

EUROPEAN SMART CITIES: THE CASE OF MADRID (SPAIN)

José M. Mella-Marquez

Asunción López-López

Victor Mella-Lopez

Autonomous University of Madrid

Madrid, March 2014

1. Introduction

The growth capacity of cities not only depends on the endowment of physical capital, but also on information and communication infrastructures and, above all, on the availability and quality of human capital. In this context of supply of production factors, has been recently introduced the concept of "smart cities" as a development strategy, based on the priority of the projects related to the information and communication technologies (ICT) to increase the competitiveness of cities. However, an approach that conceives the city as a social space that is inclusive and cohesive, must take into account also aspects relating to changes in the labor market and the distribution of income.

The discussions on the future of cities in the Western countries have been in recent years heavily influenced by the subject of the "smart cities" (SC) (Nick, 2012), which has appeared with some intellectual confusion. The confusion has arisen around relations between ICT, knowledge and creative industries (arts, media, and culture), entrepreneurial city, innovative city, society and knowledge economy.

It happens, in addition, that the brand SC is part of the political and electoral agenda of current cities, trying to respond under its name to their multiple economic, social, technological, political and environmental problems. Even the SC are conceived artificially as artifacts built as completely new cities, whose birth is a product formulated by Governments and telecommunications companies (applies to new Songdo in South Korea and many other cities in China, India, countries Arabs and America). Product made up by technology, equipment with chips and "routers", digital infrastructure, public services enabled by internet from the control room of private companies that have the appropriate "software" and that they become "captive markets" of them. Or the offer of the brand SC is presented as an opportunity for Councils to improve services in a context of urban sustainability.

As a first objective, it is relevant to clarify and make operating the concept of SC to try to understand what are the factors that determine the capacity for growth of smart cities. This will be the objective or main purpose of this article. And, to some extent, we suggest some recommendations on urban strategies of empowerment of the CI.

Then it will be exposed the concept of SC (heading 2), the source and the method of analysis used (heading 3), the analysis of the data (heading 4) and the article closes with some conclusions.

2. Operating concept of SC

The concept of SC is a digital (smart) combination of facilities and activities in urban spaces of citizens aware of their rights, independent in their decisions and actors of a responsible citizenship based on the domain of public space on the private.

It is not, therefore, a concept of technical or engineering use, as conventional thinking claims, but socio-political and cultural nature. This is based on the concept that (intelligent) citizens are aware of their collective and participatory processes of decision of the city. And their interests are represented by institutions that govern the urban space in a rigorously democratic way. The concept of SC involves the interaction between the concepts of human capital, social capital, ICT infrastructures, urban sustainability and participatory government.

The concept of SC (adopted here) implies the subordination of economic and technological aspects to the social, political and cultural; so that the progress of the city in a perspective of SC is a social and cultural change, new local governance and a commitment to all social and political agents in a new strategy of "City".

The fundamental vectors of the SCI are the efficiency in the provision of services for the achievement of a better quality of life, the promotion of economic activities socially sustainable, the social cohesion of the development process of the city based on the equitable distribution of income and the provision of public goods, and the existence of a creative and innovative culture.

It is obvious that the SC is an economic, social, ecological, political and cultural phenomenon of great complexity. And it is the result of the interaction between the economy, mobility, environment, citizenship, smart styles of life and governance. It is appropriate to make it clear that the optimum of SC is one that operates in all the mentioned senses. So it is expected that partial or incorrect approaches derived from a lack of full understanding of the concept can generate adverse feedback or problematic and even negative effects on the city and its surroundings of influence.

In this article, we will try to make operational the concept of SC through the relationships between the different aspects of the aforementioned concept and the GDP measured in purchasing power parities.

3. Source and methodology

3.1. Source

The source used is "Urban Audit 2009" of Eurostat, which provides data of European cities in the EU-27 for several years, although here it is used the most recent and latest available corresponding to the year 2009.

The variables used are which reflect different aspects that characterize to a smart city (Caragliu, Bo and Nijkamp, 2009):

- The gross domestic product per capita in purchasing power parity as the variable representative of the level of economic development of a SC. It properly quantifies urban disparities in price levels and reflects accurately the real purchasing power of the economic agents.
- The 'creative classes', i.e. the population occupied in creative and super-creative industries (Florida, 2009) (percentage of employment in cultural activities and entertainment industry).
- Human Capital, which is important not only for its effect on urban growth, but also by the indirect effect on the city which can accelerate the process of attraction of the "creative class" (proportion of the active population by different levels of qualification).
- Urban accessibility, reflecting not only the ease with which you can access a city, but also the potential market available to and from the city (multimodal accessibility index).
- Public transport, since a dense transport network can reverse the negative effects of urban density, at least in part (length of public transport network / surface).
- The penetration of the information society, by its effect on economic efficiency and the urban, social and cultural development (percentage of households with internet access).

In addition, in this article will also proceed to analyze business activities through the presence of headquarters (proportion of headquarters about the number of companies) and the number of enterprises. They will also examine the indicators of social cohesion and of the income distribution (rate of unemployment, relationship between the first and fourth quintile of income, percentage of households with income of less than 60% of the median national income, percentage of households with income below 50% of the average national income, percentage of homes-or dependent people of the social security assistance. And, finally, you will approach the

quality of the environment (the number of days in which particles PM10 concentrations exceed 50 micrograms per m³, concentration of accumulated ozone exceeding the 70 micrograms per m³, annual average concentration of NO₂).

3.2. Method

The method of data analysis is the partial correlation between variables. The procedure of partial correlation allows us to study the linear relationship between two variables with the effect of a set of controlling random variables removed. . A partial correlation coefficient is a technique of statistical control which expresses the degree of linear relationship between two variables after deleting both effects attributable to third variables.

4. Data analysis

4.1 infrastructures

In a SC, the "use of a networked infrastructure is to improve economic and political efficiency to promote the social, cultural and urban development" (Hollands, 2008). This feature is associated with indicators of infrastructure networks basically linked to ICT (mobile phones, internet networks).

