Quality of life and urban size

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Abstract

Optimal City Size Theory has been superseded by new paradigms, such as the supply-oriented dynamic approach or the city network. Nevertheless, several aspects remain to be considered. First, the quality of life concept, which in many models enters into utility functions of households, can be addressed in a different way. We test the importance of city size in the growth of cities. We test it empirically in a local dynamic framework, the city of Barcelona (Spain), in the period 1991-2000.

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1. Introduction

According to the forecasts of the World Resources Institute (1994), nearly 50% of people live in cities and the figure is expected to rise in future decades. This happens because, generically speaking, people try to satisfy their needs, which can be better achieved by living in cities. Economic analysis has long studied the problem (von Thünen, 1826; Christaller, 1933; Losch, 1940), although until the work of Alonso (1964) we had no systematic micro-economic analysis.

In the classic approach, residence location is studied in a static framework, in which the structure of the city is linear and one single centre (the central business district) exists. In this model, urban size is defined as the equilibrium between production benefits and location costs. As location costs and benefits are, by definition, equal between cities, the consequence is that all cities have the same size.

Henderson (1985) pointed out that cities are not all the same and that they produce different goods according to their size, which generates externalities. Thus, large urban areas exist due to, in economic terms, the existence of externalities related to the higher productivity that agents could achieve by being near other producers or market agents.[i] The inhabitants of these large cities benefit from residing there. However, there are certain amenities that decrease as population increases: lower levels of environmental quality, increasing congestion, higher rental prices, and so on. Between benefits and costs one can work out an optimal or, at least efficient[ii], urban size.

Nevertheless, the increasing size of cities is in contrast with what ‘optimal city size’ theory says: an increase in physical dimension decreases the advantages of agglomeration. The consequence is that medium-sized towns are expected to increase their size, since the advantages associated with their physical size are still greater than location costs. Richardson (1972), sceptical of this, explained that determinants other than physical size affect urban agglomeration economies. This criticism was assumed by Capello and Camagni (2000), who tested the influence of physical size of cities along with other theoretical explanations:

- the neoclassical and Christallerian city, complemented by the supply-oriented dynamic approach (Camagni *et al.*, 1986), which included different functions for each city;
- and the network city paradigm (Camagni, 1993; Camagni and de Blasio, 1993), which helps explain why small and / or medium-sized cities may have higher-order functions.

Here we assume this framework, in which city size, and consequently its growth rate, has as determinants generic benefits and costs, the city function, and the possibilities of being connected to the network of cities.

A second aspect of this representation that needs to be mentioned has to do with the simplification of all forces involved, as in amenities-benefits and disamenities-costs. In our view, all inhabitants of a city have a general problem: maximization of their utility. In many studies (Giannias, Liargovas and Manolas, 1999; Clark, Kahn and Ofek, 1988), the concept of quality of life is included explicitly in the utility function. In this paper the theoretical framework to examine quality of life is based on Maslow's theory of human needs. This leads us to reformulate the way amenities and disamenities are considered in order to test city size effect.

Finally, we test all these questions in a consistent local framework. In this sense, we assume that city size is related to migrations, and that they happen more frequently within metropolitan areas than between them. Then, in a relatively short period of time, ten years, a narrower territorial scope is more appropriate. In addition, in our local framework, Spain, these local migrations are much more frequent than long-distance ones. Of course, we assume that the critical factors affecting these migrations are different from those affecting migrations between metropolitan areas. In any case, this point does not invalidate our procedure, but stimulates future studies of other territorial dimensions.

Another key point supporting our procedure is the existence of two contrary economic forces: relative and absolute advantages. The first, assumed in an international framework, is relevant when labour is not mobile and when changeable currency exchange rates exist. As, in a national framework, these points are assumed not to be pertinent, then absolute advantage is more important. Nevertheless, migrations between metropolitan areas are not something so usual in the

Spanish case, where several fiscal mechanisms at national level remove the absolute advantages of the regions. Consequently, absolute advantage is much more significant locally than regionally.

The aims of the present paper are:

- to consider the influence of several in the city size;
- to reformulate the usual way of looking at amenities and disamenities by looking at the concept of quality of life;
- to test our methods empirically in a local framework.

