each category of the reference value. Here it helps us calculate the degree of fuzziness or vagueness of the linguistic competence of each company: with greater cardinality we have a more ambiguous, more imprecise linguistic competence, in such a way that the linguistic competence is distributed across virtually the entire reference value. A company with a high cardinality means that its employees have very heterogeneous linguistic competence with regard to the different languages. Cardinality is calculated by totalling the levels of pertinence of all the reference categories.

[Figure 1 about here]

In the above graphic representation we can observe a greater dispersion of competence in the graph on the right (oral competence) than in the written competence in Catalan language. Among the oral competence there are similar possibilities of finding Latin American employees with an medium or high level, while it is rather more difficult (vertical value of 0.9) to find a very high level of

competence. On the other hand, the highest level of possibility in written competence corresponds to no knowledge of this language. Next we can see a void (absence of competence at this level), while at medium levels of competence we can observe, at level 0.4, employees able to communicate at this level of written competence. Therefore, we can observe a very uneven variation of oral and written competence. In graphic terms, the linguistic union of oral and written competences in Catalan in the Latin American Restaurants analysed is:

[Figure 2 about here]

As can be observed in the union, the linguistic competences are broadly distributed across the reference values, and the sum of the values of each reference category can be observed in the graph. We refer to this value as cardinality and it is a measure of dispersion. A fuzzy set can be interpreted as indicating that we have a possibility of between 0 and 1 of finding individuals with linguistic competence for each reference category. Thus, we calculate the union between the oral communicative potential and the written communicative potential in the following manner:

Maximum communicative potential = Oral competence Written competence ,

Where if the fuzzy linguistic competence of the company for the language n.

Operations with fuzzy logic allow us to formalise the communicative relations in companies based on their linguistic profiles. Below we present some basic operations applied to the linguistic problem of communication. These operations are the basis of the optimisation treatment, in accordance with the theory of rational choice we have developed in the following paragraphs.

Given two speakers with linguistic profiles , where each linguistic profile is a fuzzy subset[3], the basic operations applied to linguistic situations between two speakers are:

[Table 3 about here]

4. Design and sample.

The empirical evidence was obtained from 26 workplaces in companies, which were selected as particularly relevant case studies precisely for the international composition of their workforces or the internationalisation of their production process. Specifically, we have focused the field work on four subsectors with specific linguistic problems: 1) Industrial companies; 2) Companies in the new technology sector; 3) Companies in the financial sector and 4) Companies in the restaurant sector.

In each of these sectors, companies, workplaces and departments were selected for conducting the survey. These companies and departments are particularly affected by coordination with workplaces located abroad, a fact that influences the value of linguistic capital in the process of promotion and selection of personnel. This allows us to establish the principal regularities in the systems of linguistic organisation in these companies, which represents another dimension of this research work. We contacted the human resources managers of 36 companies and/or workplaces by e-mail and by telephone. Of this total, 29 agreed to participate and in total we used the data obtained from 26 workplaces. In all of these companies the managers agreed to conduct the quantitative survey on all the employees in their workplace or department, except for one case, where they only agreed to distribute 15 questionnaires. In the restaurant sector, owing the small scale of the workforces, the number of questionnaires collected per workplace was lower. In total, we obtained 228 questionnaires and conducted 22 in-depth interviews.

[Chart 1 about here]

[Chart 2 about here]

5. Fuzzy maximisation and minimisation criteria in the communicative-linguistic relations between companies.

A problem with the method for analysing the maximisation of minimum communicative potential or the minimisation of the maximum loss of communicative potential developed in the previous section is that the larger the groups, the greater the probability of encountering somebody without knowledge or with poor knowledge who determines the final result and therefore affects the entire result, generating a high degree of linguistic disutility for the group made up of those who do participate in communicative relations. Each new employee in a company would involve a review of the entire linguistic policy of the same.

Furthermore, in organisations communication relationships are established between different individuals with different levels of competence, therefore the choice of their language is not conditioned by the competence of third parties. According to the method developed in the previous section, it would be necessary to analyse all the possible combinations of interactions with different numbers of speakers in order to obtain an accurate map of the results of linguistic choice according to maximin and minimax criteria. We present here an alternative based on fuzzy set theory which allows us to represent the set of communicative possibilities by considering not the linguistic repertoire of the employees, but the linguistic repertoire of the company or communicative potential of the company as a reference value on which to formalise the corporate linguistic decisions.