One of the indicators available in the Urban Audit database to verify the integration of new technologies in the development of cities is the percentage of households with internet access. In fact, it can be easily checked that there is a strong and positive relationship between the development of the cities in terms of GDP pc in purchase power and the percentage of households with access to the internet (Figure 1). You can see that, compared with other cities, Madrid, given its level of GDP pc, shows a percentage of households with internet access relatively lesser. In other words, the city can intensify the use of these technologies and achieve to increase-via investment in ICT - still more their levels of GDP pc.

4.2. Business activity

Number of companies

The creation of an enabling environment for entrepreneurship and entrepreneurship capacity are factors of the dynamism of a thriving economy that is linked to the concept of SC. The emphasis on urban development oriented to companies ("business-friendly") is considered to be relevant. Although, in that article of Caragliu, Bo and Nijkamp are not mentioned examples of this type of indicators or in the *Urban Audit* database is none corresponding exactly to the traits of an entrepreneurial city. However, approximate variables are used (number of businesses and headquarters) that can give an account of the business activity of European cities.

It is known that high levels of entrepreneurship are closely correlated with economic growth. Indeed, in general for European cities seen in *Urban Audit* (Figure 2) there is a positive correlation between the number of enterprises and the GDP per capita, and in the case of Madrid, it should be noted that the relationship is not only positive but also you can see that the city have a business capacity which would be up for its level of GDP per capita in the European urban landscape. However, the efficiency of the Madrid companies is insufficient, given that - by the number of companies-GDP pc could be higher, so there is still room to improve either the company size or their productivity or even both things at the same time.

Headquarters

It is known by recent studies (Rosenthal and Strange, 2004) that central, local and regional Governments understand that the location of headquarters has positive external effects in terms of attraction not only of more services to companies and other offices, but also through stimulation of aggregate demand and production of the cities.

In the case of Madrid, there is also an evident effect of polarization of headquarters in the city. It confirms the hypothesis that the geography of the headquarters is more concentrated than the economic activity, and it can observe that in the European context the city of Madrid presents a number of headquarters considerably greater in comparison with its GDP per capita (Figure 3). While the productivity of Madrid headquarters are indeed high, it can still be improved compared to those of the rest of Europe.

4.3. Transport

Multimodal accessibility

Case studies (Ortiz and Garnica, 2008) conclude that the greater spatial accessibility allows to raise the operational efficiency of the urban structure and socio-economic processes implicit in it, to facilitate the mobility of people, goods and services, creating more and better options for employment, housing and access to services; that is, more accessible urban spaces allow to reduce inequality of opportunities, to increase employment and to increase the production capacity of the cities.

The case of the city of Madrid presents a multimodal accessibility lesser than it should be by its level of GDP (Figure 4). This is, comparatively with other European cities, Madrid should have still greater multimodal accessibility.

Public transport

These advantages of efficiency of multimodal accessibility highlight also the evidence that public transport has a positive impact on output per capita of cities. The city of

Madrid-thanks to the efforts made in this area - displays a density of the public transport network greater than that would be up by its level of production (Figure 5); Although, there is no doubt in light of the data, that the level of efficiency in terms of GDP pc has still clearly room for improvement.

This last finding is relevant. Because it has been proven that a good service of public transport in a city is essential, because the same users can use it at a relatively low marginal cost. As the areas are urbanizing increasingly (become more dense, with different land uses, expensive parking areas), the variety of modes of transport increases and, above all, the trips on foot, bicycle and public transport. In fact, when the quality of the public service is good, trips at peak times increase of 10-20% and 20-60% in the central districts of cities (Weyrich and Lind, 2001).

4.4. Employment and human capital

City and innovation

Cities with high densities of creative individuals promote and make more frequent interactions face-to-face, facilitating creative externalities and the generation of innovations. This finding reinforces the idea that proximity between individuals with a high level of human capital is important to understand the location of innovative processes in cities.

The human capital--measured by the number of creative jobs (scientists and engineers) - turns out to be a key factor between the spatial determinants of innovation; together with investment in R & D and the existence of an urban environment of tolerance towards minorities, gays and the presence of "Bohemian" professions (artists, musicians, writers, poets, and others).

In conclusion, it should be noted that the "creative density" - i.e., the density of the "creative class"^[1] or the number of creative employment - positively affects the activity of generation of patents, in such a way that there is a relationship which strengthens creativity, density and the innovation in the 240 United States metro areas analyzed in the study end of quote.

The empirical evidence drawn from *Urban Audit* agrees with the findings of the economic literature. On one side, there is a clear positive relationship between cities with largest GDP per capita (and, when the occupancy rate is equal, work productivity is higher) and the number of greater qualification employment (levels 5 and 6)^[2] (Figure 6), and, secondly, the relationship between per capita GDP and the number of a relatively minor qualification employment (levels 3 and 4)^[3] (Figure 7) shows a positive relationship to a certain threshold of the urban per capita GDP. Threshold from which these workers have fewer opportunities of employment in the cities of greater GDP per capita, or that is to say, to increase the productive capacity of these

cities these levels of qualifications are not already required in the same proportion. In addition, the previous correlations are also consistent with the empirical evidence of which it can be deduced that there is also a correlation between GDP per capita and the density of urban employment (employment per unit of area) (Figure 8).

The city of Madrid shows a specific profile in each of these relationships. First, it has a percentage of active population with levels of education higher than that would be up by its GDP per capita, which means that the city does not take efficiently advantage of top-level human resources and that there is scope for performance improvements. Second, the city of Madrid shows, on the contrary, a percentage of the active population with intermediate studies (Vocational training and others) which makes a relatively efficient use and does not need to increase the relative weight of them to achieve higher levels of GDP per capita. And third, the density of employment is at the level that is expected - within the framework of European cities - by its GDP pc.

