Bachelor's Degree Thesis
Bachelor's Degree in Industrial Technologies Engineering

INDUSTRIAL ENGINEERING STUDIES COMPETITION AND ACCESSIBILITY IN SPAIN

Report

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ABSTRACT

This dissertation is a research on the Industrial Engineering University market. The author works on two topics, Accessibility and Competition.

The main objective of the paper is to find an adequate measure to estimate overall University Accessibility from a concrete point and a feasible measure to estimate the competition experienced by a University. In order to it, the author carries out a review on the existing literature to find if there are already existing measures that fulfils the requirements of this concrete case. According to the author's criteria the existing measures are not suitable measures that could be applied in University field because of their specificity and the data requirements. However, the proposed measures in this paper are based on the existing ones and lean on the criteria previously set by several authors.

In addition to this research an empirical study is carried out with two parts, the first on evaluates accessibility to Industrial Engineering Bachelor's degrees from the Spanish province capital cities and the second one evaluates the competition that some of the most important universities regarding this field of studies experience.

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1. Introduction

1.1 The Origin and motivation

The very first think that comes to my mind when I think about the origin of this thesis is my Erasmus in Austria, attending to subjects from the Product Science and Management Master at TU Graz, specially one of them called Production Strategies. Among the topics included in the subject, one of them was where to set the production centres and which markets where more interesting to launch a product in. One of the factors, of course, was the competition in this specific market and that is the topic I will tackle in my final thesis, concretely, the competition among the Spanish Universities regarding Industrial Engineering Degrees. A point which attracted me about the topic is that the product or products whose competition I am going to analyse are not a common one that can be distributed and sold in a shop or mall, it is a service that requires an important infrastructure in order to provide a education with sufficient quality and it is offered both publicly and privately these two characteristics make this research a different and amazing task. Furthermore, I work at the Supply Chain Department of an Enterprise that manufactures consumer goods and those goods are shipped but when it comes to study, it is the other way around, the customer is the one who moves to the "goods" and that approach was definitely a point that made the topic appealing to me.

1.2 Resemblance with the Healthcare market

The university market, as it has been mentioned before it is a special service, it can be provided both privately and publicly and it is offered in concrete places due to the needed infrastructure and other issues. The health market has similar features but further research has been done in this field. For this reason, the thesis will mostly lean on a previous study done within this area. However, there are some special features that should be pointed; health care system is quite more spread and studies are mostly regional or local and therefore all the considerations regarding accessibility and competition in health care system have to be carefully analysed before their application in university.

1.3 Industrial Engineering in Spain

Industrial Engineering is commonly known as the branch of engineering that deals with problems related with waste of time, money, materials, man-hours, machine time, energy and other resources that do not generate value. However, in Spain the term of Industrial Engineering and it includes all the possible fields related with industry and several University degrees are belong to this branch of engineering. Degrees are classified in two types: the first one is called Superior and its named Industrial Engineering itself and it's a multidisciplinary education which has two parts; the first one is the Bachelor's degree in Industrial Technologies Engineering and the second one is the master in Industrial Engineering which enables the student to practice as a Superior engineer. The second type are know as Technical Engineering, these Bachelor's degrees are sufficient to practice and they are more specialised in one concrete branch of the field. These studies allow the student to practice only in their specific industrial field, nonetheless the student owning this titles can enrol the same master to become Superior Engineers as well by doing some extra subjects in some cases.

In order to consider whether a degree belongs to this field of engineering it has been taken into account if, as mentioned before, it is possible to enrol the Industrial Engineering Master after graduating the technical degree. As a result of this sifting a catalogue of all the degrees that are included in the industrial branch has been developed.

- Bachelor's degree in Chemical Engineering
- Bachelor's degree in Electrical Engineering
- Bachelor's degree in Electromechanical Engineering
- Bachelor's degree in Electrical (and Electronic) Engineering
- Bachelor's degree in Electronic Engineering
- Bachelor's degree in Electronic (Robotic and Mechatronic) Engineering
- Bachelor's degree in Energy Engineering
- Bachelor's degree in Industrial Chemical Engineering
- Bachelor's degree in Industrial Design (and Product Development) Engineering

- Bachelor's degree in Industrial Electronics (and Automatic Control) Engineering
- Bachelor's degree in Industrial Organization Engineering
- Bachelor's degree in Industrial Technology Engineering
- Bachelor's degree in Materials Engineering
- Bachelor's degree in Mechanical Design Engineering
- Bachelor's degree in Mechanical Engineering
- Bachelor's degree in Mechatronic (and Robotic) Engineering
- Bachelor's degree in Robotic Engineering

Each university is responsible for the official name of their degrees, due to this fact there are some studies that, despite having a similar course catalogue, have a different name. Another issue to take into account is that some universities offer a general degree such as the Bachelor's degree in Electromechanical Engineering in which the student receives general knowledge in the early academic semesters and afterwards they can choose among the elective courses in order to become specialised in one concrete area, in this case mechanical or electrical.

2 Accessibility and its measurement

2.1 Introduction to accessibility

The concept of accessibility has been the focus of much literature in various fields during the last decades and several researchers have work on the matter. As a result of the different purposes, several accessibility measures have been proposed focused on different matters. Therefore, it seems that there is no general definition for accessibility due to the different approaches. For example, some researchers discuss accessibility "to" some place (e.g. PIRIE [28]) and some others do it as opposed "from" some place (e.g. GUY [14]).

2.2 Complexity of Accessibility Measurement:

Characteristics of an accessibility measure

As the concept has been applied to a number of fields there are different measures that serve to analyse accessibility with different approaches. For example, PIRIE [28] and KWAN [20] carried out studies focused on the individual accessibility while many other researchers were more focused on the access to places, for instance, HANDY AND NIEMEIER [15]. However, HANDY AND NIEMEIER [15] also affirmed that there was no perfect measure for accessibility, different purposes and situations require different approaches and therefore different measures.

Despite the lack of a general definition for the concept, several researchers have work on setting basic criteria that in general an accessibility measure needs to address and most of them agree that since accessibility is a combination of transportation system and land use patterns any accessibility index should reflect a possible change in any of them.

WEIBULL [33], developed several axioms that respond to how opportunities should not affect the value of the measure:

- The measure should not increase with increasing distances
- The measure should not increase with decreasing opportunities
- Opportunities without value should not contribute to the measure

MORRIS, DUMBEL AND WIGAN [23] developed other criteria in order to narrow performance and parameters of the measure:

- The measure should have behavioural basis: it should incorporate sociodemographic factors that influence people's activity.
- The measure should be technically feasible: this point remarks the importance of real-world application of the measure.
- The measure should be easy to interpret

VOGUES AND NADUÉ [30] pointed also the importance of disaggregation in order to accessibility along several dimensions and WILSON [34] stated that there are four questions that must be answered before the analysis is carried out:

- Degree and type of disaggregation:
  They pointed three different kinds of disaggregation: spatial, socio-economic and the purpose of the trip or the type of opportunity. The first one, spatial disaggregation refers to the grouping of individuals and it is inversely proportional to the size of the area. The smaller the area is, the higher disaggregation. The second one, socio-economic disaggregation considers the different segments of the population and divides the population, for example, by gender, age, and income level, etc.

- Definition of origins and destinations:
  The question of origin and destination is completely related with previous point, as the set of destinations to include on the analysis depends on premises done on the aggregate of potential destinations that residents identify as available for them. HANDY AND NIEMEIER [15] therefore claim that the choice set for different socio-economic groups should reflect the actual choices available to each group.

- Measurement of travel impedance:
  Travel impedance is usually measured using distance or time. The distance or the time needed to cover the distance between origin and destination can be estimated in several ways depending on the zone of study. For example,

Euclidean distance or straight line is a good way to estimate distance if the road network is enough dense, in case of rural areas DAHIGREN [8] (2008) claims that sparse road network due to natural obstacles precludes using this approximation. Other estimations are network distance, surveys of time needed by residents to cover the distance. HANDY AND NIEMEIER [15] also point the improvement in the measure by incorporating a transport cost function so that both, time and monetary costs are taken into consideration. Another improvement proposed is to include also the possibility of different transportation modes in the measure.

- Measurement of attractiveness:
  Attractiveness of a destination is the last issue and it is linked to a particular opportunity. The physical or economic size of the opportunity, the number of opportunities, etc. are possible ways to estimate attractiveness. HANDY AND NIEMEIER [15] in addition pointed that quality and price can be included in the measure; nonetheless, they also claim that such features are very subjective, thus hindering the interpretation of the measure.

2.3 Place accessibility measures

Place accessibility is derived from land pattern's use, in other words, the distribution of the potential destinations and the size, quality and character of the opportunities. It is also derived from the transportation system, ergo, the distance, the time and monetary cost of reaching each destination by different modes of transport (HANDY AND NIEMEIER [15]). Subsequently, place accessibility measures consist of two variables: the transportation that takes into account the trip impedance, i.e. the distance, time, modes of transport and the attractiveness of the destination that considers the opportunities in the place.

2.3.1 Distance measures

Distance measure are the simplest ones, they count the distance between the origin and the destination. In fact, this type of measures does not fit with the concepts explained previously because they do not take into consideration the attraction to the destination but they are more than a mobility measure because they discount distances. BHAT et al. [3] propose equation 2-A as a general equation for these measures:

$$\boldsymbol{A_i = \frac{\sum_j d_{ij}}{b}}$$

Equation 2-A: General eq. for distance accessibility measures

In general integral place accessibility consists of he distance between origin and destination d_{ij} and b, which is a general parameter that varies depending on the study. For example, GUY [14] studied local shop accessibility and he proposed equation 2-B :

$$\boldsymbol{A_i = \frac{\sum_k d_{ij(k)} E_k}{\sum_k E_k}}$$

Equation 2-B: GUY's distance accessibility measure [14]

In GUY's index the parameter b depends on E_k, which is the mean expenditure per household.

2.3.2 Cumulative-opportunity measures

Cumulative-opportunity measures evaluate the number or proportion of opportunities accessible within certain travel distance or time from a given location. These measures several researchers have worked on this concrete approach, for example, OBERG [24] and WACHS AND KUMAGAI [32]. This type of measure provides an idea of the number or proportion of opportunities available to inhabitants within a delimited area; all the opportunities within the boundaries of the area are identically weighted and therefore it is crucial to fix the maximum distance or travel time. There is no clear method in literature to calibrate this key factor but travel surveys and frequency distributions of times or distances can suggest a suitable cut-off.

BLACK AND CONROY [4] (Equation 2-C) were the very first authors to develop a cumulative-opportunity measure and since then other authors have proposed more complex and sophisticated measures that tend to gravity-type measures. For example, WEIBULL [33] focused his research on employment and he weighted attractions by the number of jobs in a zone and incorporates a term related to the travel time and car ownership HANDY [16] uses a distance-decay function to weight the opportunities.

$$\boldsymbol{A_i(T) = O_i(T)(T - t_i);}$$

Equation 2-C: BLACK AND CONROY [4] accessibility index

$O_i(T)$ = Proportion of opportunities passed in time T from zone

t_i = Mean travel time to the opportunities from zone i

2.3.3 Gravity-type measures

The very first researcher that discussed the use of physical and mathematical relationships application to cities relationships was CARROTHERS [6] in 1956. From that moment on, several researchers have developed gravity-type measures. The first one was HANSON [18] in 1959 and in the recent decades some others e.g. GEERTMAN AND VAN ECK [12], KWAN [20] or HANDY AND NIEMEIER [15].
The definition of relative accessibility A_{ij} at location i is the attraction at destination j discounted by the distance decay function between these two points. The definition of integral accessibility at location i is the sum of relative accessibility over all possible destinations divided by the total attraction of the urban area in question (SONG [29]).
The general integral gravity-type accessibility index is Equation 2-D:

$$\boldsymbol{A_i = \frac{\sum_j a_j * f(d_{ij})}{A}}$$

Equation 2-D: general gravity-type integral index

Where:

a_j= Attraction in zone j

d_{ij}= Travel time, distance or cost from zone i to zone j

$f(d_{ij})$ = Impedance function

A = Standardising factor

Several authors have proposed impedance functions, or example, HANDY AND

NEIMEIER [15], proposed the inverse power of distance (d_{ij}^{-x}), KWAN [20] suggested ($e^{-dij\beta}$). INGRAM [19], meanwhile, observed a too rapid decay in the points close to the origin and he suggested $e^{\frac{-d_{ij}^2}{v}}$ where v is the is the squared average distance between all the points.

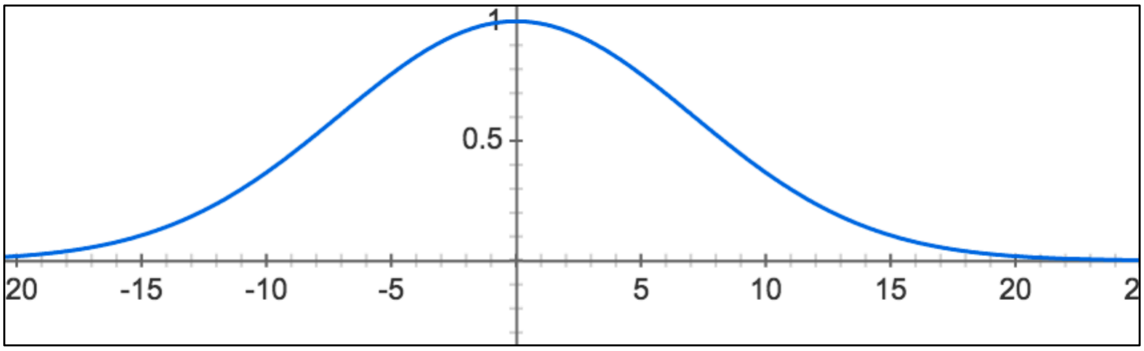


Figure 2-A: $e^{\frac{-d_{ij}^2}{v}}$ function

2.4 Spanish University accessibility measure

After the review of several studies from various researchers in this matter it becomes clear that every approach to accessibility needs a different measure. However, there are some considerations that that every accessibility measure need to be addressed before planning an accessibility analysis and its measure, as it was mentioned in previous chapters. In this dissertation, accessibility is studied from one specific municipality to the aggregate of universities offering Industrial Engineering Studies, thus we are analysing integral accessibility. The measure proposed (Equation 2-E) is similar to a gravity-type measure but it does not have a continuous behaviour due to how C (d_{ji}) is defined. On the other hand it is not a pure cumulative-opportunity measure as opportunities are weighted and, in fact, there is not cut-off because it is considered that every single university is a suitable destination regardless of the origin. Attractiveness for each centre is estimated as the aggregate of opportunities in this centre and the opportunities are the amount of student admissions by the centre. The standardizing factor is the total number of student admissions by the aggregate of universities.