5.1. Maximin criterion through fuzzy subsets.

In the model we present below the minimum area of communication between companies is maximised. In this perspective, the aim is for communication to be not only in the same language, but also among the same levels of competence between subgroups of workers. Taking as an example the case of REST-LR (Latin American Restaurants) and BANK-GB (German Bank), their linguistic competences in Catalan are:

[Figure 3 about here]

The fuzzy set resulting from the intersection indicates that the possibility of communicating perfectly in Catalan has a level of pertinence of 0.9. It is the intersection with the highest level of possibility. If all the categories of the reference value had the same value, this would mean that all these levels of communication would be equally possible. It happens there is a level of pertinence of 0.5 in category 4 (Know quite well). In other words, it is less possible that communication will occur in this language at this level. The greater the cardinality, the less certain we are about the language in which the communication will effectively occur. When we proceed in the same manner between BANK-GB and REST-LR for all the languages we have considered, we obtain the following results.

[Table 4 about here]

In the above table, cardinality a is the sum of all the reference values; cardinality b excludes the "do not know" value of the reference category. This allows us to observe the dispersion of the area where communication is possible, even though the level of competence is very low, while excluding the situation of no knowledge at all.

For Catalan, it can be observed that we found a possibility of 0.4 that the category of reference value 1 (Do not know) will occur. On the other hand, for Spanish the possibility of minimum communicative potential, starting from the left (1. Do not know), level 3 Spanish (Neither know nor do not know) has a pertinence value of 0.1. In other words, there is a very low possibility of exclusion at this level of linguistic competence. Therefore, Spanish would represent the communicative maximum of the communicative minimums between Catalan and Spanish. However, a more refined approach from the perspective of efficiency based on communicative minimums, where everything can be communicated irrespective of our level of competence, provided that we have a basic competence, should employ a different language.

So which language would maximise the communicative minimums? We propose finding the area of intersection of communicative minimum between two companies. We shall proceed in the following manner:

$$\text{Max min } (\,)_n = \text{Max } [\text{Min } (\,)_1, *\text{Min } (\,)_2, *\text{Min } (\,)_3, *\text{Min } (\,)_{4,\ldots}]$$

In order to obtain the results, the cardinality of the intersections (communicative minimums) was calculated, excluding the value 1, "do not know". Thus, cardinality *a* is the sum of all the reference values; cardinality *b* is the same as the previous one, but excludes the "do not know" value of the reference category. This allows us to observe the dispersion of the area where communication is possible, even though the level of competence is very low, while excluding the situation of no knowledge at all.

[Table 5 about here]

We obtain the following results for the relations between BANK-GB and the remaining workplaces. The shaded box represents the maximum of the communicative minimums.

[Table 6 about here]

The results of all the possible choice pairs of a communication language between the companies are as follows. In brackets the cardinality *b* with which this language is the maximum of the communicative potential minimums.

[Table 7 about here]

Of the 66 possible pairs, in 30 cases the language that best complies with this minimax criterion is English. In 23 cases, it is Catalan and only in 7 cases is it Spanish. In 7 cases there is a tie between two languages. Significantly, and in contrast to the results for the English language, the other two foreign languages considered, French and German, are never a maximin solution. The common

language of Europe and the language that best fits the maximin criterion according to Van Parijs (2003) is English. Yet how is it possible for this situation to occur in our case of a sample of workplaces located in Catalonia that employ mainly local staff? The answer is that the maximin criterion is greatly affected by minorities, and in fact its nature lies in seeking communication formulas between a heterogeneous population, and in the companies analysed, these minorities are frequent.

How should we interpret these results? In the first place, we have considered that in order to communicate it is just as important to know a language well as to know it at a very low level. The important thing is to include everyone in the communication (to maximise inclusion through minimum competences). From this perspective, it is more valuable for a company to have the capacity to communicate at different levels or degrees of competence and not just communicate at a high level, although the latter justification may be irrelevant if we return to maxim of inclusion as an ultimate goal-oriented criteria.