In conclusion, the development of Madrid-with the increase in the occupational density, which will accompany the growth of its productive capacity--will require investment in human capital that prioritizes University or higher levels of the education system; that is, all those assets linked to high level human capital and science and technology, research and development, knowledge and innovation.

Culture and creation

Research (Scott, 2006), that have caused recent debates in our country (see Manito, 2012), shows that the cultural activities tend to concentrate in the cities where play an important role in economic development, because of the great benefits that creative companies experience of the urban location, transforming the agglomeration into a "creative field". Florida (2002) argued that this spatial concentration - at least for workers of the cultural sectors and entertainment - is the result of the "amenities" (tolerance, ethnic diversity and cultural activities) that attract the "creative" workers to live in some cities than in others.

The high correlation between the creative sector and the percentage of GDP per capita (Figure 9) is the result-according to this theoretical approach- that, without experience and interaction in this type of activity, is very difficult to raise the level of income. This happens for two reasons. First, the low levels of income discourage the potential workers in the sector. And second, in these economic sectors operate an mechanism of cumulative reinforcement of growth whereby the greater the number of workers and the same density in a city, there will be a self-sustaining attraction of new creative workers who, after locating the creative "cluster", make it increasingly attractive for the future entrepreneurs.

Sport and leisure

The relationship between sports activities and leisure and the level of GDP per capita and its growth has earned some attention, at the level of cities, in recent times. Empirical evidence of the association between GDP per capita and the proportion of surface dedicated to the use of recreational sports and leisure (Figure 10) shows a positive relationship, so cities with greater economic weight also have larger endowments of sport infrastructures and leisure. The economic importance of sports infrastructures and leisure, together with activities linked to them, is considerable and rises - according to studies (Dimitrov et al., 2006^[4])-4.1% of GDP in a developed city, about twice what it had previously estimated nationwide, due to methodological reasons^[5]. The logic of this relationship is easily understandable, if one takes into account that the sport is seen increasingly as an important dimension of cultural regeneration of cities and urban promotion programs. Sport is part of the agendas of cultural programming, strategies of urban marketing, tourist attraction or foreign investment policies, and certainly it is a basic service and a relevant social benefit for the benefit of the well-being and health of citizens, which finally has the corresponding favorable effects on the level of urban production and income.

4.5. Urban morphology

The growing process of European urbanization should be viewed as a positive phenomenon, as high population densities are an important prerequisite for developing many of the SC sustainable solutions. High densities made possible public transportation. And on the contrary, families who live in individual homes create difficulties to public transportation. Urban density and morphology of the cities include complex systems that affect functionality, economy and their sustainability.

European compact cities have smaller ecological footprints than scattered cities and GDP per capita higher. The available evidence (Atkin, 2001) suggests that urban density has a significant impact on GDP per capita. Although it is difficult to make international comparisons among cities with similar sizes because of differences in economic development between countries, it can be argued that the more dense cities tend to have social networks highly developed, higher levels of development in the field of knowledge and an enhanced learning and innovation capacity.

If the long-term the urban density trend to decline continues, real estate and cities operating costs would rise considerably. Consequently, the stabilization of urban density and the reduction of the ecological footprint of cities become objectives of a sustainable urban development. Cities need to create opportunities to achieve economies of scale and scope, ensure more efficient use of limited resources and promote the creation of new capital to sustain future generations.

European empirical evidence (Figure 11) confirms what is asserting and, in particular, the comparative position of Madrid makes clear two facts of special interest. One exhibits a relatively strong economic efficiency (i.e. a GDP pc above which would be up by its level of density). Two, the city could further increase the density given its GDP pc in accordance with the urban development of European guidelines, counteract the effects of increased urban diffusion process experienced in recent times, compact interstitial suburban areas and raise its production capacity with new productivity gains.

4.6 Competitiveness and social cohesion

Unemployment and income distribution

After the emphasis on the accumulation of human capital, technological development, the attraction of talents and the productive entrepreneurship, is usually ignored the problem of increasing social polarization in our cities, as it had already demonstrated years ago (Harvey, 2000). Rather than raise the level of life of citizens, increased investment in ICT has not allowed controlling the increase of urban social inequalities. In reality, the attraction of highly qualified professionals and skilled workers in ICT (part of the "creative class" of Florida, 2002) may result in the "gentrification" of whole areas of cities. And the provisions of leisure and entertainment facilities result in the exclusion of traditional neighborhood communities and low-income residents. At the time, it is underestimated that smart cities require low-skilled labor to meet the needs of practitioners and ICT workers, so that they contribute to consolidate inequality and the duality of urban labor markets.

Accordingly, while the usual speech on the concept of SC is to emphasize the creation of prosperous cities in which every citizen has access to ICTs, education and technology, is relevant to try to check if this is really so, or conversely, if the own SC is or may be contributing to the cities of two-speed or the dualization of the city. To check this assumption can help establish strategies and priorities for action based on the SC. Because it is clear, the implementation of a strategy of entrepreneurial city, which is a nuanced version of SC, does not exclude the possibility of other progressive models of urban development.

Firstly, the progressive SC is based on the priorities of the citizens rather than to think that ICTs themselves can automatically transform and improve cities. The key point is to wonder about the role of ICTs in how people and citizens interact with each other, how they are educated, how they participate and they are involved in the political and social debate of the city over matters that affect their own lives and their environment. Technology is never neutral and can be used for different functions and has the ability to be socially used for different purposes: to incorporate the citizens to the social and political life or to marginalize them and use them as a simple commodity.

Secondly, the progressive SC needs to create a real change in the balance of power between ICT used by businesses, Government and citizens, seeking at the same time a sustainable economic growth. The emphasis of the SC is above all in the economic growth and competitiveness; but at the same time it can / should be an opportunity to reaffirm the participation and the ability to influence local decision-making in governance processes. In a word, the progressive SC should strengthen the democratic debate on the type of city in which citizens want to live.