The index proposed for analysing University accessibility is:

$$\boldsymbol{A_j = \frac{\sum_i p_i * C(d_{ij})}{P}}$$

Equation 2-E: Accessibility index

Where p_i is the number of admissions (opportunities) that centre i offers, P is the total amount of offered student admissions by the aggregate of universities and $C\ (d_{ji})$ is a coefficient of accessibility ranging between 1 and 0 depending on the network distance between the centre and the point of study. The measure has been created so that its range is [0,1], it is 0 in case there are no admissions accessible in the whole country and 1 if all the admissions are concentrated in the municipality where the point j is and it is, the index is not an absolute measure but a relative one that will serve to compare the accessibility in different locations. The coefficient is equivalent to the impedance function in gravity function and it has been designed to behave like the function proposed by INGRAM [19], it has a soft slope around the origin, then it becomes steeper and after the cut-off it becomes almost flat.

The values of this coefficient are given in table 2-B:

$\boldsymbol{C\ (d_{ji})}$	**Condition**
1	The centre i is in the same municipality that the point j
0,9	The centre i is nearby the point j but not in the same municipality, $d_{ji} \leq 30\ km$
0,8	The centre i is relatively nearby (approx. 30-40 minutes) the point j or $30\ km < d_{ji} \leq 50\ km$
0,5	The centre i is approx. 1 hour away from the point j, it is in the same province or $50\ km < d_{ji} \leq 100\ km$
0,2	The centre i is in the same Autonomous Community or $100\ km < d_{ji} \leq 200\ km$
0,1	The centre i is far away from the point j $d_{ji} > 200\ km$ but the access is possible by terrestrial transport

Table 2-A: Accessibility coefficient depending on distance and other geographical access barriers $\boldsymbol{C\ (d_{ji})}$

3. Competition and its Measurement

3.1 Introduction to Competition Measurement

When it comes to measure competition among Universities it is necessary to first consider some points, some conceptual issues. In other words, the very first thing is to identify the product or products to analyse, then it is crucial to identify which are the competitors of interest, another issue is to establish the market area where is going to take place the measurement and finally choosing the measure. Those three topics mentioned before are the classic determinants for competition and is crucial considering them in order to do a proper measurement of competition. Some other factors might be taken into consideration depending on the specific market willing to analyse.

3.2 Competitors and Products

GAYNOR AND VOGT [11] argues the competition experienced by a firm is defined for a single product and it is given by the amount of potential substitutes that the customers can choose instead of the other one. For this reason, BAKER [2] points that identifying which are products that can be considered substitutes of one another is a key point to properly measure the competition; for example sugar and another sweetener are not the same product but they can be considered substitutes on of another the same principle can be applied in the Industrial Engineering Bachelor's Degrees, despite considering different Bachelor degrees all of them allow the student to access to the Master in Industrial Engineering to become Superior Engineer. Nonetheless, there are two special cases that might be slightly different: Industrial Technologies and Chemical. Chemical Engineering is itself a superior Engineering program and Industrial Technologies provides preferential access to the master and a significantly higher mark in the previous is needed to enrol these Degrees. So it is necessary to take into consideration that these two degrees own a superior status with respect to the other studies within the field.

Regarding the competitors, the main point to take into consideration is that there are private and public centres and the raising question regarding this is if the product they offer is similar enough to consider them substitutes one of another. On the one hand, these universities have significant higher taxes, at least the price is a hundred per cent higher than in a public university, which means a minimum amount of 2600 euros more per year. On the other hand, there are regions where there would be a considerable lack of competence if these universities were not considered in the study of competence. That is the case of, for example, the region of Ávila, in this region only a private university offers an Industrial Degree or also the case of Euskadi where there is only a public university whereas three private universities.

With these two points in mind, the second one prevails over the first one and, finally, it is necessary to include private centres in the research the products offered might be different in price, however, this difference is not overriding due to the move factor. If a student has to move out the expenses to afford are even higher than the difference in price between a private and a public centre. In addition, in more competitive regions other factors such as status, facilities, lower access marks, etc. place these centres on the scope of the study and reaffirm that private product can be a substitute in several cases.

3.3 Geographic market area

Another crucial issue is to establish the area surrounding the University, which is the market area. The students who want to to choose a university may have several options but, in general, students tend to select one of the nearby centres. For this reason, the approach for this topic consist in establishing a concrete area surrounding the university experiencing the competition and the firms located within the threshold are the ones which can be considered substitutes of one another. GARNICK et al. [10] suggested several ways to set market areas.

3.3.1 Geopolitical Boundaries

The first option proposed by GARNICK et al. [10] is using pre-established geopolitical boundaries is an easy way to so and it has some advantages; education is a competence decentralised in Spain and the Autonomous Communities are in charge of it, in addition infrastructures such as roads and public transport are build to better communicate municipalities within these boundaries and due to these facts. Nevertheless, it has some disadvantages, if data is analysed in this way some competitors might be outside of the limits despite being important ones and maybe closer to the point of study than other which do belong to the region.

3.3.2 Fixed Radius

Another approach to set the market area surrounding a University is to describe a circle around the location of it and thus all the centres within the domain it can be considered as suitable competitors (GARNICK et al. [10]). As a consequence of using this method, the problem of excluding a suitable competitor near the location but out of the geopolitical boundaries established is solved. However, another problem emerges from the same root cause, the possibility of excluding a competitor that is just out of the circle stills being provable and the election of the length of the radius is not a trivial issue. The goal is to describe the market as accurately as possible, and therefore the selected longitude of the radius must be big enough to enclose the locations where the students of the centre come from and this is a difficult requirement to fulfil due to the differences between rural and urban areas, the most suitable radius for rural areas might be much longer that the needed for urban areas and therefore the stipulation of homogeneous radius and the accuracy are not compatible with one another in the concrete product analysed.

3.3.3 Variable radius

In response to the previous issues of the fixed radius approach, PHIBBS AND ROBINSON [26] suggested the variable radius approach, which is an improved version based on the people flow. In this case, the radius has not the restriction of being homogeneous for every point of study but variable depending on the provenance of the students so that the maximum amount of people who study in a concrete centre is taken into consideration, therefore the thing which is fixed is the percentage of customers enclosed in the area described by the circle. For example if 90% of the students is fixed, hence the radius necessary to enclose them is the determinate and the centres in this circle are the ones which are considered feasible competitors of the one which is the centre of the circle.

This approach can achieve better results than its fixed radius version but it has the inconvenience that it requires a previous study to the main calculation of the student flow for each centre and this data is difficult to obtain regarding public centres and even more to do so regarding private ones.

3.3.4 Student Flow

This approach is similar to the variable radius one, it uses the origin of the students to create a specific size area for each centre but the defined territory is not circular. GRESENZ et al. [13] proposed this method that employs groups of geographic areas such as the ones defined by the postal codes or in the Spanish case other geographic entities could be applicable such as towns, districts, etc. The core idea of the method is as the previous one, to enclose a concrete percentage of the customers.

The needed data for these approaches makes the only feasible options the first and the second, the geographical boundaries and the fixed radius one. For this reason, it is necessary to ensure that the restricted area selected is large enough to enclose a high percentage of students per centre and it is not possible to ensure this point with the fixed radius due to the geometry of the constricted area and the shape and situation of Spain in a peninsula. Therefore, the geographical boundary approach is the only feasible election and the Spanish Autonomies the convenient region in order to enclose a reasonable amount of students for every university.

3.4 Competition Measures

There are several competition measures that CABRAL [5] proposed in his book:

- The inverse of the number of firms: It's probably the simplest index in the compilation and it is an accurate enough when all the agents have a similar size.

$$\frac{1}{n}$$

Equation 3-A: inverse of number of firms [5]

- C_r: concentration ratio is another easy option to analyse the market concentration and its simply the sum of the market share (s) of the biggest r enterprises

$$C_r = \sum_{i=1}^{r} s_i \ ; \ C_r \in \left[\frac{r}{n}, 1\right]$$

Equation 3-B: Concentration Ratio [5]

C_r=1 indicates monopolistic market whereas $C_r = \frac{r}{n}$ (n- total number of enterprises) indicates minimum concentration.

- HHI: The Hirschman-Herfindahl Index is a bit more complicated to calculate because the market share of all the industry is needed in order to do it; it is the sum of the market share squares of the firms.

$$HHI_k = \sum_{j=1}^{n} s_j^2 \ I \ \left(d_{jk} \leq R_k\right); HHI \in \left[\frac{1}{n}, 1\right]$$

Equation 3-C: Hirschman-Herfindahl Index [5]

Where s_j^2 are market share squares of the firm *j* and *I* is an indicator equalling one, if hospital *j* were located within the distance boundary. HHI=1 indicates monopolistic market whereas HHI= $\frac{1}{n}$ (n- total number of enterprises) indicates minimum concentration.

- Instability index: it is not a static measure as the previous ones; its purpose is to evaluate evolution of the market. A market could have a very dominant firm but this position could switch to another one in a short period of time, in this case this market might be strongly competitive even though there is a dominant firm on top.

$$I = \sum_{i=1}^{n} |s_{it+1} - s_{it}|$$

Equation 3-D: Instability index [5]

In order to compare these measures two different criteria are set; the first one is the HANNAH AND KAY [17] criteria and the second one is the market in which this measures would be used.

Firstly, HANNAH AND KAY [17] established the following requirements that a good competition measure must fulfil:

- Classification according to the concentration curve: it must make noticeable the different concentration between two different markets. The concentration curve is a function showing the concentration of the market, the more concave it is the more concentrated is the market.

  In the graphic below there are several concentration curves that show different market concentrations. The curve D illustrates the behaviour of a market with certain number of firms and the lowest possible concentration, all the competitors have the market share so the production has a linear relation with the amount of firms whereas the others have a concave shape, the more concave the more concentrated the market is, thus A reflects the less competitive market.

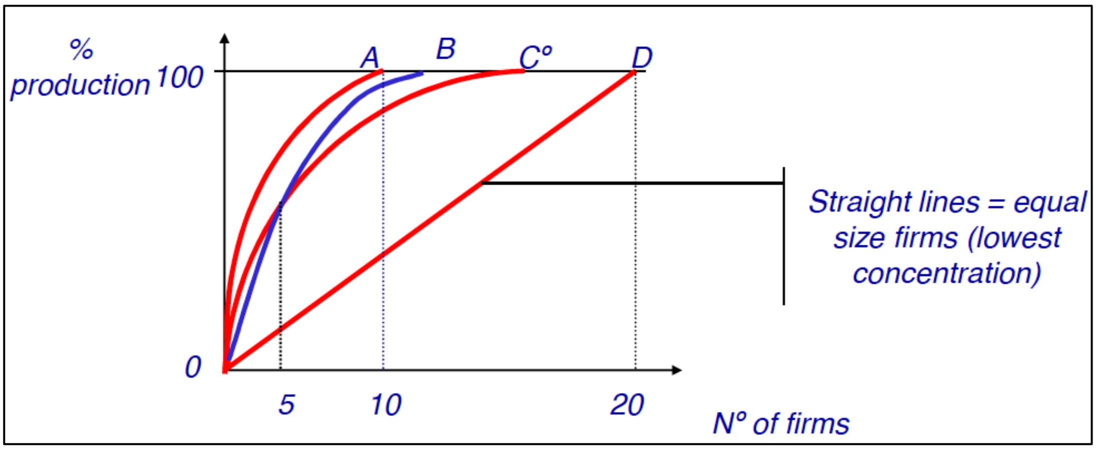


Figure 3-A: Example of several market concentration curves [2]

- Sales transfer principle: if a big enterprise merges or purchases a small one the index must grow so that it illustrates the lessening in competition that the market has experienced.

The other criterion, as it has been previously mentioned, is the concrete market willing to analyse, the Spanish Industrial Engineering Universities. If we take a look at the collected data it easy to realise that there are some universities and schools, which are significantly bigger than others therefore, it cannot be set that all the agents have the same or similar size, hence, the number of firms inverse has to be discarded and moreover, this measure does not fulfil any of the HANNAH & KAY [17] requirements. A part form that, the market can be considered static, the flux of student is not volatile the amount of admissions that each university offers remains similar during the years as each university has concrete facilities such laboratories, classrooms, etc. Furthermore, even though the study is not based on the amount total amount of students per centre, the ideal product to analyse, it is necessary to take into account that the main goal is to set a method to study competence in the university market and for this reason is also necessary to highlight that once the students are admitted in a university the biggest part tend to finish their studies in the university they started their Bachelor's Degree and this is another reason why the market as it was mentioned before should be considered static. Thus, the instability index is neither a measure suitable to analyse this specific market.

Following these two criteria only one measure is suitable to be a good measure of concentration. The C_r has to be discarded too because it does not fulfil the second principle of HANNAH & KAY [17] and can hide dominance, market power or oligopoly as it is going to be proved in the example below:

	S1	S2	S3	S4	S5
Enterprise A	0,6	0,1	0,05	0,05	0,05
Enterprise B	0,2	0,2	0,2	0,2	0,2

Table 3-A: Example of two firms with different market shares

C_{4A}=0,8 C_{4A}=0,8

HHI_A=0,3775 HHI_B=0,2

As it can be noticed, both markets have the same C_4 even though market A is much concentrated than the market B. By contrast, if the same analysis is done using the HHI it is easy to set that A is much concentrated than B.

3.5 HHI

The HHI is a measure used by the authorities of competition in order to determine if the level of competition in a market is appropriate or on the contrary if there is a monopolistic behaviour in that market. In particular, US authorities consider that a merger should be approved if the value of the Herfindahl index in the market in which businesses operate after the merger is below 0,1 o 1000 if the market share is expressed in percentage. If the index values range from 1000 to 1800, the merger should they be approved only if the increase in the HHI with respect to the index value before the merger are lower than 0,01 or 100. Values HHI above 0,18 or 1800 indicates market power and therefore the merger should not be approved without a thorough investigation, unless the increase in the HHI with respect to its value before the merger is very small (less than 0,005 or 50). European authorities are not so explicit on the following criteria when applying the HHI but in practice follow very similar to those given by the US authorities criteria.

Although it could seem HHI is the best option to analyse the University market there are some inconvenient points when it comes to do an empirical study, some practical problems. The first one is the definition of the geographical boundaries so that they enclose the relevant competitors. So even though it is the best measure, it has some disadvantages and under some circumstances it could be worse that other simpler measures (CLARKE [7]). For example, if the product or service to analyse is the existence of a concrete facility, technology or similar in the University Campus the relative size of the firm is not relevant, then the inverse of firms is a better tool to analyse the competition and a simpler way to carry out the study.

3.6 Competition measure based on HHI

One of the main requirements for a Competition measure is that it has to be technically feasible. Data has to be support the feasibility and HHI is based on the share market of each firm; this information is not available for university market due to the lack of databases in most of the universities or perhaps because od the privacy policy. In addition, establishing the market area for each firm requires the origin of its students and this information is nor available. The only information available of every university is the total amount of admissions per Degree they offer each year, there might be a significant gap between this value and the real number enrolling the Degree

For all this reason, HHI itself is not a suitable option. However, despite of the lack of data and according to MORRIS, DUMBEL AND WIGAN [23] accessibility measures should have a behavioural basis. We will extrapolate this statement to competition, the more accessible a university is for individuals the more probable is for potential students to choose the centre. Not only in terms of geography but also in socioeconomic terms.