Secondly, we have allowed everyone to be counted as a person with possibilities of communicating, even if they have a very low competence in the language, which is more common in English than in Catalan and more common in Catalan than in Spanish. Consequently, Spanish, in most cases, is used at a level that the respondents considered to be high. By contrast, respondents are more critical about their levels of competence of Catalan and Spanish. Because of this, companies have a communicative profile with a high cardinality in Catalan and English (they have good possibilities of communicating in these languages at any level). On the other hand, normally they can only communicate at a high level in Spanish. This means that when they establish communication with other companies with a foreign employee (such as new technology companies), there is no possibility of communicating with high levels of Spanish. When this situation occurs, the beneficiary language is English, given that employees often frequently consider that they have a medium level of competence. The minimax criterion severely punishes languages in which a large proportion of the sample haS a homogenous competence, producing significant disutilities. The cardinality of Catalan and English is high because there are many individuals who “know quite well”, “neither know nor do not know” or “know very little”. The question is, is such conversation efficient if the objective is not merely to include individuals?

5.2. Minimax criterion through fuzzy subsets.

We have defined the minimax criteria as a decision-making process on the communicative efficacy as the minimisation of maximum communicative loss. Given n languages and two fuzzy communicative profiles of the companies we should proceed in the following manner:

Minimax ( )$_n$ = Min [Maximum loss ( )$_1$, Maximum loss ( )$_2$, Maximum loss ( )$_3$, Max communicative loss ( )$_{4,...}$].

The loss that occurs in a communicative act is rather difficult to measure. In section 9.2, we have defined various indicators that reflect communicative losses: Communicative noise (Max – Min ( )), Communicative silence (( )) or, including the combination of silence and noise, in other words the whole area in which there is no intersection, which is the union of the two previous losses, summarised as: ( ). Alternatively, an asymmetrical measure that shows us the dissimilarity in the communicative potential between the two fuzzy sets is as follows[4]:

Dissimilarity Similarity or coincidence

;

The coincidence of a subset A in the subset B is equal to the sum of the intersections of A in B divided by the cardinality of A. The result will always be between 0 (no-coinciding competences) and 1 (identical competences). As can be observed, the calculation method employed consists of relaying on the formula of coincidence of a fuzzy subset A in a fuzzy subset B. This formula allows us to observe the similarity of the linguistic profiles between the companies. This similarity is not necessarily reciprocal. According to a given language, the coincidence of company A in company B may be different to the coincidence of company B in company A. Basically, companies with a highly defined and unambiguous level of competence, and a single reference category may be included within the communicative profile of a company with a level of linguistic competence that is more broadly distributed across the reference set, and therefore more ambiguous. For the company that has a very rigid profile and is included in the broader competences of another company, the coincidence will be equal to 1 (or the dissimilarity 0). In company A messages will always be produced that are received correctly within the broad communicative spectrum of company B. On the other hand, a company with a more diffuse level of linguistic competence exceeds the profile of the other company and it is therefore possible that the messages will not be received correctly.

In the following matrices, the rows show the extent to which the communicative profile in Catalan, Spanish and English of company A coincides with the profile of company B, and the columns the form in which the communicative profile of company B coincides with company A. Now the matrices have been established, we can estimate the communicative loss between the different companies. At level 1, there is no communicative loss. At this level, all messages issued by company A with coincide with the communicative profile of company B. Level 1 is so restrictive that no situation will arise where both companies are completely included. At a lower level of restriction, for example 0.8, we can find companies where communication would indeed occur. 8 pairs of possible communication relationships occur. If we lower the restriction to 0.6 increasing the

communicative loss, of the 66 possible relationships between companies, in 23 cases relationships of coincidence of A in B and of B in A occur (as shown in the matrices). Maximum subrelation of similarity is the name given to the set formed by the largest number of elements, in this case workplaces, which possess mutual coincidence at a given level of restriction or communicative loss.

[Table 8 about here]

At level 0.6, the following maximum subrelations of similarity occur:

1. REST-LR + INDU-JI2 + INDU-JI1 + REST-CRS + INDU-JI3 .

2 . REST-LR + TECH-CS + BANK-GB + INDU-JI2

3 . BANK-CB + TECH-ITITE)+ TECH-CIS

4 . BANK-CB + BANK-GB + COMPUTER SERVICES 2

5 . TECH-CIS + TECH-IIT + TECH-CS

The following summarises the main results:

[Figure 4 about here]

On the basis of these results, the language that minimises maximum communicative loss is Spanish at all confidence levels, given that Spanish is the most widely shared language at the same level among the sample set. The fact that we have included in our sample cases such as new technology companies, with European employees and companies of Latin American origin (restaurant sector) has contributed significantly to the results prejudicing Catalan. The favourable situation of Spanish lies in the fact that most of the respondents placed themselves in the same category: “know”, and that it represented the maximum level of competence in the proposed reference value.