Thirdly, it is essential to avoid the mistake of thinking that the SC are based on the entrepreneurship, the incorporation of ICT of last generation and highly qualified professionals, forgetting that the rest of workers are a social and cultural resource of first order, which may include all alternative political groups and environmentalists, "squatters", components of the third sector and members of urban movements and cooperative associations. They are perceived as sectors annoying for the city, when in reality they are making city and contributing with their creativity to its development.

Ultimately, a progressive SC is one that not only adopts the name or brand of such. It is much more than the incorporation of sophisticated ICT, the creation of Web auto-promotional, the existence of equipment and offices or intelligent homes, shopping centers and luxury hotels. SC incorporates all citizens to participate in the benefits of the city, fighting all types of inequality and social exclusion.

The data analysis on SC shows that greater productive capacity (and more competitiveness) is also accompanied by a greater capacity of employment expressed by a lower rate of unemployment (Figure 12), a lower proportion of household and dependent individuals (Figures 13 and 14) of social security assistance (because surely, with higher level of income, there is higher proportion of private insurance), and a lower percentage of households that receive less than half and 60% of the average national income (Figures 15 and 16).

Regarding the distribution of income (Figure 17), it is measured the correlation between GDP pc and the ratio of the first quintile on the fourth quintile pc. The ratio of the first quintile (income of those who earn less) divided by the fourth quintile of income (income of those who earn more) if it tends to one will have more equality because those who earn more and those who earned less would win the same. Conversely, if it tends to zero, those who earn less tend not to win anything. The bigger the ratio lower is inequality and, vice versa, the higher is the GDP per capita is the inequality in the distribution of income. Therefore, the evidence of European cities (there are no data for Madrid) is that when an increasing income the distributive equity diminishes; i.e., the wealthier SC are not necessarily more equitable, but rather the opposite. They show extremely citizenship polarization phenomena and strong imbalances in the levels of social cohesion.

On the other hand, it is not surprising that unemployment is associated with low levels of productive capacity of cities. As already mentioned, unemployment rate shows an inverse relationship with the level of GDP per capita (Figure 12): a higher level of this lowers unemployment and vice versa. Most of the opinion about unemployment tends to draw attention to the rate at the national level, forgetting that there are strong differences between cities; the urban geography of unemployment is extremely uneven. There is no doubt that the unemployment rates in Europe are high, particularly in Spain; but a perspective from the cities allows us to clarify this statement of general nature, to observe how the economic crisis hit all economies but in a different way.

In this sense, it is crucial to make three observations. One, the cities with the largest GDP per capita are more resistant to the crisis from the point of view of unemployment; two, on the other hand, cities with lower GDP per capita are more vulnerable to unemployment; and three, Madrid has an unemployment rate far greater than that would be up by its GDP pc. Consequently, it is evident that productive capacity has a direct influence on the levels of unemployment, so that the exit of the crisis on the labor market could come by the cities of greater PIB capita which exhibit greater opportunities than the other and are called therefore to attract more people-particularly the most qualified - in search of jobs.

However, the case of Madrid invites to think that not only the increase of the productive capacity of the city can solve the problem of unemployment. In fact, Madrid shows - what could be called - a sort of "vicious circle" of productivity; that is, a situation in which productivity gains are made primarily by declines in occupancy and unemployment increases. Effectively, the trend of European cities shows that the production levels of Madrid (GDP pc) can be achieved with much lower unemployment rates. That leads to other factors like an increase in the effective demand, the improvement in the management of human resources within the companies, the promotion of active employment policies, and the development of productive sectors as instruments in the fight against unemployment.

4.7. Urban environment

The fundamental problem of the EU cities is that they are responsible for 70% of the global primary energy consumption and it is expected that this proportion grows to 75% before the year 2030 (IEA, 2008). This fact determined that cities are responsible for most of the CO₂ emissions and are at the same time the objectives of the European energy policy. To understand what is happening, from the point of environmental sustainability, it is necessary to define cities as a complex and dynamic open ecosystem, where both the energy and natural resources are transformed to meet the needs of the various urban activities (Mella, 2003). This concept helps to understand

how the "inputs" and "outputs" of this metabolic process are highly dependent on their physical, economic, social and cultural structures. In fact, buildings (residential and non-residential) and transport absorbed most of the demand for urban energy consumption. The volume of energy demand from both sectors is strongly related to the characteristics of cities such as climatic conditions, density and urban morphology, building practices, the main economic activities and cultural habits, which are specifics in each one of them.

From the point of view of the transport, energy demand is also strongly related to the specific characteristics of the city; in particular, with urban mobility. Urban density and CO₂ emissions tend to have an inverse correlation: the lower the density of a few major cities generally their emissions from transport are higher, which suggests that more compact cities are more energy efficient in urban transport. This is precisely the sense of a SC, which is by definition of being friendly with the environment. The SC uses the ICTs as an instrument of management (smart) and pursues sustainable urban development as the ultimate goal (Caragliu, Bo and Nijkamp, 2009).

The available data allow to affirm that European cities covered by the *Urban Audit* show a negative relationship between the level of GDP per capita and the number of days in which particles PM₁₀ concentrations exceed 50 micrograms per m³ (Figure 18); and a relationship similar to the concentration of accumulated ozone that exceed 70 micrograms/m³ (Figure 19). This implies that greater levels of GDP pc are accompanied by lower levels of pollution in the form of concentrations of particles per m³ and accumulated ozone concentration, so that these cities with higher relative economic weight presented a relatively important control of their negative externalities; i.e., they limit them by means of reducing environmental pollution policies.

However, it should be taken into account that - in terms of ozone tropospheric - higher levels are recorded in suburban or rural areas which affects to a much lesser extent to the centers of the cities. It does not happen so with the annual average concentration of NO₂ (nitrogen oxides) - one of the main pollutants of the atmosphere, produced by private transport, heating and the existence of industries in the vicinity of cities - that shows a positive relationship (Figure 20); that is, it increases with the highest level of GDP per capita. In any case, Madrid shows a relative improvement of environmental efficiency, to the extent that per unit of GDP per capita - in the context of European cities - is less polluting than the rest of the cities of the continent.