In order to adequate the HHI to the available data by considering accessibility, three actions are proposed to carry out. The first one is to establish a threshold that limits the market area; this threshold has a circular shape with a fixed radius, the zone within the boundaries has to be large enough to include all the possible firms that might compete with one another. The second one is using to weight the student admissions by each competitor using a decay function dependent on the distance; this function reflects the decreasing geographic accessibility. The last action serves to same purpose than the previous one but with regard to socioeconomic accessibility, the decay function is subordinate to the cost of university. The new competition index proposed is equation 3-E:

$$\boldsymbol{C_k = \sum_{j=1}^{n} p_j^2 \quad (d_{jk} \leq R_k)}$$

Equation 3-E: Competition index based on HHI

$$p_j = \frac{\sum_{i=1}^{m}(P_{ij} * f_1(d_{ik}) * f_2(c_j))}{P_k}$$

$$f_1(d_{jk}) = 10^{-d_{jk}/R_k}$$

$$f_2(c_j) = 10^{-c_j/c_{max}}$$

$$P_k = \sum_{j=1}^{n}\sum_{i=1}^{m}(P_{ij} * f_1(d_{ik}) * f_2(c_j))$$

Where:

P_{ij} is the number of student admissions by centre i belonging to university j

P_k is the total amount of weighted student admissions within the cut-off

d_{ik} is the Euclidean distance between centre j and centre k

R_k is the cut-off radius

c_j is the price per year in university j

c_{max} is the higher price per year of all universities within the market area

The measure proposed still ranges between 1 and 0, but the proportion of weighted student admissions by each centre substitutes the market share. Decay functions f_1 and f_2 are similar to the ones that KWAN [20] pointed, however, he proposed a function with e base and in this dissertation the proposed base is 10 because a steeper slope is needed and also it has the advantage that c_j/c_{max} and d_{jk}/R_k range from 0 and 1 and subsequently f_1 and f_2 range from 0,1 to 1. C_k is read like HHI the closer its value is to 1 the more alike the market is to a monopoly, the closer to 0 the more competitive is the market, and in case it equals 1 the market is a monopoly.

4. Competition and Accessibility Empirical Study

4.1 Introduction to the Empirical Study

The case of study consists in a study of both accessibility and competition. First of all, one of the essential points is the elaboration of a detailed catalogue that includes the offer of admissions for new student in September 2015 of each university both public and private located within the Spanish borders, however distance-learning firms are not included due to the issues resulting from their decentralization, they are not located in a concrete place, and also because of the unlimited offer of admissions. These two points hinder the subsequent accessibility study because it could hide the remarkable difference in this matter among the Spanish regions.

The second part consists in evaluating accessibility along the Spanish province capital cities by means of the accessibility index developed in 2.4 (Equation 2-E).

Finally, the last part analyses competition experimented by some of the most important universities and some other universities that seem to be, a priori, monopolies in their regions. This study will be using the measure developed in chapeter 3.6, Equation 3-E.

4.2 Bachelor's Degrees Catalogue

4.2.1 Admissions offer

In Spain there are universities specialised in the field of engineering, but there is also a large amount of universities that have a special faculty dedicated to fulfil the special requirements that this type of studies need to provide the right quality to the students.

The public universities offering industrial degrees are widespread along the Spanish geography, however not all the range of studies is taught in each university and not all the universities have the same offered admissions. The following list shows the location of these universities, the degrees provided in them and the admissions per degree in 2015-2016, all the data has been extracted from an official data base[1] of the Spain government except for the private universities that have not provide this information for it and therefor the information has been obtained from other sources such as their own websites and other reliable sources:

[1] https://www.educacion.gob.es/notasdecorte/busquedaSimple.action

[2] https://www.uloyola.es/grados/ingenieria/grado-en-ingenieria-electromecanica/ficha-tecnica

ANDALUCÍA	
Universidad de Almería	
Escuela Superior de Ingeniería Ctra. Sacramento s/n La Cañada de San Urbano 04120 Almería	
Bachelor's degree in Chemical Engineering	75
Bachelor's degree in Electrical Engineering	75
Bachelor's degree in Electronic Engineering	75
Bachelor's degree in Mechanical Engineering	75
Universidad de Cádiz	
Escuela Politécnica Superior Av. Ramón Puyol s/n, 11202, Algeciras, Cádiz	
Bachelor's degree in Electrical Engineering	55
Bachelor's degree in Industrial Electronics Engeneering	50
Bachelor's degree in Industrial Technology Engineering	110
Bachelor's degree in Mechanical Engineering	50
Escuela Superior de Ingeniería Av. Universidad de Cadiz, 10, 11519 Puerto Real, Cádiz	
Bachelor's degree in Electrical Engineering	50
Bachelor's degree in Industrial Design and Product Development Engineering	55
Bachelor's degree in Industrial Electronics Engineering	55
Bachelor's degree in Industrial Technology Engineering	55
Bachelor's degree in Mechanical Engineering	55
Facultad de Ciencias Campus Universitario de Puerto Real, 11510 Puerto Real, Cádiz	
Bachelor's degree in Chemical Engineering	55
Universidad de Córdoba	
Escuela Politécnica Superior de Córdoba Ctra. Nacional IV Km. 396, 14014, Córdoba	
Bachelor's degree in Electrical Engineering	100
Bachelor's degree in Industrial Electronics Engeneering	100
Bachelor's degree in Mechanical Engineering	110
Universidad de Granada	
Facultad de Ciencias C/Fuente Nueva, s/n, 18001, Granada	
Bachelor's degree in Chemical Engineering	120
Bachelor's degree in Industrial Electronics Engineering	65
Universidad de Huelva	
Escuela Técnica Superior de Ingeniería Ctra. de Palos de la Frontera, s/n., 21071, Huelva	
Bachelor's degree in Chemical Engineering	65
Bachelor's degree in Electrical Engineering	65

Bachelor's degree in Energy Engineering	65
Bachelor's degree in Industrial Electronics Engeneering	65
Bachelor's degree in Mechanical Engineering	90
Universidad de Jaén	
Escuela Politécnica Superior (Jaén) Campus Las Lagunillas, s/n, 23071, Jaén	
Bachelor's degree in Electrical Engineering	100
Bachelor's degree in Industrial Electronics Engeneering	75
Bachelor's degree in Industrial Organization Engneering	75
Bachelor's degree in Mechanical Engineering	150
Escuela Politécnica Superior (Linares) Cinturón Sur, s/n, 23700 Linares, Jaén	
Bachelor's degree in Electrical Engineering	75
Bachelor's degree in Industrial Chemical Engineering	55
Bachelor's degree in Mechanical Engineering	75
Universidad de Málaga	
Escuela Politécnica Superior C/ Dr. Ortiz Ramos, s/n, 29010, Málaga	
Bachelor's degree in Electrical Engineering	70
Bachelor's degree in Industrial Design and Product Development Engineering	75
Bachelor's degree in Industrial Electronics Engeneering	70
Bachelor's degree in Mechanical Engineering	140
Escuela Técnica Superior de Ingeniería Industrial C/ Dr. Ortiz Ramos, s/n, 29010, Málaga	
Bachelor's degree in Electronic, Robotic and Mechatronic Engineering	65
Bachelor's degree in Energy Engineering	65
Bachelor's degree in Industrial Organization Engneering	65
Bachelor's degree in Industrial Technology Engineering	250
Facultad de Ciencias Bulevar Louis Pasteur, s/n, 29071, Málaga	
Bachelor's degree in Chemical Engineering	75
Universidad de Sevilla	
Escuela Politécnica Superior C/ Virgen de África, 7, 41011 Sevilla	
Bachelor's degree in Electrical Engineering	70
Bachelor's degree in Industrial Chemical Engineering	70
Bachelor's degree in Industrial Design and Product Development Engineering	110
Bachelor's degree in Industrial Electronics Engeneering	110
Bachelor's degree in Mechanical Engineering	110
Escuela Técnica Superior de Ingeniería Cº de los Descubrimientos, s/n, 41092, Sevilla	
Bachelor's degree in Chemical Engineering	70
Bachelor's degree in Electronic, Robotic and Mechatronic	65

Engineering	
Bachelor's degree in Energy Engineering	65
Bachelor's degree in Industrial Organization Engneering	65
Bachelor's degree in Industrial Technology Engineering	260
Facultad de Física Av. de la Reina Mercedes,s/n, 41012, Sevilla	
Bachelor's degree in Materials Engineering	30
Universidad Loyola Andalucía	
Escuela Técnica Superior de Ingeniería (Sede de Sevilla) C/ Energía Solar, 1, 41014 Sevilla	
Bachelor's degree in Electromechanical Engineering[2]	60
Bachelor's degree in Energy Engineering[3]	60
Bachelor's degree in Industrial Organization Engneering[4]	60
Bachelor's degree in Mechatronic and Robotic Engineering [5]	60

ARAGÓN	
Universidad de Zaragoza	
Escuela de Ingeniería y Arquitectura C/María de Luna, 3 50018 Zaragoza	
Bachelor's degree in Chemical Engineering	90
Bachelor's degree in Electrical Engineering	70
Bachelor's degree in Industrial Design and Product Development Engineering	75
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	120
Bachelor's degree in Industrial Technology Engineering	180
Bachelor's degree in Mechanical Engineering*	240
Escuela Universitaria Politécnica C/Ciudad Escolar, s/n, 44003,Teruel	
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	33
EUPLA C/ Mayor, s/n 50100-La Almunia, Zaragoza	
Bachelor's degree in Industrial Organization Engneering	60
Bachelor's degree in Mechatronic Engineering	60
Universidad San Jorge	
Escuela de Arquitectura y Tecnología A-23 Zaragoza-Huesca Km. 299, Villanueva de Gállego, Zaragoza	
Bachelor's degree in Energy and Environmental Engineering[6]	40

2 https://www.uloyola.es/grados/ingenieria/grado-en-ingenieria-electromecanica/ficha-tecnica
3 https://www.uloyola.es/grados/ingenieria/grado-en-ingenieria-de-la-energia/ficha-tecnica
4 https://www.uloyola.es/grados/ingenieria/grado-en-ingenieria-de-organizacion-industrial/ficha-tecnica
5 https://www.uloyola.es/grados/ingenieria/grado-ingenieria-mecatronica-y-robotica/ficha-tecnica
6 http://www.usj.es/estudios/grados/ingenieria-energia-medioambiente

ASTURIAS	
Universidad de Oviedo	
Escuela Politécnica de Ingeniería de Gijón C/Fojanes, s/n, 33204, Gijón, Asturias	
Bachelor's degree in Electrical Engineering	80
Bachelor's degree in Industrial Chemical Engineering	60
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	110
Bachelor's degree in Industrial Technology Engineering	145
Bachelor's degree in Mechanical Engineering	240
Facultad de Química Av. Julián Clavería, 8, 33006, Oviedo, Asturias	
Bachelor's degree in Chemical Engineering	50

CANARIAS	
Universidad de La Laguna	
Escuela Superior de Ingeniería y Tecnología Cº San Francisco de Paula, s/n, 38271 San Cristóbal de La Laguna, Santa Cruz de Tenerife	
Bachelor's degree in Chemical Engineering	65
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	80
Bachelor's degree in Mechanical Engineering	80
Universidad de Las Palmas de Gran Canaria	
Escuela de Ingenierías Industriales y Civiles Campus Universitario de Tafira, 35017, Las Palmas de Gran Canaria	
Bachelor's degree in Chemical Engineering	90
Bachelor's degree in Electrical Engineering	85
Bachelor's degree in Industrial Chemical Engineering	75
Bachelor's degree in Industrial Design and Product Development Engineering	100
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	120
Bachelor's degree in Industrial Organization Engneering	70
Bachelor's degree in Mechanical Engineering	85

CANTABRIA	
Universidad de Cantabria	
Escuela Técnica Superior de Ingenieros Industriales y de Telecomunicación Av. de los Castros, s/n, 39005 Santander, Cantabria	
Bachelor's degree in Chemical Engineering	60
Bachelor's degree in Electrical Engineering	60
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	60
Bachelor's degree in Industrial Technology Engineering	60
Bachelor's degree in Mechanical Engineering	60

Universidad Europea del Atlántico	
Escuela Politécnica Superior	
C/ Isabel Torres, 21, 39011 Santander, Cantabria	
Bachelor's degree in Industrial Organization Engneering[7]	40

CASTILLA Y LEÓN	
Universidad Católica Santa Teresa de Jesús de Ávila	
Facultad de Ciencias y Artes	
Calle de los Canteros, s/n, 05001, Ávila	
Bachelor's degree in Mechanical Engineering	40
Universidad de Burgos	
Escuela Politécnica Superior	
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	45
Bachelor's degree in Industrial Organization Engneering	55
Bachelor's degree in Mechanical Engineering	100
Universidad de León	
Escuela de Ingenierías Industrial e Informática	
Bachelor's degree in Electrical Engineering	100
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	100
Bachelor's degree in Mechanical Engineering	100
Escuela Superior y Técnica de Ingenieros de Minas	
Bachelor's degree in Energy Engineering	50
Universidad de Salamanca	
Escuela Politécnica Superior de Zamora	
Bachelor's degree in Materials Engineering	20
Bachelor's degree in Mechanical Engineering	50
Escuela Técnica Superior de Ingeniería Industrial	
Bachelor's degree in Electrical Engineering	30
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	25
Bachelor's degree in Mechanical Engineering	35
Facultad de Ciencias Químicas	
Bachelor's degree in Chemical Engineering	100
Universidad de Valladolid	
Escuela de Ingenierías Industriales	
Bachelor's degree in Chemical Engineering	75
Bachelor's degree in Electrical Engineering	60
Bachelor's degree in Industrial Design and Product Development Engineering	50

[7] http://www.europapress.es/cantabria/noticia-uneatlantico-recibe-primeros-informes-definitivos-favorables-aneca-14-grados-20140711122308.html

Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	100
Bachelor's degree in Industrial Organization Engneering	50
Bachelor's degree in Industrial Technology Engineering	60
Bachelor's degree in Mechanical Engineering	180

CASTILLA-LA MANCHA	
Universidad de Castilla- La Mancha	
Escuela de Ingeniería Industrial de Toledo Av. Carlos III, s/n, 45071, Toledo	
Bachelor's degree in Electrical Engineering	70
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	70
Escuela de Ingeniería Minera e Industrial de Almadén Plaza Manuel Meca, 1, 13400 Almadén, Cdad. Real	
Bachelor's degree in Electrical Engineering	35
Bachelor's degree in Mechanical Engineering	35
Escuela de Ingenieros Industriales Av. de España, s/n, 02071, Albacete	
Bachelor's degree in Electrical Engineering	65
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	65
Bachelor's degree in Mechanical Engineering	115
Escuela Técnica Superior de Ingenieros Industriales Av. Camilo José Cela, s/n, 13071, Ciudad Real	
Bachelor's degree in Electrical Engineering	40
Bachelor's degree in Industrial Electronics Engeneering	40
Bachelor's degree in Mechanical Engineering	50
Facultad de Ciencias y Tecnologías Químicas de Ciudad Real Av. Camilo José Cela, s/n, 13071, Ciudad Real	
Bachelor's degree in Chemical Engineering	55