2. The relation between amenities and disamenities, and city size.

Generally speaking, urban size is the result of market forces, pushing towards the maximisation of utility levels for residents and profits for firms. Optimal city size is calculated as the result of the maximum difference between a location cost curve and the aggregate agglomeration advantage curve. Both utility and profits are affected through a wide and diverse set of conflicting amenities and disamenities. If the balance between them is positive or higher than in alternative locations, people will have powerful reasons for living in that place. However, if the balance is negative or lower than in other municipalities, people will have incentives to leave the location. This is the mechanism that drives cities to grow or decrease in size. The usual way of representing this problem is seen in diagrams 1 and 2.

[INSERT DIAGRAM 1]

[INSERT DIAGRAM 2]

Thus, optimal city size theory says that size affects the amount of amenities and disamenities, which, at the same time, influence again city size. Therefore, a two-way, contemporaneous relation exists. Finally, as Burnell and Galster (1992) ask, the question is "at what population may the disamenities of large size begin to outweigh the productivity advantages?" This is exactly what we want to measure, but the point is, how?

The usual way of posing the question is too simple. Thus, the classic picture of benefits, costs and city size represents on the vertical axis benefits and costs, while city size lies on the horizontal axis. This simple way of representing the relation between the variables of the problem is an example of the final representation of the test of optimal city size theory. Many studies address this question by regressing different measurements of benefits and costs against linear or more complex representations of city size[iii]:

$$\textit{Costs} = f(\textit{Size, Other factors}) \quad (1)$$

$$\textit{Benefits} = f(\textit{Size, Other factors}) \quad (2)$$

Of course, all models assume that, later on, the balance between benefits and costs influences city size:

$$\textit{Change of Size} = f(\textit{Benefits, Costs, Other factors}) \quad (3)$$

3. Amenities, disamenities and quality of life.

Though economic factors have important territorial consequences, non-economic ones also do. Many economically advanced industrial societies have increased dramatically the level of material well-being. This has led to post-materialist values, which have seen economic factors as a relative question that is part of a much more complex understanding of how people take decisions (Inglehart, 1990)[iv]. Thus, economic factors, such as the distance to the central business district, may be just one factor among several when a household is deciding its place of residence. At this point, to understand the definition of quality of life, the concept of human need needs to be introduced. Thus, human nature looks for continuous improvement, which means that a need already satisfied becomes the starting point for new needs. Then, new social needs have to be interpreted as a new way of satisfying our needs in a new environment. But then, are needs really everything that we express as needs?

Maslow (1975) sees five different kinds of needs, from objective to subjective: physiological needs, health and security, ownership and love, need to being loved, and self-fulfilment.

Following Maslow, once we have covered the more basic and objective needs, we are ready to try to cover more spiritual needs. Nevertheless, several authors have denied linearity in the needs classification of Maslow (Doyal and Gough, 1994); others have classified them in a Marxist dialectic (Heller, 1978); and others have developed their own classifications. Thus there is no consensus on the definition and nature of human needs. Our point here is that we can only evaluate overall needs when we intend to optimise these needs. Then, we can supersede the basic *objective* idea of welfare and move on to the more complex idea of quality of life.

Here we understand quality of life in the social sense, as defined in Liu (1978, p. 249): "The optimal level of quality of life is produced only by combining both the physical and psychological inputs (...). Therefore, the quality of life that each individual perceives is assumed to be directly dependent on his capability constraints to exchange and to acquire, while the major concern for a society is how to improve an individual's capability by shifting the constraint curve outward to the right". For our purposes, we will understand quality of life as the satisfaction that receives a household from his physic and human environments. We interpret then quality of life as social or human wellbeing, and we will assume it to influence and restrict human opportunities (Smith, 1977 y Mulligan et al, 2004). This definition influences the analysis scope that has to be local-urban, territorially speaking.

Quality of life is a multidimensional concept. According to Wish (1986), there may be many vectors to consider. We need to study all of them if we are to reach a full definition of quality of life. Here we assume that benefits and costs cannot be considered separately, but jointly in a composite quality of life measure, because benefits and costs considered apart are difficult to interpret in human need terms.