Even though, this last statement is nuanced in two directions. First, in order to avoid self-satisfaction, it is very relevant to take into account the fact that are more and more stations indicating dangerous and illegal levels of NO₂, with peaks of up to 200 µg/m³ of concentration of nitrogen dioxide, with exceedances of the quality objectives of the values recommended by the World Health Organization. Second, it is recommended not to forget that greater acuity of the crisis of the Spanish economy in relation to that of the EU, is that there is less traffic, lower energy consumption and

less industrial activity, which allows to improve environmental records; to which must be added a weather with more instability that assists in the same sense (OSE, 2011).

5. Conclusions

The growing process of urbanization in Europe and, in particular, in Spain and Madrid, demand a new conception of cities, making them more inhabitable, more economically efficient, more balanced, more politically participatory and more environmentally responsible. This concept of the city can generate new development opportunities in terms of an appropriate integration of ICT in different urban systems, optimization of economic processes, more sustainable energy consumption, the development of a more inclusive society and a more democratic Government.

Strategies of the city of Madrid in terms of SC-in agreement with the results obtained to achieve increasingly higher levels of GDP pc - must be articulated around a further development of ICT, an improvement of multimodal accessibility, greater efficiency of the public transport network, and an increased productivity and the size of the companies. Besides it is needed a prioritization of investment in higher educational levels, an intensification of the projection of Madrid as a city of culture and leisure, a potentiation of agglomeration economies, a decided fight against excessive unemployment, a clear commitment by advanced sectors and creators of employment, an improved environmental quality, and an ambition for a society more cohesive.

The great challenges of all kinds posed by Madrid City as a SC asked for intelligent strategies to take advantage of its enormous potential for development. It requires a political vision of long-range and a close cooperation of public authorities, private companies, organizations and social movements, universities and research centers, and the society as a whole. Ultimately, Madrid City needs smart strategies for smart people.

^[1]The "creative class" (Florida, 2002) is defined by aggregation of two types of occupations: the "super-creativa" (employees in the areas of science, engineering, education, computer programming, research, arts, design and media workers) that is considered "fully engaged in the creative process" (Florida, 2002, p.69) and "creative professionals" who are employed in the health, finance and business, the legal profession and part of education.

^[2]the level 5 corresponds to the first stage of university education (which includes graduates and graduates) and level 6 corresponds to the second stage of university education (which includes the passage to a qualification in the area of specialization or research aptitude) (Handbook of *Urban Audit*, 2010).

^[3]the level 3 corresponds to higher education to secondary school (which includes training of third cycle) and level 4 is the not-top post-secondary (non-equivalent to a first university degree, diploma type programs).

^[4] this study concluded that, in 2004, sport, in a broad sense (i.e., considering all activities linked to sports equipment and leisure), it generated a value added equivalent to 3.7% of GDP in the EU.

^[5] the growing relationship between GDP per capita and provision of space for sports and leisure activities allows us to understand how to increase this amount with the development of cities and regions. For example, estimates for the case of Andalusia (Junta de Andalucía, 2010) conclude that the weight of sporting activities is 2.2% of regional GDP, very below 3.7% EU or 4.1% of the GDP of a city relatively developed as Sheffield in England.

REFERENCES

- Atkins, W. S. (2001). **European Best Practice in the Delivery of Integrated Transport**, (Tech.Rep. No. 1 - Benchmarking). Epsom Surrey: WS Atkins Transport Planning.
- Caragliu, A., Del Bo, Ch. y Nijkamp, P. (2009), **Smart cities in Europe**.
<http://ideas.repec.org/p/dgr/vuarem/2009-48.html>
- Dimitrov, D., Helmenstein, C., Kleissner, A., Moser, B. y, Schindler, D. (2006): Die makroökonomischen Effekte des Sports in Europa, Studie im Auftrag des Bundeskanzleramts, Sektion Sport, Viena, citado en Comisión Europea (2007), **Libro Blanco sobre el Deporte**. Luxemburgo: Oficina de Publicaciones Oficiales de las Comunidades Europeas
- Florida, R. (2002) **The Rise of the Creative Class: and How it's Transforming Work, Leisure, Community and Everyday Life**. New York: Basic Books.
- Harvey, D. (2000), **Spaces of Hope**. Edinburgh University Press, Edinburgh.
- Hollands, R.G. (2008), "Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?", **City**, vol.. 12, Nº. 3, pp. 303-320
- IEA (2008), **World Energy Outlook**, OECD/IEA 2008
- Manito, F. (Ed.) (2012), **Ciudades Creativas. Cuartas Jornadas**:
<http://www.globbttv.com/30/microsite/ciudadescreativas>.
- Mella, J.M. (2003), **El medio ambiente urbano en España**. Thomson Cívitas. Madrid.
- Ortiz, C., Garnica, R. (2008), "La accesibilidad espacial en la definición de territorios inteligentes". **ACE, Arquitectura, Ciudad y Entorno**, año II, núm.6, febrero, pp. 759-776
- OSE-Observatorio de la Sostenibilidad en España, **Informe de Sostenibilidad 2011**, Ministerio de Medio Ambiente y Medio Rural y Marino. Calidad del aire urbano. Capítulo 5, pp. 186-189
- Rosenthal, S. y Strange, W. (2004), "Evidence on the nature and source of agglomeration economies", en Henderson, J.V., Thisse, J.F. (Eds.), **Handbook of Urban and Regional Economics**, vol. 4, North Holland.
- Weyrich, P., and Lind, W. (2001), **Twelve Anti-Transit Myths: A Conservative Critique**, Free Congress Research and Education Center, Smart Growth America (www.smartgrowthamerica.org/weyrich3.pdf).