CATALUNYA	
Universitat Autónoma de Barcelona	
EU Salesiana Sarrià Pº Sant Joan Bosco, 74, 08017, Barcelona	
Bachelor's degree in Electrical Engineering	40
Bachelor's degree in Industrial Electronics and Automatic Control	40
Bachelor's degree in Industrial Organization Engneering	60
Bachelor's degree in Mechanical Engineering	50
Facultad de Ciencias Campus de la UAB, Plaza Cívica, s/n, 08193 Bellaterra, Barcelona	
Bachelor's degree in Chemical Engineering	80
Universitat de Barcelona	
Facultad de Química	

C/Martí i Franquès, 1-11, 08028, Barcelona	
Bachelor's degree in Chemical Engineering	70
Bachelor's degree in Materials Engineering	40
Universitat de Girona	
Escuela Politécnica Superior C/ Mª Aurèlia Capmany, 61 17071 Girona	
Bachelor's degree in Electrical Engineering	40
Bachelor's degree in Electrical Engineering+Industrial Electronics and Automatic Control	15
Bachelor's degree in Industrial Electronics and Automatic Control	60
Bachelor's degree in Industrial Technology Engineering	80
Bachelor's degree in Industrial Technology Engineering+Business Administration and Management	15
Bachelor's degree in Mechanical Engineering	90
Universitat de Lleida	
Escuela Politécnica Superior C/ de Jaume II, 69, 25001 Lleida	
Bachelor's degree in Industrial Electronics and Automatic Control	45
Bachelor's degree in Mechanical Engineering	75
Universidad Ramón Llull	
IQS School of Engineering C/ Via Augusta, 390, 08017 Barcelona	
Bachelor's degree in Industrial Technology Engineering	70
Bachelor's degree in Chemical Engineering	30
Universitat Politécnica de Catalunya	
EEI Av. Pla de la Massa, 8, 08700 Igualada, Barcelona	
Bachelor's degree in Chemical Engineering	80
Bachelor's degree in Industrial Organization Engneering	80
EPSEM Av. Bases de Manresa, 61-73, 08242, Manresa, Barcelona	
Bachelor's degree in Chemical Engineering	140
Bachelor's degree in Industrial Electronics and Automatic Control	140
Bachelor's degree in Mechanical Engineering	140
EPSEVG Av. de Víctor Balaguer,1, 08800, Vilanova i la Geltrú, Barcelona	
Bachelor's degree in Electrical Engineering	200
Bachelor's degree in Industrial Design and Product Development	100
Bachelor's degree in Industrial Electronics and Automatic Control	200
Bachelor's degree in Mechanical Engineering	200
ETSEIAAT C/Colom, 11, 08222, Terrassa, Barcelona	
Bachelor's degree in Chemical Engineering	270
Bachelor's degree in Electrical Engineering	270
Bachelor's degree in Industrial Design and Product Development	60

Bachelor's degree in Industrial Electronics and Automatic Control	270
Bachelor's degree in Industrial Technology Engineering	180
Bachelor's degree in Mechanical Engineering	270
ETSEIB Av. Diagonal, 647 08028 Barcelona	
Bachelor's degree in Chemical Engineering	75
Bachelor's degree in Industrial Technology Engineering	450
Bachelor's degree in Materials Engineering	40
EUETIB C/ Comte d'Urgell, 187, 08036, Barcelona	
Bachelor's degree in Chemical Engineering	60
Bachelor's degree in Electrical Engineering	100
Bachelor's degree in Energy Engineering	60
Bachelor's degree in Industrial Electronics and Automatic Control	120
Bachelor's degree in Mechanical Engineering	210
Universitat Pompeu Fabra	
Elisava Les Rambles, 30-32, 08002 Barcelona	120
Bachelor's degree in Industrial Design Engineering	120
Tecnocampus Av. Ernest Lluch, 32, 08302, Mataró, Barcelona	
Bachelor's degree in Industrial Electronics and Automatic Control and Mechanical Engineering	90
Universitat Rovira i Virgili	
Escuela Técnica Superior de Ingeniería Av. Països Catalans, 26, 43007, Tarragona	
Bachelor's degree in Chemical Engineering	80
Bachelor's degree in Electrical Engineering	90
Bachelor's degree in Industrial Electronics and Automatic Control	60
Bachelor's degree in Mechanical Engineering	60
Universitat de Vic-Universitat Central de Catalunya	
Facultad de Ciencias y Tecnología C/ Sagrada Família, 7. 08500 Vic, Barcelona	
Bachelor's degree in Industrial Technology Engineering	40
Bachelor's degree in Mechatronic Engineering	40

COMUNIDAD DE MADRID	
Universidad Carlos III de Madrid	
Escuela Politécnica Superior Av. Universidad, 30 (edificio Sabatini), 28911, Leganés, Madrid	
Bachelor's degree in Electrical Engineering	75
Bachelor's degree in Energy Engineering	50
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	150
Bachelor's degree in Industrial Technology En gineering	215

Bachelor's degree in Mechanical Engineering	175
Universidad Alfonso X El Sabio	
Escuela Politécnica Superior Av. Universidad, 1, 28691 Villanueva de la Cañada, Madrid	
Bachelor's degree in Electrical Engineering[8]	40
Bachelor's degree in Industrial Design and Product Development Engineering[9]	40
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering[10]	40
Bachelor's degree in Mechanical Engineering[11]	80
Universidad Antonio de Nebrija	
Escuela Politécnica Superior C/ de los Pirineos, 55, 28040, Madrid	
Bachelor's degree in Industrial Design and Product Development Engineering[12]	30
Bachelor's degree in Industrial Technology Engineering[13]	45
Bachelor's degree in Mechanical Engineering[14]	45
Universidad Autónoma de Madrid	
Facultad de Ciencias C/ Francisco Tomás y Valiente, 7, 28049 Madrid	
Bachelor's degree in Chemical Engineering	80
Universidad Complutense de Madrid	
Facultad de Ciencias Físicas Ciudad Universitaria, Plaza Ciencias, 1, 28040 Madrid	
Bachelor's degree in Materials Engineering	50
Facultad de Ciencias Químicas Ciudad Universitaria, s/n, 28040 Madrid	
Bachelor's degree in Chemical Engineering	82
Universidad de Alcalá	
Escuela Politécnica Superior Ctra. Madrid-Barcelona, Km. 33,600, 28805 Alcalá de Henares, Madrid	
Bachelor's degree in Industrial Electronics Engeneering	75
Universidad Europea de Madrid	
Escuela de Arquitectura, Ingeniería y Diseño C/ Tajo, s/n, Villaviciosa de Odón, 28670, Madrid	
Bachelor's degree in Industrial Organization Engneering[15]	40
Bachelor's degree in Energy Engineering[16]	40
Bachelor's degree in Industrial Electronics and Automatic Control	40

[8] http://www.uax.es/grado-en-ingenieria-electrica.html
[9] http://www.uax.es/grado-en-ingenieria-en-diseno-industrial-y-desarrollo-de-producto.html
[10] http://www.uax.es/grado-en-ingenieria-electronica-industrial-y-automatica.html
[11] http://www.uax.es/grado-en-ingenieria-mecanica.html
[12] http://www.universia.es/estudios/uan/grado-ingenieria-diseno-industrial-desarrollo-producto/st/115949
[13] http://www.universia.es/estudios/uan/grado-ingenieria-tecnologias-industriales/st/209080
[14] http://www.universia.es/estudios/uan/grado-ingenieria-mecanica/st/179499
[15] http://universidades.consumer.es/universidad-europea-de-madrid/ingeniero-en-organizacion-industrial
[16] http://universidades.consumer.es/universidad-europea-de-madrid/ingeniero-tecnico-industrial-especialidad-en-electricidad

Engeneering[17]	
Bachelor's degree in Industrial Technology Engineering[18]	40
Bachelor's degree in Mechanical Engineering[19]	40
Universidad Pontificia Comillas	
Escuela Técnica Superior de Ingeniería (ICAI) C/Alberto Aguilera, 25, 28015, Madrid	
Bachelor's degree in Industrial Technology Engineering[20]	360
Universidad Rey Juan Carlos	
Escuela Superior de Ciencias Experimentales y Tecnología. Campus de Móstoles C/Tulipán, s/n, 28933 Móstoles, Madrid	
Bachelor's degree in Energy Engineering	45
Bachelor's degree in Materials Engineering	50
Bachelor's degree in Chemical Engineering	50
Bachelor's degree in Industrial Organization Engneering	45
Bachelor's degree in Industrial Technology Engineering	75
Escuela Superior de Ciencias Experimentales y Tecnología. Campus de Vicálvaro Pº de los Artilleros s/n. 28032, Madrid	
Bachelor's degree in Industrial Organization Engneering	72
Universidad Politécnica de Madrid	
Escuela Técnica Superior de Ingeniería y Diseño Industrial Ronda de Valencia, 3, 28012 Madrid	
Bachelor's degree in Mechanical Engineering	115
Bachelor's degree in Chemical Engineering	60
Bachelor's degree in Electrical Engineering	75
Bachelor's degree in Industrial Design and Product Development Engineering	70
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	115
Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos Campus Ciudad Universitaria, Calle del Prof. Aranguren, 3, 28040 Madrid	
Bachelor's degree in Materials Engineering	75
Escuela Técnica Superior de Ingenieros de Minas y Energía C/ de Ríos Rosas, 21, 28003 Madrid	
Bachelor's degree in Energy Engineering	170
Escuela Técnica Superior de Ingenieros Industriales C/ de José Gutiérrez Abascal, 2, 28006 Madrid	
Bachelor's degree in Chemical Engineering	60
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	0

[17] http://universidades.consumer.es/universidad-europea-de-madrid/ingeniero-tecnico-industrial-especialidad-en-electronica-industrial
[18] http://universidades.consumer.es/universidad-europea-de-madrid/ingeniero-industrial
[19] http://universidades.consumer.es/universidad-europea-de-madrid/ingeniero-tecnico-industrial-especialidad-en-mecanica
[20] http://www.icai.upcomillas.es/es/grados/giti

Bachelor's degree in Industrial Organization Engneering	50
Bachelor's degree in Industrial Technology Engineering	400

COMUNITAT VALENCIANA	
Universidad Cardenal Herrera-CEU	
Escuela Superior de Enseñanzas Técnicas C/ San Bartolome, 55, Alfara del Patriarca 46115, Valencia	
Bachelor's degree in Industrial Design and Product Development Engineering[21]	60
Universidad de Alicante	
Escuela Politécnica Superior C/San Vicente del Raspeig, s/n, 03690 Sant Vicent del Raspeig, Alicante	
Bachelor's degree in Chemical Engineering	60
Bachelor's degree in Robotic Engineering	60
Universidad Jaume I de Castellón	
Escuela Superior de Tecnología y Ciencias Experimentales Av. De Vicent Sos Baynat, s/n, 12071, Castellón de la Plana	
Bachelor's degree in Chemical Engineering	60
Bachelor's degree in Electrical Engineering	80
Bachelor's degree in Industrial Design and Product Development Engineering	120
Bachelor's degree in Industrial Technology Engineering	60
Bachelor's degree in Mechanical Engineering	80
Universidad Miguel Hernández de Elche	
Escuela Politécnica Superior de Elche Av. De la Universidad,s/n, 03202 Elx, Alicante	
Bachelor's degree in Electrical Engineering	50
Bachelor's degree in Industrial Electronics Engeneering	75
Bachelor's degree in Mechanical Engineering	125
Universitat de València	
Escuela Técnica Superior de Ingeniería Av. De la Universitat, s/n, 46100 Burjassot, Valencia	
Bachelor's degree in Chemical Engineering	60
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	50
Universitat Politécnica de València	
Centro Florida Universitaria C/ Rei en Jaume I, 2, 46470 Catarroja, Valencia	
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	70
Bachelor's degree in Mechanical Engineering	70
Escuela Politécnica Superior de Alcoy Plaça Ferrándiz i Carbonell s/n, 03801 Alcoi, Valencia	

[21] http://www.universia.es/estudios/uch/grado-ingenieria-diseno-industrial-desarrollo-productos/st/146738

Bachelor's degree in Chemical Engineering	50
Bachelor's degree in Electrical Engineering	65
Bachelor's degree in Mechanical Engineering	95
Escuela Técnica Superior de Ingeniería del Diseño Camino de Vera, s/n 46022 Valencia	
Bachelor's degree in Electrical Engineering	85
Bachelor's degree in Industrial Design and Product Development Engineering	140
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	150
Bachelor's degree in Mechanical Engineering	160
Escuela Técnica Superior de Ingenieros Industriales Camino de Vera, s/n 46022 Valencia	
Bachelor's degree in Chemical Engineering	80
Bachelor's degree in Energy Engineering	75
Bachelor's degree in Industrial Organization Engneering	80
Bachelor's degree in Industrial Technology Engineering	275

EUSKADI	
Mondragón Unibertsitatea	
Escuela Politécnica Superior C/Loramendi, 4, 20500 Mondragón, Guipúzcoa	
Bachelor's degree in Energy Engineering[22]	40
Bachelor's degree in Industrial Design and Product Development Engineering[23]	80
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering[24]	40
Bachelor's degree in Industrial Organization Engneering[25]	40
Bachelor's degree in Mechanical Engineering[26]	80
Universidad de Deusto	
Facultad de Ingeniería Av. de las Universidades, 24, 48007, Bilbao, Bizkaia	
Bachelor's degree in Industrial Design Engineering[27]	50
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering[28]	50
Bachelor's degree in Industrial Organization Engneering[29]	50
Bachelor's degree in Industrial Technology Engineering[30]	50

[22] http://www.mondragon.edu/es/estudios/grados/ingenieria-de-la-energia/
[23] http://www.mondragon.edu/es/estudios/grados/grado-en-ingenieria-en-diseno-industrial-y-desarrollo-de-producto/
[24] http://www.mondragon.edu/es/estudios/grados/grado-en-ingenieria-en-electronica-industrial/
[25] http://www.mondragon.edu/es/estudios/grados/grado-en-ingenieria-en-organizacion-industrial/
[26] http://www.mondragon.edu/es/estudios/grados/grado-en-ingenieria-mecanica/
[27] http://www.universia.es/estudios/deusto/grado-ingenieria-diseno-industrial/st/239382
[28] http://www.universia.es/estudios/deusto/grado-ingenieria-electronica-industrial-automatica/st/239381
[29] http://www.universia.es/estudios/deusto/grado-ingenieria-organizacion-industrial/st/178776
[30] http://www.universia.es/estudios/deusto/grado-ingenieria-tecnologias-industriales/st/239407