Another aspect to consider is: can we measure quality of life? Myers (1988) lists four approaches to quality of life analysis:

- the personal well-being approach which measures life-satisfaction of individuals;
- the community trend approach which focuses on quality of life components and trends within the community;

- the liveability comparisons approach which focuses on comparing different urban areas according to a number of objective indicators assumed to reflect quality of life; and
- the market/resident approach in which housing price and/or wage differentials are theorised to compensate for quality of life differences between urban areas.

The last two attempt to compare quality of life in urban areas directly through construction of quality of life indices and subsequent ranking of urban areas. Nevertheless, a critical question, posed in Burnell and Galster (1992), arises: if these measures suggest any pattern between quality of life and city size, "do they really reflect a meaningful relation between residents' quality of life and city size, or do they reflect inherent biases in the methodologies used to obtain the quality of life index values?" Here we will assume the objective indicators based approach, and we will use two different alternatives to reach the final composite measurement of quality of life.

4. City size and quality of life in Barcelona's metropolitan area

4.1. The local environment

The analysis focuses on the province of Barcelona, one of the four provinces of the region of Catalonia. Catalonia (NUTS II in the European administrative classification) is one of Spain's most developed regions, located in the north-east of the country. The region is divided into four administrative provinces (NUTS III in the European administrative classification). Barcelona is the most populated one, with 76% of the region’s inhabitants: 4,628,277 in 1996. Together with Madrid, it is Spain's most populated and urbanised province. It has 314 municipalities, organised in 11 administrative groups, called *comarques.* These municipalities are the basic unit of measurement in our study. Describing territorial groups is a very important part of the work; elsewhere, we used different territorial groups, defined as urban systems and urban subsystems (see Artís and Suriñach (dir.), 1999). These aggregations were developed following commuting and services areas criteria.

Thus, the local framework of our study is four territorial dimensions: the 11 *comarques*, 24 urban systems, 48 urban subsystems and 314 municipalities. The 24 urban systems and their subsystems (if the former can be partitioned), together with their size, are shown in Table 1.

Diagram 3 also shows the distribution of the population among urban subsystems, giving a Gini index of 0.54. This figure shows that a substantial part of the total population is concentrated in a small number of municipalities: the city of Barcelona had 33% of the total population of the province in 1996. There are also differences in terms of urban development. Some systems and subsystems are best described as urban areas or simply cities (near Barcelona), while others, further away from Barcelona, are rural areas. The province is similar to other areas in Europe, in which a large city has a relatively wide area of influence: its suburbs, its surrounding towns, industrial clusters, and so on.

[INSERT TABLE 1]

[INSERT DIAGRAM 3]

Despite the differences between systems or subsystems, they are much smaller than those between municipalities. In any case, the main characteristic of systems or subsystems is not their more homogeneous size, but that they clearly form separate areas on the basis of commuting and services criteria.[v]

4.2. The data

In Royuela, Suriñach and Reyes (2003), the quality of life of these 314 municipalities of Barcelona province was analysed. Here we assume this wide database[vi] and 17 basic quality of life components, listed in Table 2. These authors developed a weighted (*a priori*) arithmetic average index of partial indicators that express the relative standardised position of every individual (municipality, subsystem or system) after combining the variability of all variables, with a Paasche-type temporal aggregation. The final 17 indices were constructed after the use of a number of basic indicators, and allows for an intermediate structure of three indicators, related to the Individual Opportunities for Progress (IOP), to the Social Equilibrium (ISE), and to the Community Conditions of Life (CCL). This database referred to all years in the 1991-2000 period. In order to summarise the quality of life in a unique figure, we used two alternatives: the average index, named ISQV, weighted after explicit agreement between policymakers (the weights of the average index are displayed in table 1)[vii], and the principal component index, where of course there is no possibility of using arbitrary weights (we saved up to six components to collect more than the 60% of total variance).

The function that every city has was controlled by a dummy variable that is set at 1 for cities with a minimum amount of basic services, such as health and education services. Two different levels of ‘higher function’ cities were examined. Thus, from the initial 314 municipalities we chose 48 as basic functional cities and 24 as central cities. These dummies were considered as cumulative to give us a threshold effect.