6. Evaluation of the results and of the techniques applied.

The theory of rational choice, combined with a formalisation based on fuzzy set theory, produced a series of techniques that make it possible to come up with new approaches to the situation and processes of selection. As we have indicated throughout the paper, optimisation processes can incorporate numerous alternative solutions. The dissimilarity option as an indicator of

communicative loss, which we have operationalised through the coincidence matrix of a fuzzy subset with another fuzzy subset, allows us to determine the optimal linguistic relationships in a situation of equal competence in a language between two speakers.

The communication relationships based on the criteria of communicative loss reflect relationships of equality from the indicator employed, operationalised as symmetry. The optimal language with this indicator was Spanish, given that this language has very similar and unambiguous or well-defined competence profiles in the sample of companies analysed. On the other hand, the maximin procedure, as we have observed, favoured inclusion (or punished exclusion). This means that low or medium competence in English, distributed in a similar manner between the sample of analysed companies, is the shared language, irrespective of the level of competence. Without doubt, English is a language shared by many of those who have recently arrived in Catalonia from the rest of the world. Many Latin American employees stated they knew this language at the same level as Catalan. And the majority of local employees from the analysed sectors stated they had a medium level of competence. Thus, it is a broadly shared language, but at very low levels of efficacy, as we were able to demonstrate when we applied the minimax criterion.

Finally, the results observed are conditioned by both the number of responses and the sectors analysed. The limited scope of the interviews conducted (228), given the large number of workplaces analysed, impedes a continuous representation of the linguistic profiles of the centres analysed (the representation adopts a discrete form). Working with very specific situations (companies, departments and workplaces in specific sectors particularly affected by globalisation) gives rise to difficulties of generalisation inherent to the exemplary and specific situations of case studies.

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Tables, figures and charts.

Table 1. Frequency distribution of linguistic competence in REST-LR

	Written knowledge						Oral knowledge					
Knowledge of Catalan	None	Little	Average	Good	Excellent	n	None	Little	Average	Good	Excellent	n
	1	2	3	4	5		1	2	3	4	5	
REST-LR	14	1	5	6	4	30	5	2	8	8	7	30

Table 2. Fuzzy subset of linguistic competence in REST-LR.

	Written knowledge						Oral knowledge					
Knowledge of Catalan	None	Little	Average	Good	Excellent	n	None	Little	Average	Good	Excellent	Card
	1	2	3	4	5		1	2	3	4	5	
REST-LR	14/14	1/14	5/14	6/14	4/14	2.1	5/8	2/8=	8/8	8/8	7/8	3.7
	=1	=0.1	=0.4	=0.4	=0.3		=0.6	0.3	=1.0	=1.0	=0..9	

Table 3. Basic operations applied to linguistic situations between two speakers

Name	Operation	Description
Maximum communicative potential	Max ( ) =	Union of communicative potential of the two speakers Defines the area in which at least one of the two speakers has linguistic competence
Minimum communicative potential	Min ( ) =	Intersection of the communicative potential of the two speakers Defines the area in which both speakers have the same linguistic competence.
Communicative noise	Max – Min ( )	Area between the intersection and union of the communicative potential of two speakers Defines the area where only one of the two speakers has linguistic competence.
Communicative silence	( )	Negation of the union. Defines the area where none of the two speakers has linguistic competence.
Union of communicative noise and silence	( )	Negation of the intersection. Defines the space where there is no linguistic coincidence between the two speakers
Linguistic coincidence		Asymmetrical measure which indicates the degree to which the competence of one speaker is included in the reference value of the other speaker, or coincidence of a fuzzy subset in another fuzzy subset

Source: The authors.

Table 4. Intersections between BANK-GB and REST-LR

	1	2	3	4	5	Card. a	Card. b
Catalan	0.4	0.3	0.3	0.5	0.9	2.3	1.9
Spanish	0.0	0.0	0.1	0.1	1.0	1.2	1.2
English	0.1	0.1	0.6	0.8	0.1	1.7	1.5
French	1.0	0.4	0.1	0.1	0.1	1.7	0.7
German	1.0	0.0	0.0	0.0	0.0	1.0	0.0

Table 5. Cardinality of the intersections of communicative potential between BANK-GB and REST-LR

	1	2	3	4	5	Card. a	Card. b
Catalan	0.4	0.3	0.3	0.5	0.9	2.3	1.9
Spanish	0.0	0.0	0.1	0.1	1.0	1.2	1.2
English	0.1	0.1	0.6	0.8	0.1	1.7	1.5

French	1.0	0.4	0.1	0.1	0.1	1.7	0.7
German	1.0	0.0	0.0	0.0	0.0	1.0	0.0

Table 6. Maximin BANK-GB in relation to other workplaces.