Bachelor's degree in Mechanical Engineering[31]	50
Universidad de Navarra	
Escuela Superior de Ingenieros Pº de Manuel Lardizabal, 13, 20018, San Sebastián, Gipuzkoa	
Bachelor's degree in Electrical Engineering[32]	60
Bachelor's degree in Industrial Design and Product Development Engineering[33]	60
Bachelor's degree in Industrial Electronics Engeneering[34]	60
Bachelor's degree in Industrial Organization Engneering[35]	60
Bachelor's degree in Industrial Technology Engineering[36]	60
Bachelor's degree in Mechanical Engineering[37]	60
Universidad del País Vasco-Euskal Herriko Unibertsitatea	
Escuela de Ingeniería de Bilbao C/Urkixo Zumarkalea, s/n, 48013, Bilbao, Bizkaia	
Bachelor's degree in Electrical Engineering	70
Bachelor's degree in Industrial Chemical Engineering	0
Bachelor's degree in Industrial Electronics Engeneering	130
Bachelor's degree in Industrial Organization Engneering	50
Bachelor's degree in Mechanical Engineering	130
Escuela de Ingeniería de Guipúzcoa Plaza Europa 1 20018 , San Sebastián, Guipúzcoa	
Bachelor's degree in Electrical Engineering	65
Bachelor's degree in Industrial Chemical Engineering	0
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	117
Bachelor's degree in Mechanical Engineering	117
Escuela Universitaria de Ingeniería de Vitoria- Gasteiz C/ Comandante Izarduy, 2, 01006 Vitoria, Álava	
Bachelor's degree in Electrical Engineering	0
Bachelor's degree in Industrial Chemical Engineering	40
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	60
Bachelor's degree in Mechanical Engineering	100
Facultad de Ciencia y Tecnología Barrio Sarriena s/n 48940 Leioa – Bizkaia	
Bachelor's degree in Chemical Engineering	80
Bachelor's degree in Industrial Electronics Engeneering	40

[31] http://www.universia.es/estudios/deusto/grado-ingenieria-mecanica/st/239384
[32] http://www4.tecnun.es/fileadmin/grados/ANECA/Memorias/ielectrica.pdf
[33] http://www4.tecnun.es/fileadmin/grados/ANECA/Memorias/idisenio.pdf
[34]http://www4.tecnun.es/fileadmin/grados/ANECA/Memorias/ielectronicaind.pdf
[35] http://www4.tecnun.es/fileadmin/grados/ANECA/Memorias/iorganizacion.pdf
[36] http://www4.tecnun.es/fileadmin/grados/ANECA/Memorias/tecnologias.pdf
[37] http://www4.tecnun.es/fileadmin/grados/ANECA/Memorias/mecanica.pdf

EXTREMADURA	
Universidad de Extremadura	
Centro Universitario de Mérida C/Sta. Teresa Jornet, 38, 06800 Mérida, Badajoz	
Bachelor's degree in Industrial Design and Product Development Engineering	60
Escuela de Ingenierías Industriales Av. De Elvas, s/n, 06071, Badajoz	
Bachelor's degree in Electrical Engineering	75
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	75
Bachelor's degree in Materials Engineering	75
Bachelor's degree in Mechanical Engineering	75
Facultad de Ciencias Av. De Elvas, s/n, 06071, Badajoz	
Bachelor's degree in Chemical Engineering	40
Bachelor's degree in Industrial Chemical Engineering	40

GALICIA	
Universidad de A Coruña	
Escuela Politécnica Superior Av. 19 de febrero s/n 15405 Ferrol, A Coruña	
Bachelor's degree in Industrial Technology Engineering	60
Bachelor's degree in Mechanical Engineering	50
Escuela Universitaria de Diseño Industrial C/Dr. Vázquez Cabrera, s/n, 15403, Ferrol, A Coruña	
Bachelor's degree in Industrial Design and Product Development Engineering	70
Escuela Universitaria Politécnica C/ Mendizábal (Campus de Esteiro), s/n, 15403 Ferrol, A Coruña	
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	50
Bachelor's degree in Electrical Engineering	60
Universidad de Santiago de Compostela	
Escuela Técnica Superior de Ingeniería C/ Lope Gómez De Marzoa, s/n, 15701, Santiago de Compostela, A Coruña	
Bachelor's degree in Chemical Engineering	60
Universidad de Vigo	
Escuela de Ingeniería Industrial (campus) Calle Maxwell, s/n36310 Vigo, Pontevedra	
Bachelor's degree in Electrical Engineering	50
Bachelor's degree in Industrial Organization Engneering	76
Escuela de Ingeniería Industrial (cidade) C/Conde de Torrecedeira, 86, 36208, Vigo, Pontevedra	
Bachelor's degree in Industrial Chemical Engineering	50
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	90

Bachelor's degree in Industrial Technology Engineering	105
Bachelor's degree in Mechanical Engineering	143
Escuela Técnica Superior de Ingeniería de Minas C/Maxwell, s/n36310 Vigo, Pontevedra	
Bachelor's degree in Energy Engineering	50

ILLES BALEARS	
Universitat de les Illes Balears	
Escuela Politécnica Superior Ctra. Valldemossa Km 7.5 07122-Palma de Mallorca	
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	60

LA RIOJA	
Universidad de La Rioja	
Escuela Técnica Superior de Ingeniería Industrial C/ Luis de Ulloa, 4, 26004, Logroño	
Bachelor's degree in Electrical Engineering	25
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	25
Bachelor's degree in Mechanical Engineering	75

MURCIA	
Universidad de Murcia	
Facultad de Química Campus de Espinardo 30100 Murcia	
Bachelor's degree in Chemical Engineering	80
Universidad Politécnica de Cartagena	
Escuela Técnica Superior de Ingeniería Industrial Calle Doctor Fleming, s/n, 30202 Cartagena, Murcia	
Bachelor's degree in Industrial Chemical Engineering	50
Bachelor's degree in Industrial Technology Engineering	80
Bachelor's degree in Electrical Engineering	50
Bachelor's degree in Industrial Electronics and Automatic Control Engeneering	90
Bachelor's degree in Mechanical Engineering	115

NAVARRA	
Universidad Publica de Navarra	
Escuela Técnica Superior de Ingenieros Industriales y Telecomunicación (Pamplona) Campus de Arrosadía, 31006 Pamplona, Navarra	
Bachelor's degree in Electrical and Electronical Engineering	60
Bachelor's degree in Electromechanical Engineering	240
Bachelor's degree in Industrial Technology Engineering	150

Bachelor's degree in Mechanical Engineering	90
Escuela Técnica Superior de Ingenieros Industriales y Telecomunicación (Tudela) Av. Tarazona, 31500 Tudela, Navarra	
Bachelor's degree in Mechanical Design Engineering	50

Table 4-A: Catalogue of offered admissions in September 2015

4.2.2 Price of Industrial Engineering Degrees

The Spanish universities have gradually implemented the European Credit Transfer and Accumulation System, usually the price of the degrees is established by region where the university is and it also depends on the field of study. However, the region government does not set the price per credit in private universities, as they do not receive money from public funds. In order to compare the cost for a student, as the private universities tend to publish the price per year and not per credit, a whole academic year price comparison will be done.

4.2.2.1 Public Universities

As it has been mentioned previously, the region is responsible for fixing the price per credit and depending on the experimental degree of the study program. The next table shows the price of a whole academic year in each region.

REGION	Price/credit	Price/year*
Andalucía	12,62	757,2
Aragón	22,73	1363,8
Principado de Asturias	17,26	1035,6
Islas Baleares	20,53	1231,8
Canarias	18,95	1137
Cantabria	15,56	933,6
Castilla-La Mancha	18,87	1132,2
Castilla y León	27,72	1663,2
Catalunya	39,53	2371,8
Galicia	13,93	835,8
La Rioja	21,21	1272,6
Comunidad de Madrid	27,9	1674
Comunitat Valenciana	23,85	1431
Extremadura	16,83	1009,8
Navarra	22,53	1351,8
Euskadi	19,19	1151,4

Murcia	16,78	1006,8
Distance learning university	22,16	1330

*This is an approximate price; it can vary as each university chooses extra taxes for administration costs, insurance, etc.

Table 4-B: Cost per year in public universities

4.2.2.2 Private Universities

On the other hand, private universities are responsible for setting the price of their studies as the governments do not fund them, therefor these universities have higher prices and also the variation in price among them is higher

University	Price/year*	Average price
Mondragón Unibertsitatea	6000	6000
EU Salesiana Sarrià	6426	6426
Universidad Alfonso X El Sabio	7390	7390
Universidad Antonio de Nebrija	10837 12550	11979
Universidad Cardenal Herrera-CEU	7390 7410 8700	7833,33
Universidad Católica Santa Teresa de Jesús de Ávila	15600	15600
Universidad de Deusto	8436	8436
Universidad de Navarra	10560	10560
Universidad Europea de Madrid	10860 11085 13137	11450,4
Universidad Europea del Atlántico	5520	5520
Universidad Loyola Andalucía	7800	7800
Universidad Pontificia Comillas	11644,59 12440,61	12042,6
Universidad Ramón Llull	10500 11220	12042,6
Universidad San Jorge	9000	9000
Universitat Pompeu Fabra Tecnocampus Elisava	5600 8436	6883
Uvic-UCC	5485	5485

Table 4-C: Cost per year in private universities

4.3 Accessibility study

Using the measure A_j that has been created to analyse this concrete market the accessibility study consists in evaluating the access to university ease in several points of the Spanish geography. One possibility would have been to create a grid regular and then analyse its nodes. However, using this method there is no possibility of choosing all the concrete locations wanted to analyse, in order to do it, the grid is irregular and its nodes are the towns desired. In this case, to link this study with the competition one, the nodes are the province capital cities and thus the index will show difference in accessibility among the different provinces.

The example below shows how A_j is calculated:

$$\boldsymbol{A_i = \frac{\sum_j a_j * f(d_{ij})}{A}}$$

$$\boldsymbol{A_{Sevilla} = \frac{1265 \cdot 1 + 350 \cdot 0,5 + 590 \cdot 0,2 + 2588 \cdot 0,1}{28288} = 0,147}$$

The following table shows A_j for the mentioned locations:

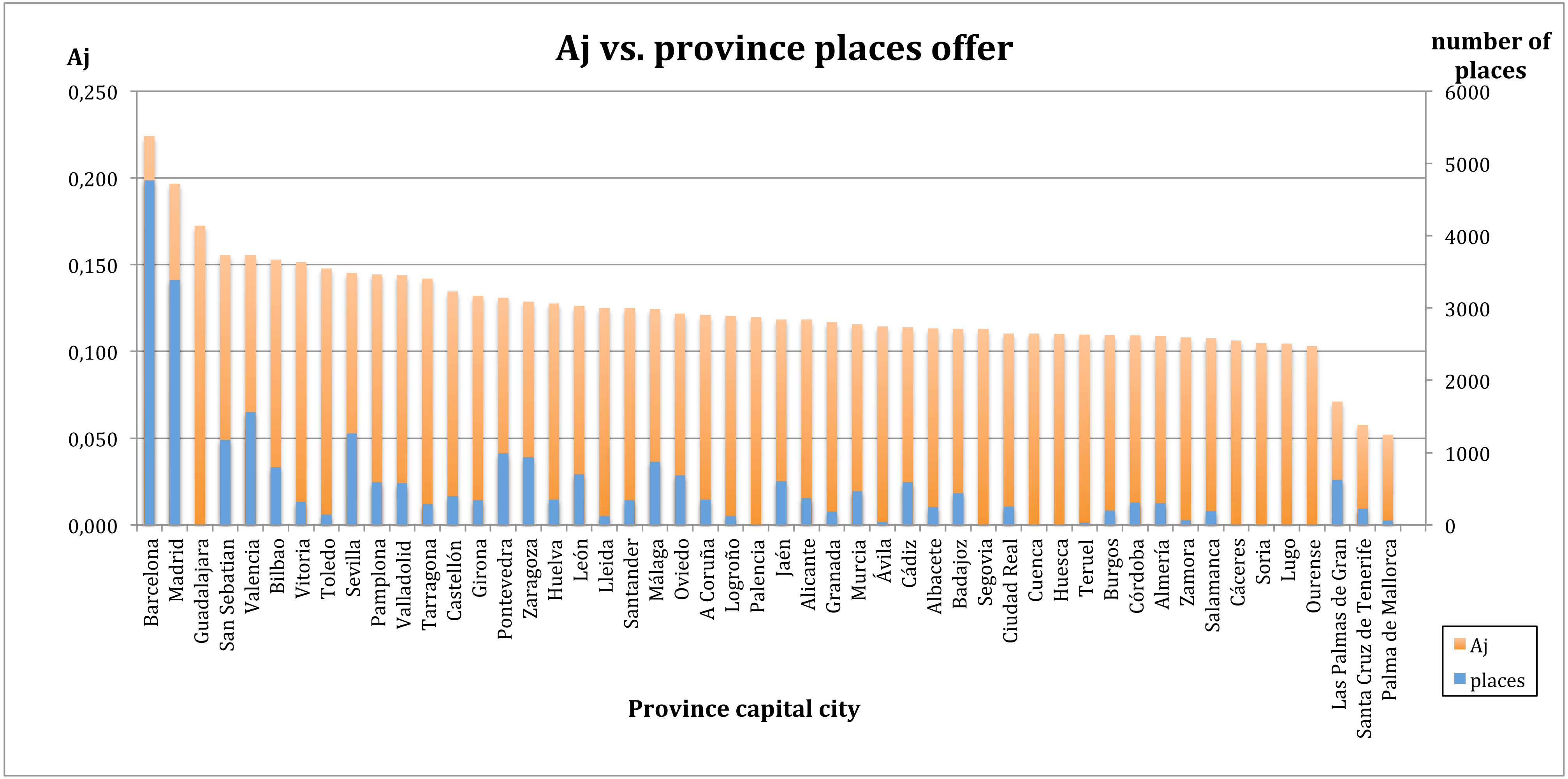
PROVINCE	CAPITAL CITY	A_j
Sevilla	Sevilla	**0,147**
Huelva	Huelva	**0,129**
Málaga	Málaga	**0,126**
Jaén	Jaén	**0,120**
Granada	Granada	**0,119**
Cádiz	Cádiz	**0,115**
Córdoba	Córdoba	**0,114**
Almería	Almería	**0,110**
Zaragoza	Zaragoza	**0,130**
Huesca	Huesca	**0,112**
Teruel	Teruel	**0,111**