Finally, the network city paradigm was approximated through an indicator of the telephone cells installed in 1996, as in Capello and Camagni (2000). We understand that, though nowadays this variable might not be appropriate, for the considered period it can be seen as a good indicator of the network paradigm. The descriptive statistics of all these variables are shown in Tables 3 and 4.

[INSERT TABLE 2]

[INSERT TABLE 3]

[INSERT TABLE 4]

Finally, we also considered the possibility of having spatial interactions. Thus, we computed the time that one person lasts in arriving by car: to the capital of the province, Barcelona; to the nearer central city, and to the closer functional city.

4.3. The estimation results

Table 5 displays the estimation results of equation (4). As we want to measure the change in size as a function of size, we considered the possibility of having endogeneity and consequently we used the two-stages least squared method, where as instrument of size in 1991 we used the size in 1900, clearly uncorrelated with the change in size between 1991 and 2000, but correlated with size in 1991.

[INSERT TABLE 5]

Columns (a) to (d) give separately the estimations of the change in size of the 314 municipalities of the Barcelona province between 1991 and 2000 against every key factor: city function (a), network city paradigm (b), quality of life (c, weighted index) and (d, principal components), and additionally we have also computed alone the city size effect, introduced up to the squared power in order to capture any optimal point. When that variable was included in the equation there could arise a problem of endogeneity. Thus, we used two stages least squares with the population of municipalities in 1900, which is related with contemporaneous city size but not with its growth. From these first columns we can see how all considered factors are statistically significant, also the city size as a whole, because given the high multicolineallity we can not use individual p-values. Interestingly we see how cities with higher functions in the system experience lower growth rates. All other parameters have the expected positive signs, while population shows a maximum, also as expected.

Next, in columns (e) and (f) all factors are considered together. The R^2 is much higher, and now more interestingly, we see that the more significant parameters are the ones related with the network paradigm and to quality of life in any of its possible expressions. Here, the two parameters of city size are jointly significant, and express an optimal point that is higher than when city size was considered alone into the regression. This is, if consider all other factors, quality of life and the network paradigm, bigger cities are more attractive to people to live.[viii]

Finally, in columns (g) and (f) we have included the variables that considers the distance of every municipality to the centre of the system (Barcelona) or to the nearer higher function cities. The parameters related to that variables show how being far away from Barcelona or from central cities influences negatively the growth rates. Now we also see how the parameters of the network paradigm and of quality of life have lower values than before, although they continue being statistically significant. Finally, the optimal value of city size that arises from the parameters is slightly higher than in the former case, and they are also more significant. We interpret that as a higher importance of the role of size.

Finally, the signs and values of the parameters of this equation lead to several conclusions:

- The cities with a relatively high function in the metropolitan system have a general relative loss of population, with lower growth rates;
- Cities with a higher level of connection in the metropolitan network increase their population;
- Quality of life is a key aspect to consider if we want to explain the growth of cities; and,
- City size has a polynomial relation with city size growth rates. We have also seen that when other factors are taken into account, the optimal size that arises from the estimates is higher and higher. We interpret that as a proof of the importance of the role of size.

5. Conclusions

In this paper we have examined the role of city size in the growth of cities. We have considered the classical theories joint with the supply-oriented dynamic approach and the city network paradigm. Additionally we have also considered the concept of quality of life in the utility function of households. All points have been empirically tested in a local dynamic framework, the city of Barcelona (Spain) in the period 1991-2000.

The basic result is that size matters, also when other factors are considered. Additionally we have seen the existence of a maximum size, after which cities decrease their growth rates. The other factors are also seen as important, and maybe the more significant one is the one related with the network paradigm.

Futures work has to be developed in order to consider explicitly the spatial distribution of cities. Additionally, we assume the possibility of extending the analysis to include different dimensions of quality of life. And finally, there has to be explored the influence of the aggregation of the spatial units into the estimations.