	Catalan	Spanish	English	French	German
BANK-CB	1.5	1.1	0.9	0.7	0
REST-CR	1.9	1.1	1.7	0.7	0
REST-LR	1.9	1.2	1.5	0.7	0
INDU-JI1	1.7	1.1	1.9	1.8	0
INDU-JI2	1.9	1.1	1.2	1.3	0
TECH-IIT	1.3	1.1	2.5	0.7	0.2
TECH-ITITE	1.2	1.2	1.8	1.2	0
TECH-CIS	1.5	1.1	1.9	1.1	0.2
INDU-JI3	2	1.1	1.2	0.3	0
TECH-CS	1.8	1.1	2.7	0.6	0.2
TECH-FIT	0.9	1.2	2.2	0.6	0.3

Table 7. Maximum of the communicative potential minimums.

	BANK-CB	BANK-GB	REST-CR	REST-LR	INDU-JI1	INDU-JI2	TECH-IIT	TECH-ITITE	TECH-CIS	INDU-JI3	T
BANK-CB	-	Catalan (1.5)	Catalan (1.5)	Catalan (1.4)	Spanish-English (1.3)	Catalan (1.5)	Spanish (1.3)	Spanish-English (1.3)	Catalan (1.4)	Catalan (1.5)	C
BANK-GB	-	-	Catalan (1.9)	Catalan (1.9)	Catalan (1.7)	Catalan (1.9)	English (2.5)	English (1.8)	English (1.9)	Catalan (2)	E
REST-CR	-	-	-	Catalan (2.5)	Catalan (2.3)	Catalan (2.6)	English (1.5)	English (1.9)	English (2.1)	English (2.5)	E
REST-LR	-	-	-	-	Catalan (2.9)	Catalan (3)	Spanish-English (1.3)	English (1.6)	English (1.7)	Catalan (2.5)	C
INDU-JI1	-	-	-	-	-	Catalan (2.8)	English (1.8)	English (2.3)	English (2.4)	Catalan (2.7)	E
INDU-JI2	-	-	-	-	-	-	Catalan (1.3)	English (1.6)	English (1.7)	Catalan (2.5)	C ((
TECH-IIT	-	-	-	-	-	-	-	Spanish (1.7)	English (1.7)	Spanish-Catalan (1.3)	E
TECH-ITITE	-	-	-	-	-	-	-	-	English (2.3)	English (1.7)	E

TECH-CIS	-	-	-	-	-	-	-	-	-	English (1.7)	E
INDU-JI3	-	-	-	-	-	-	-	-	-		C (1
TECH-CS	-	-	-	-	-	-	-	-	-	-	-
TECH-FIT	-	-	-	-	-	-	-	-	-	-	-

Table 8 Coincidence matrix of language profiles. Catalan language. Coincidences greater than 0.6.

	BANK-CB	BANK-GB	REST-CR	REST-LR	INDU-JI1	INDU-JI2	TECH-IIT	TECH-ITITE	TECH-CIS
BANK-CB	1	0,6	0,5	0,3	0,4	0,5	0,3	0,7	0,9
BANK-GB	1	1	0,7	0,5	0,5	0,6	0,5	1	1
REST-CR	1	0,9	1	0,7	0,7	0,8	0,6	1	1
REST-LR	0,9	0,9	1	1	0,9	1	0,8	0,9	0,9
INDU-JI1	0,8	0,7	0,7	0,7	1	0,9	0,6	0,6	0,7
INDU-JI2	1	0,9	0,9	0,8	0,8	1	0,6	0,9	1
INDU-JI3	1	1	0,9	0,8	0,8	0,8	1	1	1
TECH-IIT	0,8	0,7	0,5	0,4	0,3	0,4	0,4	1	0,9
TECH-ITITE	0,8	0,6	0,4	0,3	0,3	0,4	0,3	0,7	1
TECH-CIS	0,9	0,7	0,5	0,4	0,3	0,5	0,4	0,8	1
TECH-CS	1	0,9	0,6	0,5	0,4	0,6	0,5	0,9	1
TECH-FIT	0,5	0,5	0,4	0,5	0,3	0,3	0,4	0,6	0,5