Asturias	Oviedo	**0,123**
Las Palmas	Las Palmas de Gran Canaria	**0,112**
Santa Cruz de Tenerife	Santa Cruz de Tenerife	**0,107**
Cantabria	Santander	**0,126**
Valladolid	Valladolid	**0,145**
León	León	**0,128**
Palencia	Palencia	**0,120**
Ávila	Ávila	**0,116**
Segovia	Segovia	**0,114**
Burgos	Burgos	**0,111**
Zamora	Zamora	**0,108**
Salamanca	Salamanca	**0,109**
Soria	Soria	**0,106**
Guadalajara	Guadalajara	**0,172**
Toledo	Toledo	**0,149**
Albacete	Albacete	**0,113**
Ciudad Real	Ciudad Real	**0,112**
Cuenca	Cuenca	**0,110**
Barcelona	Barcelona	**0,225**
Tarragona	Tarragona	**0,143**
Girona	Girona	**0,133**
Lleida	Lleida	**0,126**
Madrid	Madrid	**0,198**
Valencia	Valencia	**0,157**
Castellón	Castellón	**0,136**
Alicante	Alicante	**0,120**
Gipuzkoa	San Sebatián	**0,157**
Bizkaia	Bilbao	**0,155**
Álava	Vitoria	**0,153**
Badajoz	Badajoz	**0,113**
Cáceres	Cáceres	**0,106**
Pontevedra	Pontevedra	**0,131**
A Coruña	A Coruña	**0,121**

Lugo	Lugo	**0,104**
Ourense	Ourense	**0,103**
Islas Baleares	Palma de Mallorca	**0,102**
La Rioja	Logroño	**0,122**
Murcia	Murcia	**0,117**
Navarra	Pamplona	**0,146**

Table 4-D: A_j value in capital province cities

In order to clarify the table above the graph 3-C shows the a comparative between the A_j index and the total amount of student admissions in the whole province where the municipality belongs to:



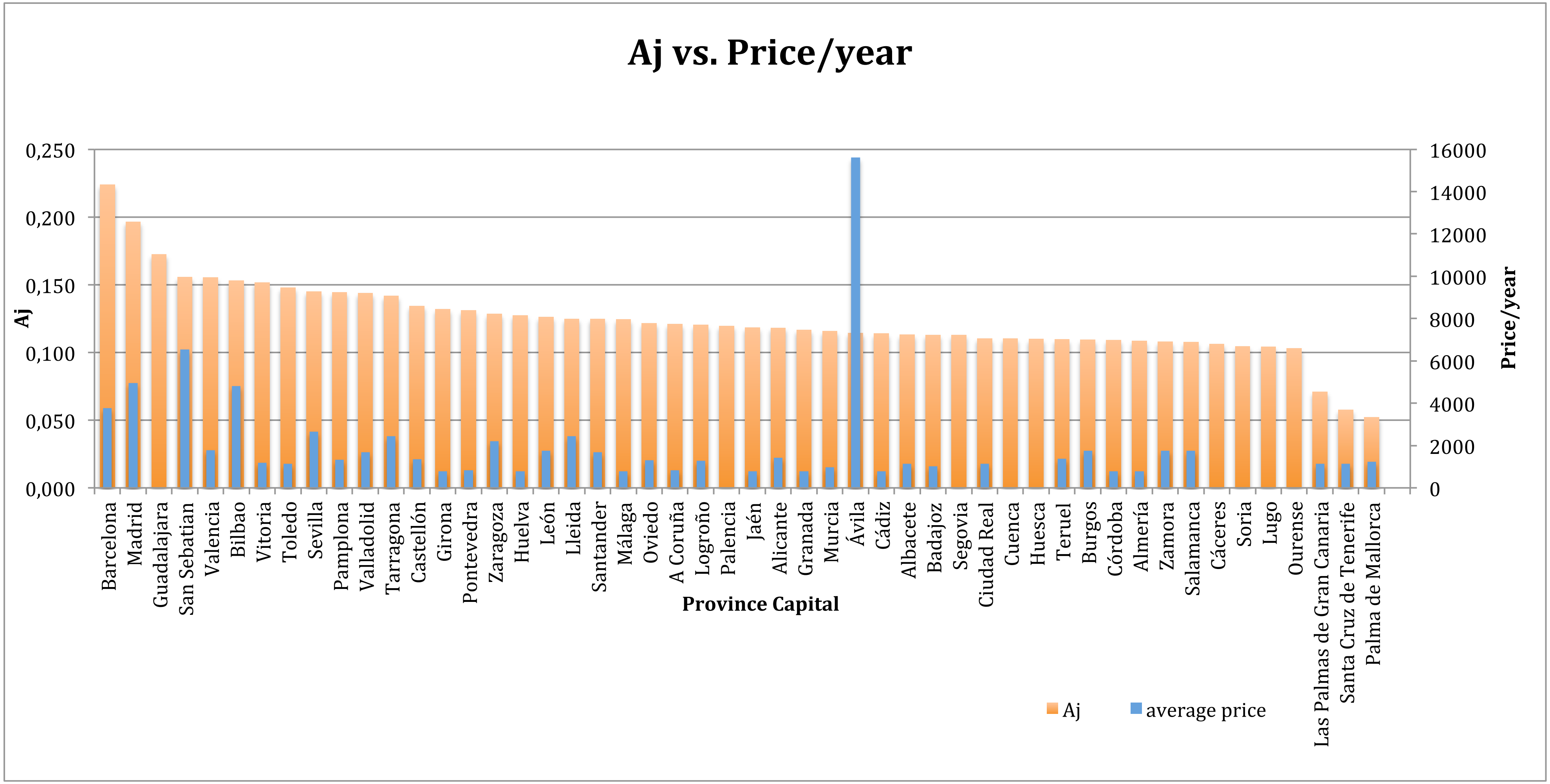
Graph 4-A: A_j value in capital province cities vs. place offer in its province

As it is noticeable in the graph above, and it was predictable and trivial the capital cities of the provinces hosting the largest amount of admissions are on top regarding geographical ($\boldsymbol{A_j}$).

However, there are some cities that may seem to have a low accessibility index but as it is perceptible they own a good accessibility to Engineering studies. The most remarkable case is Guadalajara ($\boldsymbol{A_j} = 0{,}172$), in its province there are no universities offering Industrial Engineering studies, nonetheless it is the third province capital city concerning accessibility. The index reflexes the amount of admissions close to the city and indeed Guadalajara has great connection with Madrid and the surrounding municipalities that also host university centres, especially Alcalá de Henares, which is only 27 km distance and 20 minutes by train but also Madrid, which is 1 hour far by train. There are other similar cases such as Toledo ($\boldsymbol{A_j} = 0{,}148$) or León ($\boldsymbol{A_j} = 0.126$) that even they host a very low number of admissions they have a good accessibility.

In conclusion, once the geographical accessibility analysis is done it possible to establish that except for the territories outside the Iberian Peninsula, overall Spanish regions have good accessibility in terms of geography, even those with no offer, and it is also very homogeneous except for the biggest cities and the surrounding area, which stand above the rest.

The graph 3-D illustrates the relation between university fees and accessibility:



Graph 4-B: Average university cost vs. Aj

From the graph above we can extract that, in general, the cities owning a higher Aj have also higher fees except for the Valencia that has a good accessibility index despite not hosting many private university admissions and the nearby cities to the big capital cities such as Guadalajara, Toledo or Pamplona.

Figure 4-A shows the geographical accessibility using a colour gradient from green to red so the red areas whose accessibility index is the lowest and the green ones are those holding a higher value.

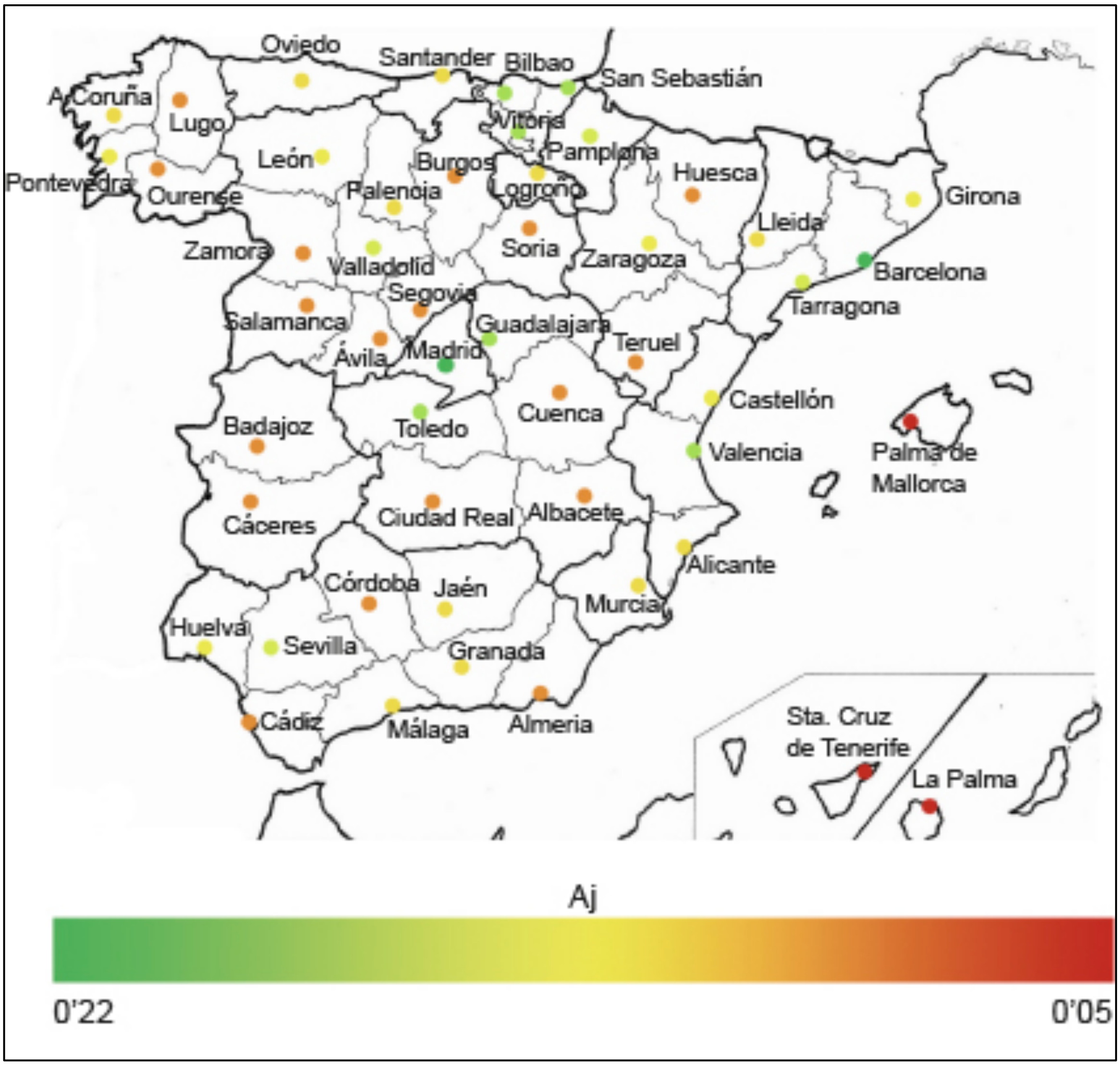


Figure 4-A: Accessibility index across the Spanish territory

4.3 Competition study

The competition study shows the competition experienced by seven Universities: Universitat Politècnica de Catalunya, Universidad Politécnica de Madrid, Universitat Politècnica de València, Universidad de Navarra (San Sebastián), Universidad de Sevilla, Universidad de Extremadura and Universidad de Oviedo. It is done by means of Equation 3-E, the competition index based on HHI:

$$C_k = \sum_{j=1}^{n} p_j^2 \quad (d_{jk} \leq R_k)$$

Equation 3-E: Competition index based on HHI

In this study the value R_k, the radius that limits the market zone, is 150 km. This radius is sufficient to enclose the universities located in the same province and in the nearby provinces that might be potential competitors. Universities with more than one centre have to be analysed from one of the centres, as the origin of the radius have to be placed in one concrete location.
The results of the analysis are shown on the table 4-E:

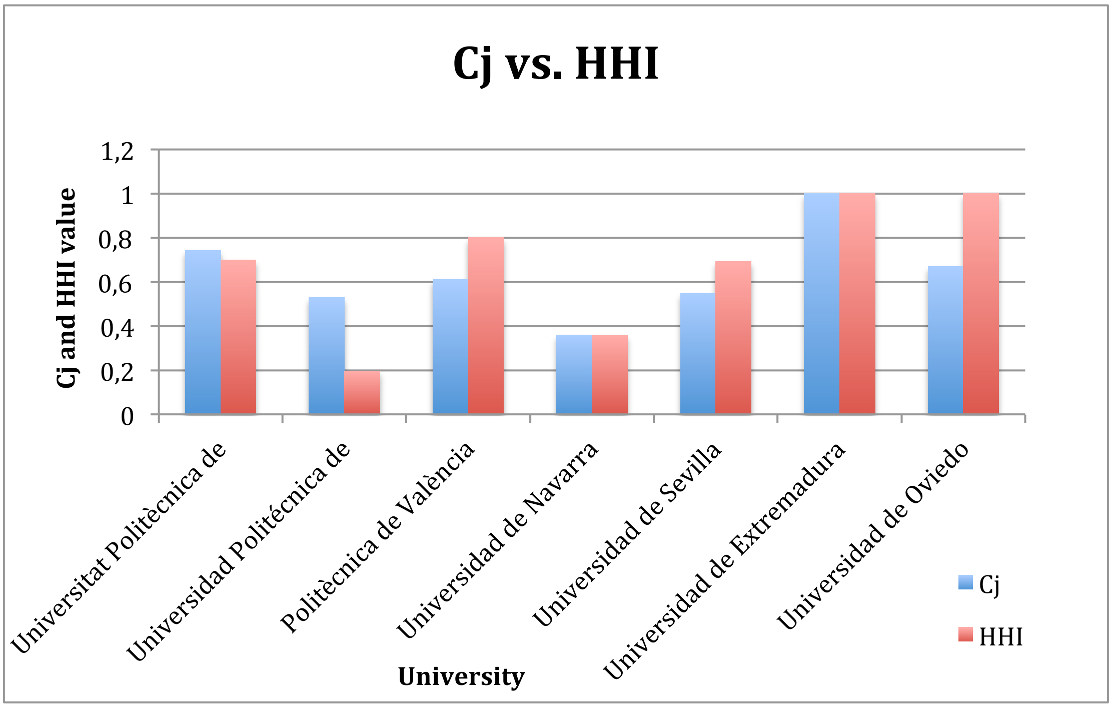
University	Reference centre	city	Cj
Universitat Politècnica de Catalunya	ETSEIB	Barcelona	0,743
Universidad Politécnica de Madrid	ETSII	Madrid	0,529
Politècnica de València	ETSII	València	0,611
Universidad de Navarra	Escuela Superior de Ingenieros	San Sebastián	0,360
Universidad de Sevilla	Escuela Politécnica Superior	Sevilla	0,548
Universidad de Extremadura	Centro Universitario de Mérida	Mérida	1
Universidad de Oviedo	Escuela Politécnica de Ingeniería de Gijón	Gijón	0,670

Table 4-E: Cj values for several Universities

Table 4-F shows the results obtained when applying the HHI to the same Universities with a provincial market area:

University	Reference centre	City	HHI
Universitat Politècnica de Catalunya	ETSEIB	Barcelona	0,699
Universidad Politécnica de Madrid	ETSII	Madrid	0,197
Politècnica de València	ETSII	València	0,800
Universidad de Navarra	Escuela Superior de Ingenieros	San Sebastián	0,360
Universidad de Sevilla	Escuela Politécnica Superior	Sevilla	0,693
Universidad de Extremadura	Centro Universitario de Mérida	Mérida	1
Universidad de Oviedo	Escuela Politécnica de Ingeniería de Gijón	Gijón	1

Table 4-F: HHI values for several Universities



Graph 4-C: Cj and HHI comparison

As the graph 4-C and the tables 4-G and 4-H show there is an improvement in accuracy with the proposed index C_j as it introduces accessibility features that are not present in HHI. The case of Universidad Politécnica de Madrid is a good example; there are many universities less accessible than, Universidad Politécnica de Madrid in terms of both economy and distance and therefore the competition shown by HHI is lowered when analysing the market with the new competition index C_j. On the other hand when analysing little province that it may seem monopolies C_j shows that the nearby universities that belong to other provinces can be suitable competitors.