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Table 1. List of urban systems and subsystems within Barcelona province

Urban Systems (and their subsystems if they can be divided)	**Size (1996 inhabitants)**	**Number of municipalities**
System of l'Alt Penedès	**73,196**	**27**
Subsystem of Sant Sadurní	14,093	4
Subsystem of Vilafranca	59,103	23
System of l'Anoia	**86,964**	**33**
System of Bages	**152,586**	**35**
Subsystem of Manresa	122,895	27
Subsystem of Bages Nord	29,691	8
System of Baix Llobregat Nord	**123,778**	**12**
Subsystem of Esparraguera-Olesa	31,864	3
Subsystem of Martorell	73,582	8
Subsystem of Sant Andreu de la Barca	18,332	1
System of Baix Montseny	**22,792**	**9**
System of Barcelona	**1,508,805**	**1**
System of Berguedà	**38,606**	**31**
System of Besòs	**413,106**	**8**
Subsystem of Badalona	231,514	4
Subsystem of Sant Adrià del Besòs	33,361	1
Subsystem of Masnou	25,056	2
Subsystem of Santa Coloma de Gramenet	123,175	1
System of Cerdanyola, Montcada and Ripollet	**106,474**	**3**
Subsystem of Cerdanyola	50,503	1
Subsystem of Montcada i Reixac	27,068	1
Subsystem of Ripollet	28,903	1
System of Cornellà	**82,490**	**1**
System of Delta del Llobregat	**135,310**	**5**
Subsystem of Gavà	41,090	2
Subsystem of Castelldefels	38,509	1
Subsystem of Viladecans	55,711	2
System of Garraf	**90,435**	**6**
System of Granollers	**173,168**	**23**
Subsystem of Pla de Granollers	159,659	19
Subsystem of Congost	13,509	4
System of Maresme Nord	**59,537**	**7**
Subsystem of la Riera de Calella	33,843	4
Subsystem of la Tordera	25,694	3
System of Maresme Sud	**213,771**	**18**
Subsystem of la Riera d'Arenys	28,799	5
Subsystem of Mataró	145,570	10
Subsystem of la Riera de Premià	39,402	3
System of Mollet-Parets	**70,331**	**10**
System of Osona	**122,923**	**51**
Subsystem of Osona Nord	19,422	9

Subsystem of Vic	78,299	36
Subsystem of Manlleu	25,202	6
System of El Prat de Llobregat	**63,255**	**1**
System of la Riera de Caldes	**29,193**	**7**
System of Rubí - Sant Cugat	**101,295**	**2**
Subsystem of Rubí	54,085	1
Subsystem of Sant Cugat	47,210	1
System of Sabadell	**283,954**	**10**
Subsystem of Barberà del Vallès	42,542	2
Subsystem of Sabadell	223,530	6
Subsystem of Castellar	17,822	2
System of Sant Boi	**84,477**	**3**
System of Terrassa	**177,824**	**6**
System of la Vall Baixa de Llobregat	**415,430**	**9**
Subsystem of Esplugues and Sant Just	60,116	2
Subsystem of Sant Feliu de Llobregat	35,797	1
Subsystem of l'Hospitalet	255,050	1
Subsystem of Molins	37,662	4
Subsystem of Sant Joan Despí	26,805	1

Table 2. Quality of Life Components and their variables

COMPOSITE QUALITY OF LIFE INDEX (CQLI)

CQLI = 1/3 IOP + 1/3 ISE + 1/3 CCL

IOP = Individual Opportunities for Progress

IOP = 0.30 WI + 0.25 LI + 0.175 ELI + 0.175 MotI + 0.10 DI

WI= Wealth Index

+ *per capita* available family wealth
+ Average tax return per taxpayer
+ Average tax paid per taxpayer
+ *per capita* value added
+ Value added growth in last five years

LI= Labour Index

+ Labour activity rate
+ Rate of unemployment
+ Gini Index of economic activity concentration
  - GI of workers (15 sectors)
  - GI of social security payers (10 sectors)
+ Labour formation index
  + Number of classes
  + Number of students

ELI= Educational Level Index

+ Average of studied years per person

MotI = Motorization Index

+ Number of vehicles per 1,000 inhabitants

DI = Demographic Index

- Mortality rate
+ Birth rate

+ Average age level index
  - Average age level in the municipality
  - Average age level in the *comarca*