Figure 1. Graphic representation of two fuzzy linguistic profiles in REST-LR

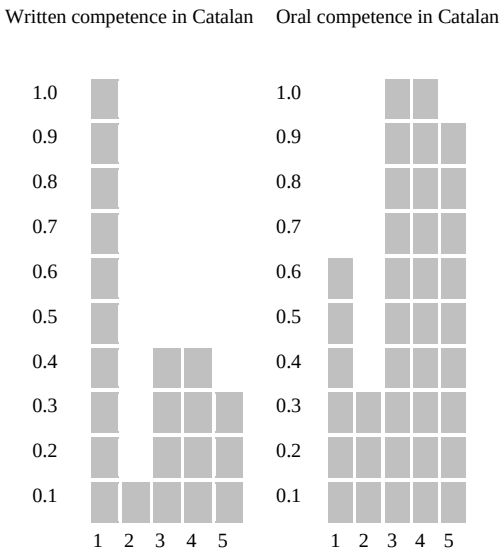


Figure 2. Oral and written competences and communicative profile

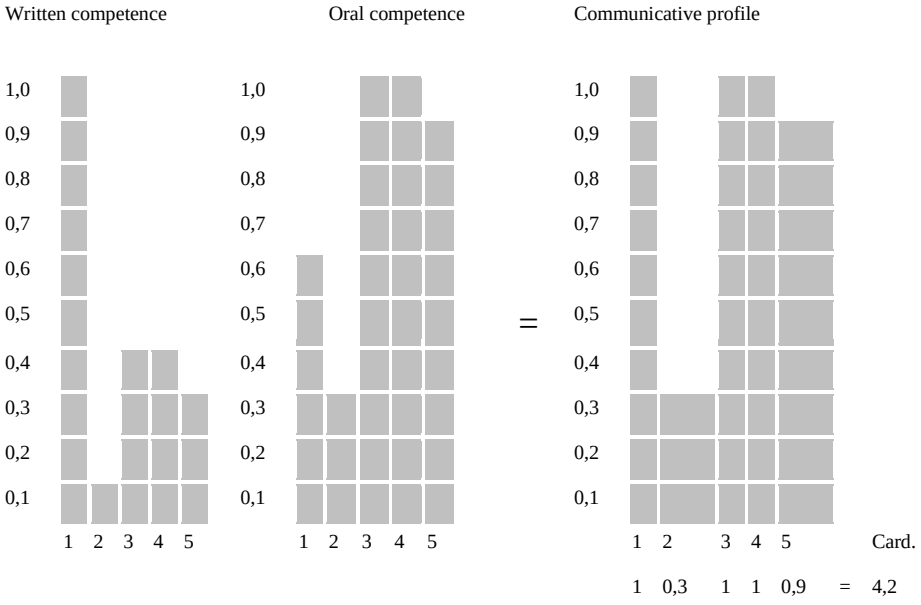
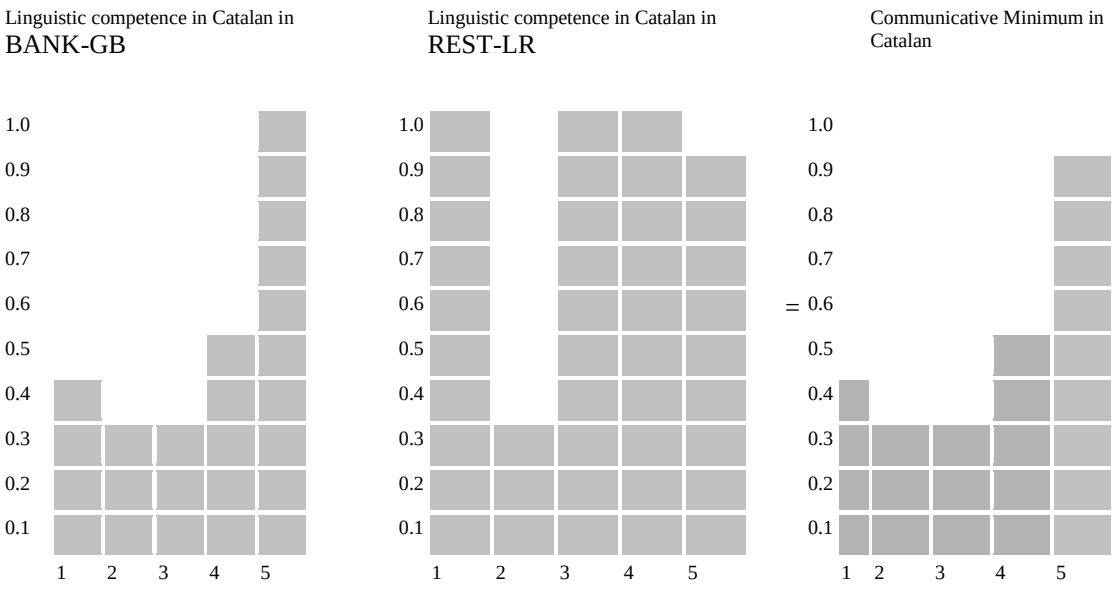