On the other hand, the other conclusion drawn by the analysis is that, overall, there is a lack of competition. Most of the territories are monopolies or host a University owning a dominant market share; in the majority of provinces there is only one university or in case. The most populated territories host a higher number of firms; notwithstanding, some universities such as Universitat Politècnica de Catalunya or as Universitat Politècnica de Valencia do not experience much competition as their size is much larger that their neighbours. There are only two firms that experience enough competition to consider that the market behaviour differs from monopoly or oligopoly; Universidad Politécnica de Madrid (Madrid) and Universidad de Navarra (San Sebstián).

5 Conclusions

To conclude this Bachelor's thesis the first thing to remark is that the main characteristic of a measure both for accessibility and competition is feasibility. Data is the mainstay of this feasibility and the measure relies on it.

Regarding accessibility, apart from feasibility, the measure has to be adequate for the concrete case of study and its purpose. The huge amount of measures that has been proposed during the recent decades and the lack of a standard definition for this concept proves that every case of study has its own features that are translated into requirements and the measure has to fulfil them, without considering particularities of the region, the purpose of the trip and carrying out an accurate disaggregation and analysing the attraction of admissions it is impossible to propose a proper measure that estimates accessibility.

On the other hand competition does not have those peculiarities that accessibility has with regard of the measure. The study has to be equally well planned defining the correct market area and choosing the adequate measure so that the relation between the complexity of the study and complexity of the measure are balanced. However, if the most complex measure is chosen because there is available data to calculate it no mistake will be committed. The main issue is just this one data; this dissertation is a clear example. The perfect analysis of competition would have been by means of HHI with a variable market area defined by the student flow, however it has been impossible to carry out the study this way as there is no information available of the real number of students and its origin.

Despite of the difficulties regarding data, the proposed measures in this paper can estimate both competition and accessibility in a satisfactory way.

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7 Appendices

7.1 C_j Calculation

UNIVERSIDAD DE EXTREMADURA (**Centro Universitario de Mérida)**									
School	**University**	**Places**	**Price**	**Price/Max**	**f1 (d)**	**d**	**dmax**	**f2(c)**	**Pj*f1*f2**
Centro Universitario de Mérida	Universidad de Extremadura	60	1010	1	0,1	0	0	1	6
Escuela de Ingenierías Industriales	Universidad de Extremadura	300	1010	1	0,1	70	0,467	0,341	10,244
Facultad de Ciencias	Universidad de Extremadura	80	1010	1	0,1	70	0,467	0,341	2,732
		440	**max.Price**			**dmax**			18,975
			1010			150			

Table 7-A.1 UNIVERSIDAD DE EXTREMADURA C_J calculation

University	Sum	Sum/total adm.	(Sum/total adm.)^2	Cj
Universidad de Extremadura	18,975	1	1	**1**

Table 7-A.2 UNIVERSIDAD DE EXTREMADURA C_J calculation

UNIVERSITAT POLITÉCNICA DE CATALUNYA									
School	**University**	**Adm.**	**Price**	**Price/Max**	**f1 (d)**	**d**	**dmax**	**f2(c)**	**Pj*f1*f2**
EU Salesiana Sarrià	UAB	210	12042	1	0,100	1,5	0,010	0,977	20,522
Facultad de Ciencias	UAB	80	2371,8	0,197	0,635	13	0,087	0,819	41,635
Facultad de Química	UB	110	2371,8	0,197	0,635	0,2	0,001	0,997	69,678
Escuela Politécnica Superior	UdG	340	2371,8	0,197	0,635	87	0,580	0,263	56,822
Escuela Politécnica Superior	UdL	120	2371,8	0,197	0,635	126	0,840	0,145	11,021
IQS School of Engineering	UPC	100	2371,8	0,197	0,635	2	0,013	0,970	61,618
EEI	UPC	160	2371,8	0,197	0,635	49	0,327	0,471	47,917
EPSEM	UPC	420	2371,8	0,197	0,635	46	0,307	0,494	131,711
EPSEVG	UPC	700	2371,8	0,197	0,635	37	0,247	0,567	252,041
ETSEIAAT	UPC	1590	2371,8	0,197	0,635	21	0,140	0,724	731,874
ETSEIB	UPC	565	2371,8	0,197	0,635	0	0,000	1,000	358,995
EUETIB	UPC	550	2371,8	0,197	0,635	3	0,020	0,955	333,735
Elisava Escuela Superior de Diseño	UPF	120	8436	0,701	0,199	5	0,033	0,926	22,146
Tecnocampus	UPF	90	5600	0,465	0,343	31	0,207	0,621	19,166
Escuela Técnica Superior de Ingeniería	URV	290	2371,8	0,197	0,635	77	0,513	0,307	56,507
Facultad de Ciencias y Tecnología	Uvic-UCC	100	5485	0,455	0,350	62	0,413	0,386	13,526
		5545	**max.Price**			**dmax**			2228,916
			12042			150			

Table 7-B.1 UNIVERSITAT POLITÉCNICA DE CATALUNYA C_J calculation

University	Sum	Sum/total adm.	Columna1	Cj
UAB	62,157	0,028	0,001	**0,744**
UB	69,678	0,031	0,001	
UdG	56,822	0,025	0,001	
UdL	11,021	0,005	0,000	
UPC	1917,891	0,860	0,740	
UPF	41,312	0,019	0,000	
URV	56,507	0,025	0,001	
Uvic-UCC	13,526	0,006	0,000	

Table 7-B.2 UNIVERSITAT POLITÉCNICA DE CATALUNYA C_J calculation

UNIVERSIDAD POLITÉCNICA DE MADRID (Escuela Técnica Superior de Ingenieros Industriales)									
School	**University**	**Adm.**	**Price**	**Price/Max**	**f1 (d)**	**d**	**dmax**	**f2(c)**	**Pj*f1*f2**
Escuela Politécnica Superior	Uc3	665	1860	0,119	0,760	13	0,087	0,819	413,927
Escuela Politécnica Superior	Uax	200	7390	0,474	0,336	5	0,033	0,926	62,227
Escuela Politécnica Superior	Nebrija	120	11979	0,768	0,171	2	0,013	0,970	19,859
Facultad de Ciencias	Uam	80	1860	0,119	0,760	12	0,080	0,832	50,566
Facultad de Ciencias Físicas	Complu	50	1860	0,119	0,760	3	0,020	0,955	36,286
Facultad de Ciencias Químicas	Complu	82	1860	0,119	0,760	3	0,020	0,955	59,509
Escuela Politécnica Superior	Alcala	75	1860	0,119	0,760	30	0,200	0,631	35,961
Escuela de Arquitectura, Ingeniería y Diseño	Europea	40	11495,4	0,737	0,183	20	0,133	0,736	5,393
Escuela de Arquitectura, Ingeniería y Diseño Campus Villaviciosa y Alcobendas	Europea	160	11495,4	0,737	0,183	20	0,133	0,736	21,573
Escuela Técnica Superior de Ingeniería (ICAI)	Icai	360	12042,6	0,772	0,169	2	0,013	0,970	59,021
Escuela Superior de Ciencias Experimentales y Tecnología, Campus de Móstoles	Rey juan carlos	95	1860	0,119	0,760	20	0,133	0,736	53,108
Escuela Superior de Ciencias Experimentales y Tecnología. Campus de Móstoles	Rey juan carlos	170	1860	0,119	0,760	20	0,133	0,736	95,035
Escuela Superior de Ciencias Experimentales y Tecnología. Campus de Vicálvaro	Rey juan carlos	72	1860	0,119	0,760	8	0,053	0,884	48,391
Escuela Técnica Superior de Ingeniería y Diseño Industrial	Upm	435	1860	0,119	0,760	4	0,027	0,940	310,879
Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos	Upm	75	1860	0,119	0,760	4	0,027	0,940	53,600
Escuela Técnica Superior de Ingenieros de Minas y Energía	Upm	170	1860	0,119	0,760	1	0,007	0,985	127,219
Escuela Técnica Superior de Ingenieros Industriales (ETSII)	Upm	510	1860	0,119	0,760	0	0,000	1,000	387,560
Escuela de Ingeniería Industrial de Toledo	Toledo	140	1132	0,073	0,846	70	0,467	0,341	40,448
Facultad de Ciencias y Artes	Avila	40	15600	1,000	0,1	85	0,567	0,271	1,085
		3539	**max.Price**			**dmax**			1881,649
			15600			150			

Table 7-C.1 UNIVERSIDAD POLITÉCNICA DE MADRID C_J calculation

University	Sum	Sum/total adm.	Columna1	Cj
Uc3	413,927	0,220	0,048	**0,529**
Uax	62,227	0,033	0,001	
Nebrija	19,859	0,011	0,000	
Uam	50,566	0,027	0,001	
Complu	95,795	0,051	0,003	
Alcala	35,961	0,019	0,000	
Europea	26,966	0,014	0,000	
Icai	59,021	0,031	0,001	
Rey juan carlos	196,535	0,104	0,054	
Upm	879,258	0,467	0,061	
Toledo	40,448	0,021	0,120	
Avila	1,085	0,001	0,240	

Table 7-C.2 UNIVERSIDAD POLITÉCNICA DE MADRID C_J calculation

UNIVERSIDAD DE NAVARRA (Escuela Superior de Ingenieros)									
School	**University**	**Adm.**	**Price**	**Price/Max**	**f1 (d)**	**d**	**dmax**	**f2(c)**	**Pj*f1*f2**
Escuela Politécnica Superior	Mondragón Unibertsitatea	280	6000	0,568	0,270	48	0,320	0,479	36,222
Facultad de Ingeniería	Universidad de Deusto	415	8436	0,799	0,159	76	0,507	0,311	20,536
Escuela Superior de Ingenieros	Universidad de Navarra	600	10560	1,000	0,100	0	0,000	1,000	60,000
Escuela de Ingeniería de Bilbao	UPV-EHU	380	1186	0,112	0,772	76	0,507	0,311	91,371
Escuela de Ingeniería de Guipuzcoa	UPV-EHU	299	1186	0,112	0,772	2	0,013	0,970	223,886
Escuela Universitaria de Ingeniería de Vitoria- Gasteiz	UPV-EHU	200	1186	0,112	0,772	75	0,500	0,316	48,834
Facultad de Ciencia y Tecnología	UPV-EHU	120	1186	0,112	0,772	76	0,507	0,311	28,854
Escuela Técnica Superior de Ingeniería Industrial	Universidad de La Rioja	125	1273	0,121	0,758	102	0,680	0,209	19,786
Escuela Técnica Superior de Ingenieros Industriales y Telecomunicación. Sede de Tudela	Universidad Pública de Navarra	590	1350	0,128	0,745	62	0,413	0,386	169,698
Escuela Técnica Superior de Ingenieros Industriales y de Telecomunicación	Universidad de Cantabria	300	934	0,088	0,816	148	0,987	0,103	25,235
Escuela Politécnica Superior	Universidad Europea del Atlántico	40	5520	0,523	0,300	148	0,987	0,103	1,238
		3349	**max.Price**			**dmax**			752,660
			10560			150			

Table 7-D.1 UNIVERSIDAD DE NAVARRA C_J calculation

University	Sum	Sum/total adm.	Columna1	Cj
Mondragón Unibertsitatea	36,222	0,050	0,002	
Universidad de Deusto	20,536	0,028	0,001	
Universidad de Navarra	60,000	0,083	0,007	
UPV-EHU	392,944	0,541	0,293	**0,360**
Universidad de La Rioja	19,786	0,027	0,001	
Universidad Pública de Navarra	169,698	0,234	0,055	
Universidad de Cantabria	25,235	0,035	0,001	
Universidad Europea del Atlántico	1,238	0,002	0,000	

Table 7-D.2 UNIVERSIDAD DE NAVARRA C_J calculation

UNIVERSIDAD DE OVIEDO (**Escuela Politécnica de Ingeniería de Gijón**)									
School	**University**	**Adm.**	**Price**	**Price/Max**	**f1 (d)**	**d**	**dmax**	**f2(c)**	**Pj*f1*f2**
Escuela Politécnica de Ingeniería de Gijón	Universidad de Oviedo	635	1355	0,2455	0,568	0	0	1	360,830
Facultad de Química	Universidad de Oviedo	50	1355	0,2455	0,568	24	0,160	0,692	19,656
Escuela Superior y Técnica de Ingeniero de Minas	Universidad de León	600	1760	0,3188	0,480	100	0,667	0,215	62,036
Escuelas de Ingenierías Industrial e Informática	Universidad de León	100	1760	0,3188	0,480	101	0,673	0,212	10,182
Escuela Técnica Superior de Ingenieros Industriales y de Telecomunicación	Universidad de Cantabria	300	934	0,1692	0,677	149	0,993	0,102	20,634
Escuela Politécnica Superior	Universidad Europea del Atlántico	40	5520	1	0,1	149	0,993	0,102	0,406
		1725	**max.Price**			**dmax**			473,744
			5520			150			

Table 7-E.1 UNIVERSIDAD DE OVIEDO C_J calculation

University	Sum	Sum/total adm.	Columna1	Cj
Universidad de Oviedo	380,486	0,803	0,645	**0,670**
Universidad de León	72,218	0,152	0,023	
Universidad de Cantabria	20,634	0,044	0,002	
Universidad Europea del Atlántico	0,406	0,001	0,000	