ISE = Index of Social Equilibrium

ISE = 0.2 HAI + 0.2 SII + 0.2 OCI + 0.2 CongI + 0.2 SOASI

HAI= Housing Access Index

+ Rate of hiring housing
+ Last year finished houses per 1,000 inhabitants
+ Rate of new subsidised houses
- House price index in the largest city in the system

MigrI= Migration Index

+ Rate of immigration in the municipality
+ Rate of immigration in the *comarca*
+ Population growth of the municipality

SII= Sex Inequality Index

+ Sex inequality in education levels
+ Sex inequality in education labour activity

OCI= Obligatory Commuting Index

+ Outside commuting index
+ 1 - rate of workers who commute to the Barcelona urban area
+ 1 - rate of students who commute to the Barcelona urban area
+ Distance from the nearest capital (as centre of services)

CongI= Congestion Index

- Automobile density

SOASI= Social and Old Age Services Index

+ Number of old age residences over 1,000 old age inhabitants
+ Number of old age cultural houses over 1,000 old age inhabitants
+ Number of old age open-day residences over 1,000 old age inhabitants

CCL = Community Conditions of Life

CCL = 0.15 HC + 0.065 PTI + 0.21 EFI + 0.21 HFI + 0.15 CEI + 0.15 CFMMI + 0.065 MFSI

HC= Housing Characteristics

+ Index of housing conditions
+ Houses size per inhabitant
+ Rate of one-family houses
+ Housing services index (water, phone, etc.)

PTI= Public Transport Index

- 1-Rate of public transport users among workers
- 1-Rate of public transport users among students
+ Train services
+ Number of urban buses per potential users

EFI= Educational Facilities Index

+ Educational services index
  + Basic school units
  + Primary school units
  + High school units

+ Special education units
+ Students per school unit index
  - Basic school
  - Primary school
  - High school
+ University Index
  + University courses per 10,000 inhabitants between 19 and 24
  + University's diversity of supply

HFI= Health Facilities Index

+ Pharmacies per 1,000 inhabitants
+ Hospitals per 1,000 inhabitants
+ Hospital beds per 1,000 inhabitants
+ Outpatients' health centres
+ Number of workers in the health sector per 1,000 inhabitants

CEI= Climate and Environment Index

Environment index
+ Air quality index in Catalonia

Climate index
- Yearly temperature range
+ Average temperature

CFMMI= Cultural Facilities and Municipal Media Index

Cultural facilities index
+ Theatres and theatre diversity
+ Museums and museum diversity
+ Bookshops and bookshop diversity
+ Municipal archives and municipal archive diversity
+ Cinemas and cinema diversity
+ Art galleries
+ Sport centres and sport centre diversity

Municipal Media index
+ Written media
+ TV and radio
+ Municipal bulletins

MFSI= Municipal Financial State Index

- Debt: payable passive /total active
- Taxes over total revenues
- Taxes *per capita*

Source: Royuela, Suriñach and Reyes (2003)

Table 3. Descriptive statistics (1).

	Min	*Max*	*Average*	*Median*	*Std Dev*	*Kurtosis*	*Skewness*
POP	28	1643542	14828	1769	96284.46	263.91	15.70
Growth rate (1991-2000)	-54.1%	228.9%	0	0	0.35	7.34	2.20
FUNSUB	0	1	0.153	0	0.36	1.77	1.94
FUNSIS	0	1	0.076	0	0.27	8.32	3.20
TELXHAB	125	1095.2	439.8	414.7	121.04	5.32	1.71
CQLI	76.34	117.31	100.29	100.90	6.02	1.29	-0.71
IOP	65.62	136.57	95.50	94.70	11.70	0.28	0.44
ISE	74.79	146.63	107.10	107.00	8.73	1.81	0.15
CCL	63.84	175.25	92.88	87.80	17.63	2.61	1.56
Dist_BCN	0.00	139.15	49.03	46.69	22.29	0.80	0.79
Dist_Sis	0.00	68.45	18.05	16.00	10.56	1.31	0.75
Dist_Sub	0.00	68.45	15.76	14.33	10.98	1.02	0.67

Note: FUNSIS: dummy variable for the 24 central cities of the province. FUNSUB: dummy variable for the 48 functional cities; TELXHAB: installed telephone cells; POP: population of every municipality; CQLI Composite Quality of Life Index; IOP: Individual Opportunities of Progress; ISE: Index of Social Equilibrium; CCL: Community Conditions of Life. Dist_ means the distance measured in minutes from one city to Barcelona o to the nearer city that can be considered as a head of a System or Subsystem.