Figure 3. Minimum (intersections) of communication possibilities in Catalan language



0.4 0.3 0.3 0.5 1.0 2.4 1.0 0.3 1.0 1.0 0.9 4.1 0.4 0.3 0.3 0.5 1.0 2.4

Figure 4. Coincidences at different levels of dissimilarity

Coincidences in Catalan

At coincidence level, 1. Communicative loss=0.

Possible combinations: 0

At level, 0.8. Communicative loss=0.2

Possible combinations=5

Combinations with communicative loss=61

At coincidence level, 0.6. Communicative loss=0.4

Possible combinations=23

Combinations with communicative loss=43

Coincidences in Spanish

At coincidence level, 1. Communicative loss=0

Possible combinations: 4

Combinations with communicative loss=62

At level, 0.8. Communicative loss=0.2

Possible combinations: 48

Combinations with communicative loss=18

At level 0.6

Possible combinations: 55

Combinations with communicative loss=11

Coincidences in English

At coincidence level, 1. Communicative loss=0

Possible combinations=0

At coincidence level, 0.8. Communicative loss=0.2

Possible combinations=9

Combinations with communicative loss=57

At coincidence level, 0.6. Communicative loss=0.4

Possible combinations=33

Combinations with communicative loss=33

From the above results, it can be observed that

At coincidence level 0.8, the combinations in which communicative loss occurs are:

1. Catalan: 68 combinations with communicative loss
2. English: 57 combinations with communicative loss
3. Spanish: 18 combinations with communicative loss

At coincidence level 0.6, the combinations in which communicative loss occurs are:

1. Catalan: 44 combinations with communicative loss
2. English: 32 combinations with communicative loss
3. Spanish: 11 combinations with communicative loss

Chart 1. Summary of the information collected.

Company	Área / Department / Company where the fieldwork was carried out	Abs.	Relat.
Industrial sector		**42.**	
JAPANESE INDUSTRY 1 (INDU-JI1)	Human Resources Department	22	9.6
JAPANESE INDUSTRY 2 (INDU-JI2)	Logistics Department	10	4.3
JAPANESE INDUSTRY 3 (INDU-JI3)	Comercial Department	10	4.3
JAPANESE INDUSTRY 4 (INDU-JI4)	Human Resources Department	(Only in-depth interviews)	
New technologies sector	Software area	**111.**	
CATALAN SOFTWARE (TECH-CS)	Software area	15	6.5
INFORMATION TECHNOLOGY IN THE WORKPLACE (TECH-ITITE)	Labour intermediation	38	16.6
CENTRAL INFORMATION SERVICES (TECH-CIS)	Central Services	26	11.4
INTERNACIONAL INFORMATION TECHNOLOGY (TECH-IIT)	International services	10	4.3
FRENCH INFORMATION TECHNOLOGY (TECH-FIT)	Computer services	22	9.6
Financial services sector		**28.**	
GERMAN BANK (BANK-GB)	Central services	19	8.3
CATALAN BANK (BANK-CB)	Central services	9	3.9
Catering sector		**47.**	
LATIN RESTAURANT 1 (REST-LR1)	Ethnic restaurant	5	2.2
LATIN RESTAURANT 2 (REST-LR2)	Ethnic restaurant	3	1.3
LATIN RESTAURANT 3 (REST-LR3)	Ethnic restaurant	7	3.1
LATIN RESTAURANT 4 (REST-LR4)	Ethnic restaurant	1	0.4
LATIN RESTAURANT 5 (REST-LR5)	Ethnic restaurant	4	1.7
LATIN RESTAURANT 6 (REST-LR6)	Ethnic restaurant	3	1.3
LATIN RESTAURANT 7 (REST-LR7)	Ethnic restaurant	2	0.9
LATIN RESTAURANT 8 (REST-LR8)	Ethnic restaurant	3	1.3
LATIN RESTAURANT 9 (REST-LR9)	Ethnic restaurant	1	0.4
LATIN RESTAURANT 10 (REST-LR10)	Ethnic restaurant	2	0.9
CATALAN RESTAURANT 1 (REST-CR1)	Restaurant chain	4	1.7
CATALAN RESTAURANT 2 (REST-CR2)	Restaurant chain	6	2.6
CATALAN RESTAURANT 3 (REST-CR3)	Restaurant chain	2	0.9
CATALAN RESTAURANT 4 (REST-CR4)	Restaurant chain	2	0.9
CATALAN RESTAURANT 5 (REST-CR5)	Restaurant chain	2	0.9
Total		**228**	**100.**