FIGURES

Figure 1. Relation between the GDP PC and y the % of homes with access to internet

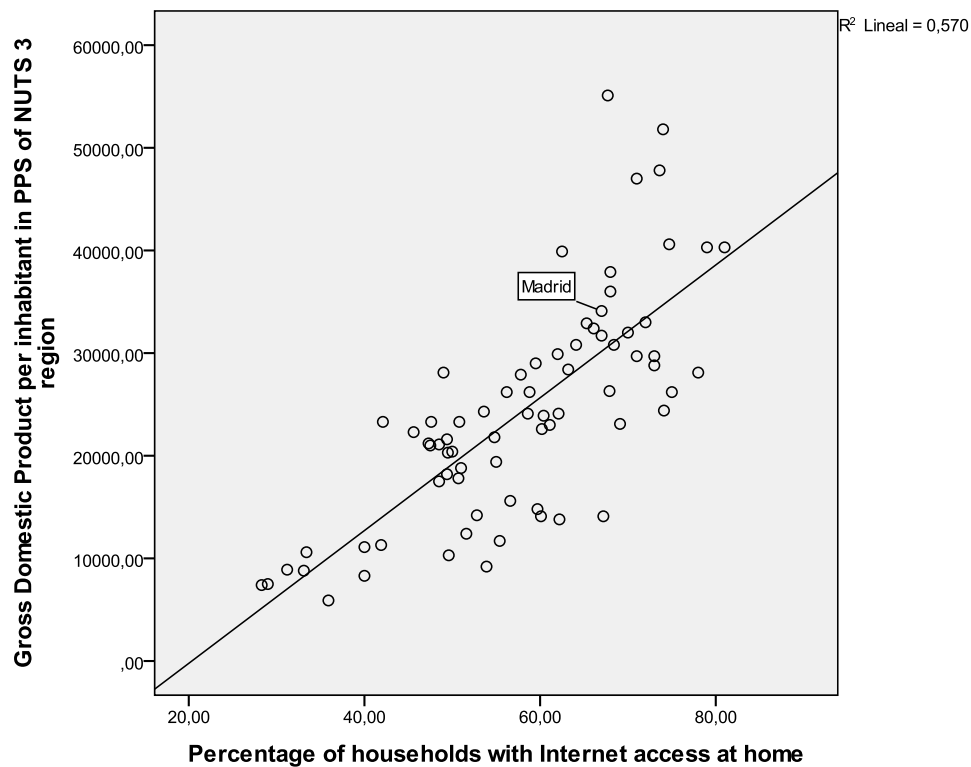


Figure 2. Relation between the GDP PC and the number of companies

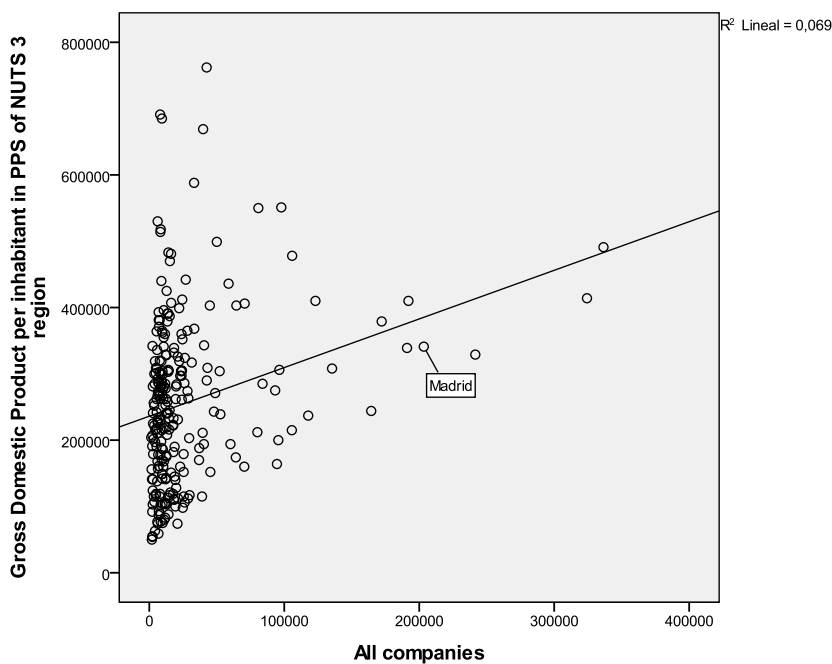


Figure 3. Relation between the GDP PC and the companies with headquarters

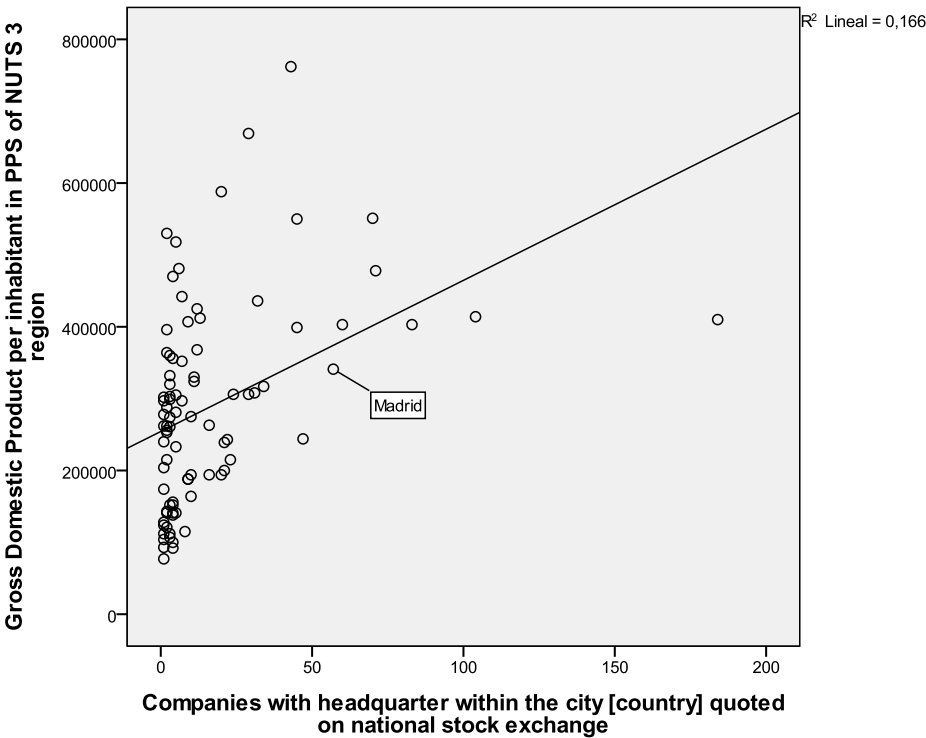