Table 4. Descriptive Statistics (2). Correlations .

	POP	**Growth rate (1991-2000)**	**FUNSUB**	**FUNSIS**	**TELXHAB**	**CQLI**	**IOP**	**ISE**	**CCL**	**Dist_BCN**	**Dist_Sis**
Growth rate (1991-2000)	-0,092										
FUNSUB	0,299	-0,160									
FUNSIS	0,369	-0,150	0,677								
TELHAB	0,045	0,545	-0,061	-0,017							
CQLI	-0,008	0,315	-0,068	-0,039	0,172						
IOP	0,059	0,445	0,069	0,038	0,359	0,623					
ISE	-0,137	0,290	-0,039	-0,020	0,070	0,719	0,171				
CCL	0,064	-0,269	-0,196	-0,115	-0,193	0,381	-0,221	0,057			
Dist_BCN	-0,213	-0,247	-0,370	-0,235	-0,196	-0,344	-0,576	-0,147	0,235		
Dist_Sis	-0,207	-0,101	-0,481	-0,493	-0,018	-0,320	-0,333	-0,228	0,060	0,751	
Dist_Sub	-0,193	-0,055	-0,611	-0,414	0,011	-0,321	-0,336	-0,224	0,059	0,772	0,923

See foot note from Table 3.

Table 5. Estimation results of equation (4)

	(a)	(b)	(d)	(c)	(d)	(e)	(f)	(g)	(h)
Intercept	0.252245	-4.122	0.284436	-7.985	0.227	-11.123	-3.457	-6.308	-2.017
	0.0000	*0.0000*	*0.3204*	*0.0000*	*0.000*	*0.0000*	*0.000*	*0.0002*	*0.002*
FUNSIS	-0.1014					-0.0352	-0.02152	-0.30656	-0.433
	0.0055					*0.4860*	*0.8315*	*0.1028*	*0.1112*
FUNSUB	-0.10613					0.177310	0.08926	0.448758	0.328929
	0.0062					*0.0010*	*0.3504*	*0.0315*	*0.2222*
LTELXHAB		0.719207				0.645588	0.588387	0.515782	0.518698
		0.0000				*0.0000*	*0.000*	*0.0000*	*0.000*
Log(CQLI)				1.783		1.680		0.988521	
				0.0000		*0.0000*		*0.0063*	
Log(1st_Factor)					0.135		0.095		0.060
					0.0000		*0.000*		*0.003*
Log(POP)			0.028794			-0.00531	0.089102	0.185634	0.162475
			0.6686			*0.9246*	*0.3486*	*0.1216*	*0.2043*
Log(POP^2)			-0.00454			-0.00459	-0.00926	-0.0203	-0.01714
			0.2347			*0.1241*	*0.172*	*0.0180*	*0.0721*
log(D_BCN)								-0.31517	-0.21308
								0.0000	*0.0191*
log(D_Sis)								-0.16645	-0.20002
								0.0132	*0.0342*
log(D_Sub)								0.120222	0.100108
								0.1037	*0.3078*
R^2	0.028824	0.272318	0.009007	0.097184	0.142	0.307709	0.351	0.355643	0.379
adj R^2	0.022579	0.269985	0.002634	0.094290	0.139	0.294179	0.339	0.336567	0.360
F-Stat	4.62	116.76	5.20	33.59	51.62	27.13	27.70	20.36	20.59
(sig)	0.010588	0.000000	0.006026	0.000000	0.0000	0.000000	0.000	0.000000	0.000
Method	OLS	OLS	TS-LS	OLS	OLS	TS-LS	TS-LS	TS-LS	TS-LS
Instrument			Pop 1900			Pop 1900	Pop 1900	Pop 1900	Pop 1900

Note: P-values of the t-statistics appears in cursive. N=314 municipalities.
The dependent variable is change rate of population between 1991 and 2000. Variables are in logs, except the dummies. For the names of the variables, see notes to Table 3. ^2: is the squared power of the log of population.