Source: Authors

Chart 2. Distribution of the absolute frequencies of language knowledge in the workplaces analysed

	WRITTEN KNOWLEDGE						ORAL KNOWLEDGE					
CATALAN	None	Little	Average	Good	Excellent	n	None	Little	Average	Good	Excellent	n
	1	2	3	4	5		1	2	3	4	5	
BANK-CB	0	0	1	1	6	8	0	0	1	2	6	9

BANK-GB	3	2	2	4	8	19	0	2	2	2	13	19
REST-CR	2	0	3	3	4	12	0	1	3	3	8	15
REST-LR	14	1	5	6	4	30	5	2	8	8	7	30
INDU-JI1	0	2	3	3	2	10	0	1	1	5	3	10
INDU-JI2	1	1	7	7	5	21	0	0	2	9	11	22
INDU-JI3	1	1	0	1	1	4	1	0	1	0	3	5
TECH-IIT	2	1	1	0	6	10	2	1	1	0	6	10
TECH-ITITE	1	0	3	4	27	35	0	1	1	3	33	38
TECH-CIS	2	1	2	4	17	26	0	0	3	4	19	26
TECH-CS	2	2	1	2	8	15	1	0	1	4	9	15
TECH-FIT	12	1	2	2	3	20	11	2	1	2	4	20
Total	40	12	30	37	91	210	20	10	25	42	122	219
	WRITTEN KNOWLEDGE						ORAL KNOWLEDGE					
SPANISH	1	2	3	4	5	n	**1**	**2**	**3**	**4**	**5**	n
BANK-CB	0	0	0	2	6	8	0	0	0	2	7	9
BANK-GB	0	0	1	2	16	19	0	0	0	2	17	19
REST-CR	0	0	0	1	12	13	0	0	0	1	13	14
REST-LR	2	0	2	6	20	30	0	0	0	3	27	30
INDU-JI1	0	0	0	3	7	10	0	0	0	3	7	10
INDU-JI2	0	0	0	3	18	21	0	0	0	3	19	22
INDU-JI3	0	0	0	1	3	4	0	0	0	1	4	5
TECH-IIT	0	0	0	4	6	10	0	0	0	2	8	10
TECH-ITITE	0	0	0	1	34	35	0	0	0	0	38	38
TECH-CIS	0	0	0	5	21	26	0	0	0	7	19	26
TECH-CS	1	0	0	1	13	15	0	0	0	1	14	15
TECH-FIT	5	2	3	4	6	20	4	3	3	3	7	20
Total	8	2	6	33	162	211	4	3	3	28	180	218

	WRITTEN KNOWLEDGE						ORAL KNOWLEDGE					
ENGLISH	1	2	3	4	5	n	**1**	**2**	**3**	**4**	**5**	n
BANK-CB	0	0	6	2	0	8	0	0	8	1	0	9
BANK-GB	1	0	4	7	7	19	0	1	4	8	6	19
REST-CR	2	2	2	1	1	8	2	3	4	1	1	11
REST-LR	14	6	4	3	1	28	8	7	5	6	0	26
INDU-JI1	0	1	4	4	1	10	0	1	5	3	1	10
INDU-JI2	2	3	11	5	0	21	1	5	11	5	0	22
INDU-JI3	1	0	2	1	0	4	0	2	2	1	0	5
TECH-IIT	0	0	2	4	4	10	0	0	1	5	4	10
TECH-ITITE	1	4	13	13	4	35	1	3	16	14	4	38
TECH-CIS	3	2	9	8	3	25	3	1	11	8	3	26
TECH-CS	3	1	3	4	4	15	0	0	7	4	4	15
TECH-FIT	0	0	3	9	8	20	0	0	3	10	7	20
Total	27	19	63	61	33	203	15	23	77	66	30	211