Figure 4. Relation between the GDP PC and the multimodal accessibility index

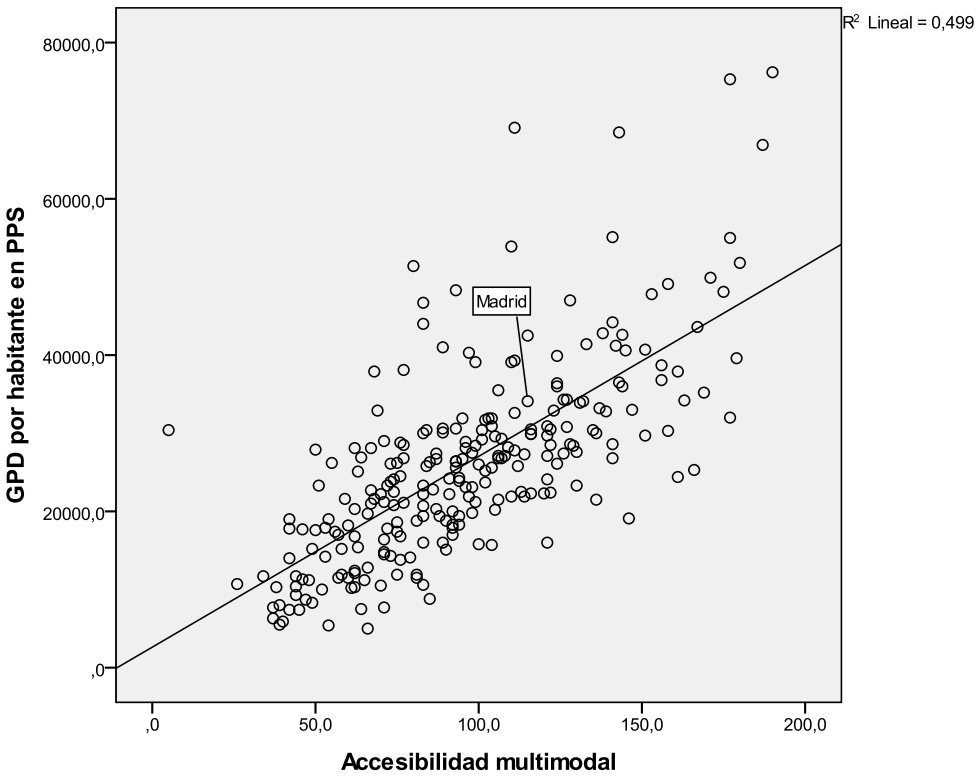


Figure 5. Relation between the GDP PC and the density of public transport network

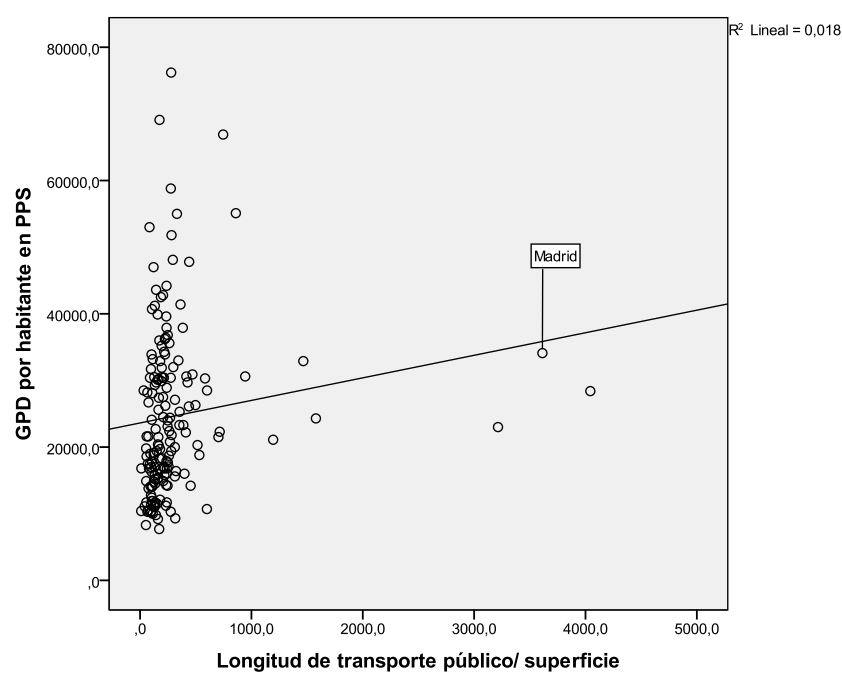


Figure 6. Relation between the GDP PC and the active population of highest qualification