Diagram 1. The optimal city size theory.

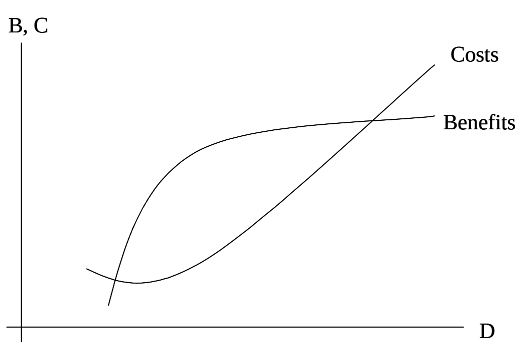


Diagram 2. Neoclassical supply-oriented dynamic approach

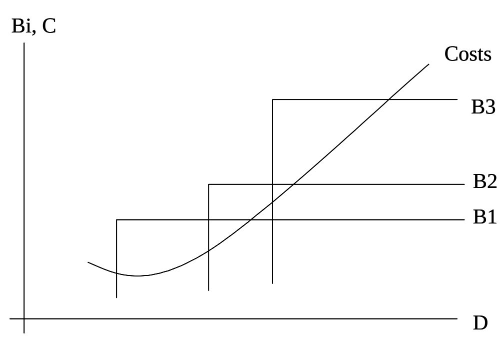
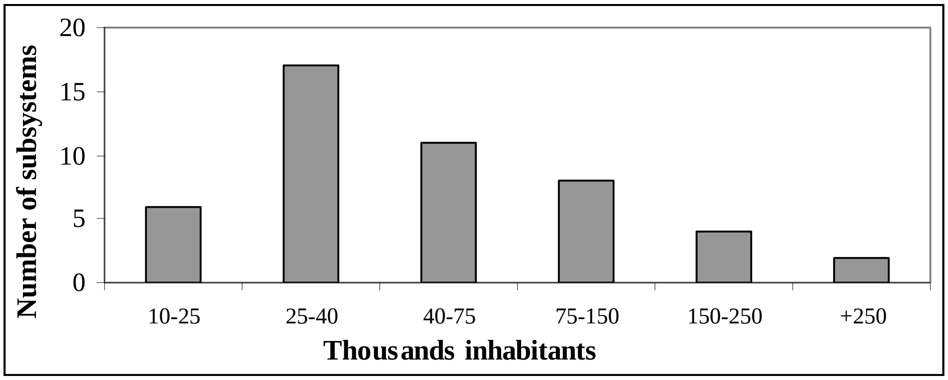


Diagram 3. Population distribution between subsystems



1. Notes

[i] These increasing returns to scale at the aggregate level can arise from constant returns to scale at the micro level. See, for instance, Duranton and Puga (2004).

[ii] See Becker and Henderson (2000) for a example where competition amongst land developers will produce cities of efficient size, usually larger than the optimal size.

[iii] See Capello and Camagni ( ) or Royuela and Suriñach (2005)

[iv] The social materialist vision of reality that predominates is the instrumental character of economic activities that allows people earning resources that are used in other activities giving satisfaction. The post-materialist vision, however, argues that in societies characterised by abundance resources are not infinite, but they are sufficient, such that choices are made in terms of opportunity costs. Thus, even a job can be valued highly, apart from the earnings it produces.

[v] Each system or subsystem has basic health or educational services that are not shared with other systems or subsystems. So general services such as Universities and large hospitals are not considered as defining features of urban systems or subsystems.

[vi] We used more than 500 basic variables, related to all 314 municipalities and mostly referring to different periods of time (1991-2000). These figures indicate the size of the data base.

[vii] As in Drewnowski (1974)

[viii] We have to admit that the high level of multicolineality makes these parameters difficult to interpret, and then, to infer a optimal value of city size.