Table 7-E.2 UNIVERSIDAD DE OVIEDO C_J calculation

UNIVERSIDAD DE SEVILLA (**Escuela Politécnica Superior)**									
School	**University**	**Adm.**	**Price**	**Price/Max**	**f1 (d)**	**d**	**dmax**	**f2(c)**	**Pj*f1*f2**
Escuela Politécnica Superior	Universidad de Sevilla	470	776	0,099	0,795	0	0,000	1,000	373,775
Escuela Técnica Superior de Ingeniería	Universidad de Sevilla	525	776	0,099	0,795	4	0,027	0,940	392,650
Facultad de Física	Universidad de Sevilla	30	776	0,099	0,795	2	0,013	0,970	23,137
Escuela Técnica Superior de Ingeniería (Sede de Sevilla)	Universidad Loyola Andalucía	240	7800	1,000	0,100	5	0,033	0,926	22,227
Escuela Politécnica Superior	Universidad de Málaga	355	776	0,099	0,795	150	1,000	0,100	28,232
Escuela Técnica Superior de Ingeniería Industrial	Universidad de Málaga	445	776	0,099	0,795	150	1,000	0,100	35,389
Facultad de Física	Universidad de Málaga	75	776	0,099	0,795	150	1,000	0,100	5,965
Escuela Técnica Superior de Ingeniería	Universidad de Huelva	350	776	0,099	0,795	84	0,560	0,275	76,662
Escuela Politécnica Superior de Córdoba	Universidad de Córdoba	310	776	0,099	0,795	122	0,813	0,154	37,891
Facultad de Ciencias	Universidad de Cádiz	55	776	0,099	0,795	96	0,640	0,229	10,020
Escuela Superior de Ingeniería	Universidad de Cádiz	270	776	0,099	0,795	95	0,633	0,233	49,951
Escuela Politécnica Superior	Universidad de Cádiz	265	776	0,099	0,795	150	1,000	0,100	21,075
		3390	**max.Price**			**dmax**			1076,974
			7800			150			

Table 7-F.1 UNIVERSIDAD DE SEVILLA C_J calculation

University	Sum	Sum/total adm.	Columna1	Cj
Universidad de Sevilla	788,652	0,732	0,536	
Universidad Loyola Andalucía	22,227	0,021	0,000	
Universidad de Málaga	69,586	0,065	0,004	**0,548**
Universidad de Huelva	28,232	0,026	0,001	
Universidad de Córdoba	37,891	0,035	0,001	
Universidad de Cádiz	81,046	0,075	0,006	

Table 7-F.2 UNIVERSIDAD DE SEVILLA C_J calculation

UNIVERSITAT POLITÉCNICA DE VALENCIA (**Escuela Técnica Superior de Ingenieros Industriales)**									
School	**University**	**Adm.**	**Price**	**Price/Max**	**f1 (d)**	**d**	**dmax**	**f2(c)**	**Pj*f1*f2**
Escuela Superior de Enseñanzas Técnicas	Ceu	60	7410	1,000	0,100	8	0,053	0,884	5,307
Escuela Politécnica Superior	Alicante	120	1431	0,193	0,641	76	0,507	0,311	23,955
Escuela Superior de Tecnología y Ciencias Experimentales	Castellon	400	1431	0,193	0,641	61	0,407	0,392	100,525
Escuela Politécnica Superior de Elche	Elche	250	1431	0,193	0,641	137	0,913	0,122	19,565
Escuela Técnica Superior de Ingeniería	Uv	110	1431	0,193	0,641	10	0,067	0,858	60,480
Centro Florida Universitaria	Upv	140	1431	0,193	0,641	11	0,073	0,845	75,801
Escuela Politécnica Superior de Alcoy	Upv	210	1431	0,193	0,641	88	0,587	0,259	34,869
Escuela Técnica Superior de Ingeniería del Diseño	Upv	535	1431	0,193	0,641	0,5	0,003	0,992	340,332
Escuela Técnica Superior de Ingenieros Industriales	Upv	510	1431	0,193	0,641	0	0,000	1,000	326,928
Escuela de Ingenieros Industriales	Uclm	245	1132	0,153	0,703	140	0,933	0,117	20,094
		2580	**max.Price**			**dmax**			1007,857
			7410			150			

Table 7-G.1 UNIVERSITAT POLITÉCNICA DE VALENCIA C_J calculation

University	Sum	Sum/total adm.	Columna1	Cj
Ceu	5,307	0,005	0,000	**0,611**
Alicante	23,955	0,024	0,001	
Castellon	100,525	0,100	0,010	
Elche	19,565	0,019	0,000	
Uv	60,480	0,060	0,004	
Upv	777,931	0,772	0,596	
Uclm	20,094	0,020	0,000	

Table 7-G.2 UNIVERSITAT POLITÉCNICA DE VALENCIA C_J calculation

7.2 A_j Calculation

ANDALUCIA

	SEVILLA			ALMERÍA			CÁDIZ			CORDOBA		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	1265	1	0,045	300	1	0,011	0	1	0,000	310	1	0,011
	0	0,9	0,000	0	0,9	0,000	325	0,9	0,010	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000
	350	0,5	0,006	0	0,5	0,000	265	0,5	0,005	0	0,5	0,000
	590	0,2	0,004	185	0,2	0,001	1265	0,2	0,009	1130	0,2	0,008
	27803	0,1	0,088	26893	0,1	0,095	27803	0,1	0,088	25938	0,1	0,092
	28288	4,05	**0,147**	28288	3,55	**0,110**	28288	4,05	**0,116**	28288	3,55	**0,116**

Table 7-H.1: Andalucía A_J calculation

	GRANADA			HUELVA			JAÉN			MÁLAGA		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	185	1	0,007	350	1	0,012	605	1	0,021	875	1	0,031
	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000	185	0,8	0,005	0	0,8	0,000
	605	0,5	0,011	1265	0,5	0,022	0	0,5	0,000	0	0,5	0,000
	1175	0,2	0,008	0	0,2	0,000	255	0,2	0,002	495	0,2	0,003
	25413	0,1	0,090	25763	0,1	0,091	24978	0,1	0,088	24978	0,1	0,088
	28288	3,55	**0,119**	28288	3,55	**0,129**	28288	4,05	**0,120**	28288	4,05	**0,126**

Table 7-H.2: Andalucía A_J calculation

ARAGÓN

	HUESCA			ZARAGOZA			TERUEL		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	0	1	0,000	775	1	0,027	33	1	0,001
	0	0,9	0,000	40	0,9	0,001	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000
	968	0,5	0,017	120	0,5	0,002	0	0,5	0,000
	0	0,2	0,000	748	0,2	0,005	2860	0,2	0,020
	26410	0,1	0,093	25695	0,1	0,091	24485	0,1	0,087
	28288	3,55	**0,112**	28288	3,55	**0,129**	28288	3,55	**0,110**

Table 7-I: Aragón A_J calculation

ASTURIAS

	OVIEDO		
Total adm.	Adm.	$C(d_{ji})$	Aj
28288	50	1	0,002
	635	0,9	0,020
	0	0,8	0,000
	0	0,5	0,000
	1040	0,2	0,007
	25653	0,1	0,091
	910	0,05	0,002
	28288	3,55	**0,122**

Table 7-J: Asturias A_J calculation

CANARIAS

	SANTA CRUZ DE TENERIFE			LAS PALMAS		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	225	1	0,008	625	1	0,022
	0	0,9	0,000	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000
	0	0,5	0,000	0	0,5	0,000
	0	0,2	0,000	0	0,2	0,000
	0	0,1	0,000	0	0,1	0,000
	28288	3,55	**0,058**	28288	3,55	**0,071**

Table 7-K: Canarias A_J calculation

CANTABRIA

	SANTANDER		
Total adm.	Adm.	$C(d_{ji})$	Aj
28288	340	1	0,012
	0	0,9	0,000
	0	0,8	0,000
	795	0,5	0,014
	1205	0,2	0,009
	25038	0,1	0,089
	28288	3,55	**0,125**

Table 7-L: Cantabria A_J calculation

CASTILLA – LA MANCHA

	ALBACETE			CUIDAD REAL			CUENCA			GUADALAJARA			TOLEDO		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	245	1	0,009	255	1	0,009	0	1	0,000	0	1	0,000	140	1	0,005
	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000	75	0,9	0,002	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000
	0	0,5	0,000	0	0,5	0,000	0	0,5	0,000	3264	0,5	0,058	3084	0,5	0,055
	1935	0,2	0,014	1055	0,2	0,007	3332	0,2	0,024	180	0,2	0,001	370	0,2	0,003
	25198	0,1	0,089	26068	0,1	0,092	24046	0,1	0,085	23859	0,1	0,084	23784	0,1	0,084
	28288	3,55	**0,113**	28288	3,55	**0,110**	28288	3,55	**0,110**	28288	3,55	**0,147**	28288	3,55	**0,148**

Table 7-M: Castilla – La Mancha A_J calculation

CASTILLA Y LEÓN

	ÁVILA			BURGOS			LEÓN			PALENCIA			SALAMANCA		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	adm.	coef	Ai	Adm.	$C(d_{ji})$	Aj
28288	40	1	0,001	200	1	0,007	700	1	0,025	0	1	0	190	1	0,007
	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000	0	0,9	0	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000	575	0,8	0,0162	0	0,8	0,000
	0	0,5	0,000	0	0,5	0,000	0	0,5	0,000	200	0,5	0,00354	70	0,5	0,001
	4134	0,2	0,029	1360	0,2	0,010	1530	0,2	0,011	1000	0,2	0,00707	615	0,2	0,004
	23204	0,1	0,082	25763	0,1	0,091	25148	0,1	0,089	25763	0,1	0,0911	26503	0,1	0,094
	28288	3,55	**0,114**	28288	4,05	**0,109**	28288	3,55	**0,126**	28288	4,05	**0,120**	28288	3,55	**0,108**

Table 7-N.1: Castilla y León A_J calculation

	SEGOVIA			SORIA			VALLADOLID			ZAMORA		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	0	1	0,000	0	1	0,000	575	1	0,020	70	1	0,002
	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000
	0	0,5	0,000	0	0,5	0,000	0	0,5	0,000	190	0,5	0,003
	4104	0,2	0,029	1730	0,2	0,012	4359	0,2	0,031	1315	0,2	0,009
	23274	0,1	0,082	25648	0,1	0,091	25763	0,1	0,091	25803	0,1	0,091
	28288	3,55	**0,113**	28288	3,55	**0,105**	28288	4,05	**0,144**	28288	3,55	**0,108**

Table 7-N.2: Castilla y León A_J calculation

CATALUNYA

	BARCELONA			GIRONA			LLEIDA			TARRAGONA		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	1705	1	0,060	340	1	0,012	120	1	0,004	290	1	0,010
	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000
	2380	0,8	0,067	0	0,8	0,000	0	0,8	0,000	700	0,8	0,020
	680	0,5	0,012	520	0,5	0,009	450	0,5	0,008	280	0,5	0,005
	750	0,2	0,005	4345	0,2	0,031	4605	0,2	0,033	3635	0,2	0,026
	21863	0,1	0,077	22173	0,1	0,078	22203	0,1	0,078	22473	0,1	0,079
	28288	3,55	**0,224**	28288	3,55	**0,132**	28288	3,55	**0,125**	28288	3,55	**0,142**

Table 7-O: Catalunya A_J calculation

COMUNIDAD DE MADRID

	MADRID		
Total adm.	Adm.	$C(d_{ji})$	Aj
28288	1954	1	0,069
	1130	0,9	0,036
	75	0,8	0,002
	140	0,5	0,002
	40	0,2	0,000
	24039	0,1	0,085
	28288	3,55	**0,196**

Table 7-P: Comunidad de Madrid A_J calculation

COMUNITAT VALENCIANA

	ALACANT			CASTELLÓ			VALÉNCIA		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	370	1	0,013	400	1	0,014	1565	1	0,055
	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000
	80	0,5	0,001	1565	0,5	0,028	400	0,5	0,007
	1950	0,2	0,014	323	0,2	0,002	413	0,2	0,003
	24978	0,1	0,088	25090	0,1	0,089	25000	0,1	0,088
	28288	3,55	**0,118**	28288	3,55	**0,134**	28288	3,55	**0,155**

Table 7-Q: Comunitat Valenciana A_J calculation

EUSKADI

	BILBAO (BIZKAIA)			VITORIA (ÁLAVA)			SAN SEBASTIAN (GUIPUZKOA)		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	795	1	0,028	320	1	0,011	899	1	0,032
	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000
	0	0,8	0,000	280	0,8	0,008	0	0,8	0,000
	1839	0,5	0,033	2409	0,5	0,043	1985	0,5	0,035
	915	0,2	0,006	540	0,2	0,004	125	0,2	0,001
	23829	0,1	0,084	23829	0,1	0,084	24369	0,1	0,086
	28288	3,55	**0,153**	28288	3,55	**0,151**	28288	3,55	**0,156**

Table 7-R: Euskadi A_J calculation

EXTREMADURA

	CACERES			BADAJOZ		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	0	1	0,000	380	1	0,013
	0	0,9	0,000	0	0,9	0,000
	0	0,8	0,000	0	0,8	0,000
	440	0,5	0,008	60	0,5	0,001
	0	0,2	0,000	0	0,2	0,000
	27848	0,1	0,098	27848	0,1	0,098
	28288	3,55	**0,106**	28288	3,55	**0,113**

Table 7-S: Extremadura A_J calculation

GALICIA

	A CORUÑA			LUGO			OURENSE			PONTEVEDRA		
Total adm.	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj	Adm.	$C(d_{ji})$	Aj
28288	110	1	0,004	0	1	0,000	0	1	0,000	0	1	0,000
	0	0,9	0,000	0	0,9	0,000	0	0,9	0,000	987	0,9	0,031
	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000	0	0,8	0,000
	240	0,5	0,004	110	0,5	0,002	0	0,5	0,000	240	0,5	0,004
	987	0,2	0,007	1227	0,2	0,009	1337	0,2	0,009	350	0,2	0,002
	26951	0,1	0,092	26951	0,1	0,092	26951	0,1	0,092	26951	0,1	0,091
	28288	3,55	**0,109**	28288	3,55	**0,104**	28288	3,55	**0,103**	28288	3,55	**0,131**

Table 7-:T Galicia A_J calculation

ILLES BALEARS

	PALMA DE MALLORCA		
Total adm.	Adm.	$C(d_{ji})$	Aj
28288	60	1	0,002
	0	0,9	0,000
	0	0,8	0,000
	0	0,5	0,000
	0	0,2	0,000
	28228	0,1	0,000
	28288	3,55	**0,052**

Table 7-U: Illes Balears A_J calculation

LA RIOJA

	LOGROÑO		
Total adm.	Adm.	$C(d_{ji})$	Aj
28288	125	1	0,004
	0	0,9	0,000
	0	0,8	0,000
	910	0,5	0,016
	1415	0,2	0,010
	25828	0,1	0,088
	28288	3,55	**0,120**

Table 7-V: La Rioja A_J calculation

MURCIA

MURCIA			
Total adm.	Adm.	C(d_{ji})	Aj
28288	80	1	0,003
	0	0,9	0,000
	385	0,8	0,011
	370	0,5	0,007
	0	0,2	0,000
	27453	0,1	0,094
	28288	3,55	**0,116**

Table 7-W: Murcia A_J calculation

NAVARRA

PAMPLONA			
Total adm.	Adm.	C(d_{ji})	Aj
28288	590	1	0,021
	0	0,9	0,000
	0	0,8	0,000
	1344	0,5	0,024
	2330	0,2	0,016
	24020	0,1	0,082
	28288	3,55	**0,144**

Table 7-Y: Navarra A_J calculation