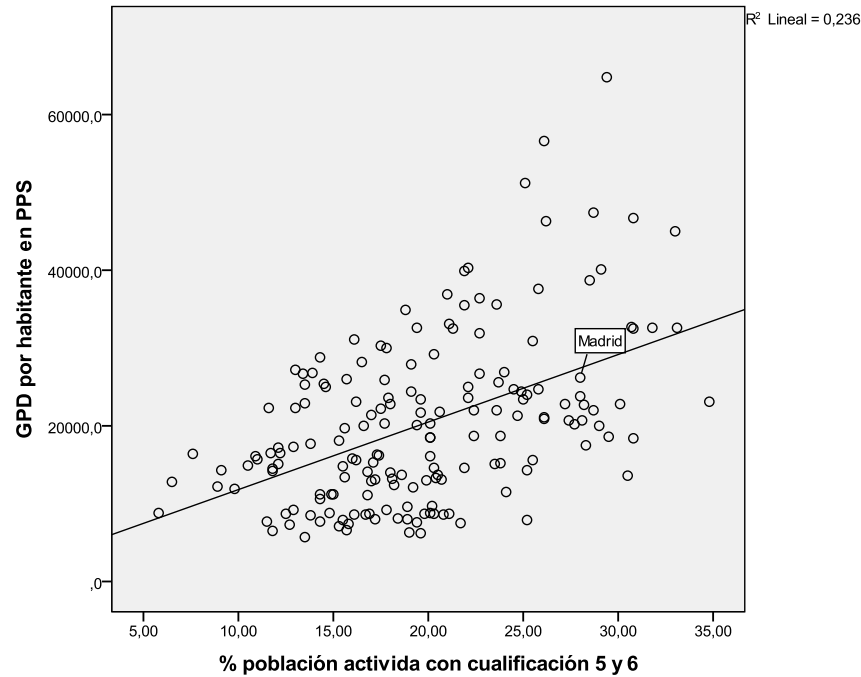


Figure 7. Relation between the GDP PC and the active population with intermediate qualification

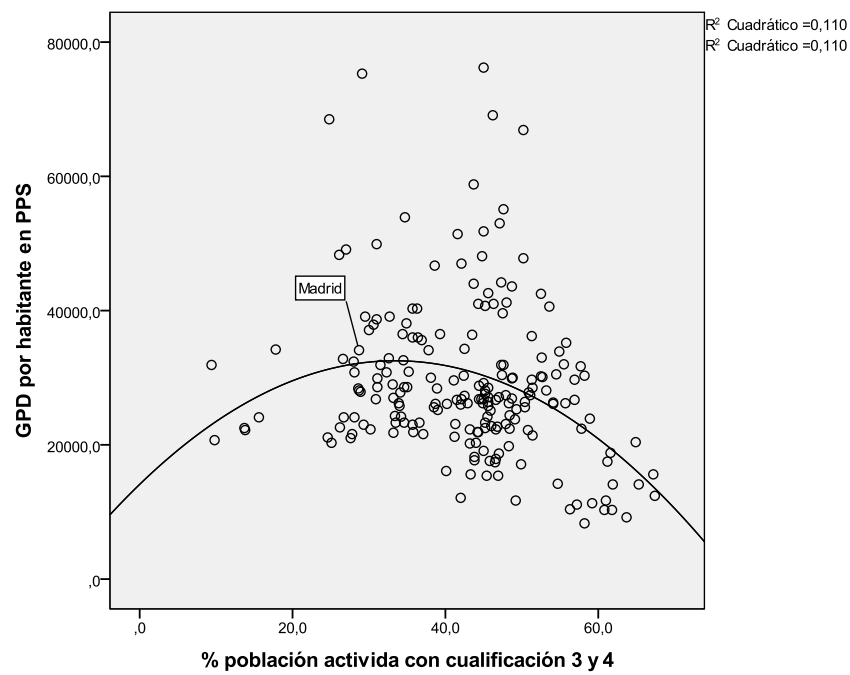


Figure 8. Relation between the GDP PC and the employment density

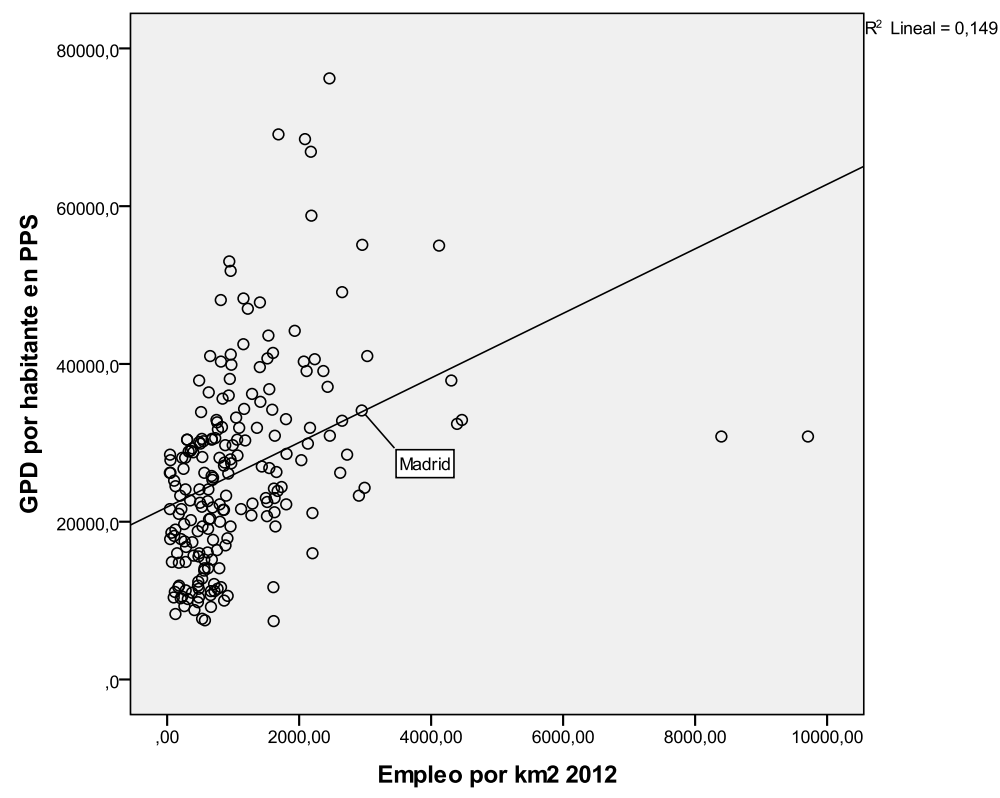


Figure 9. Relation between the GDP PC and the employment in leisure and cultural activities

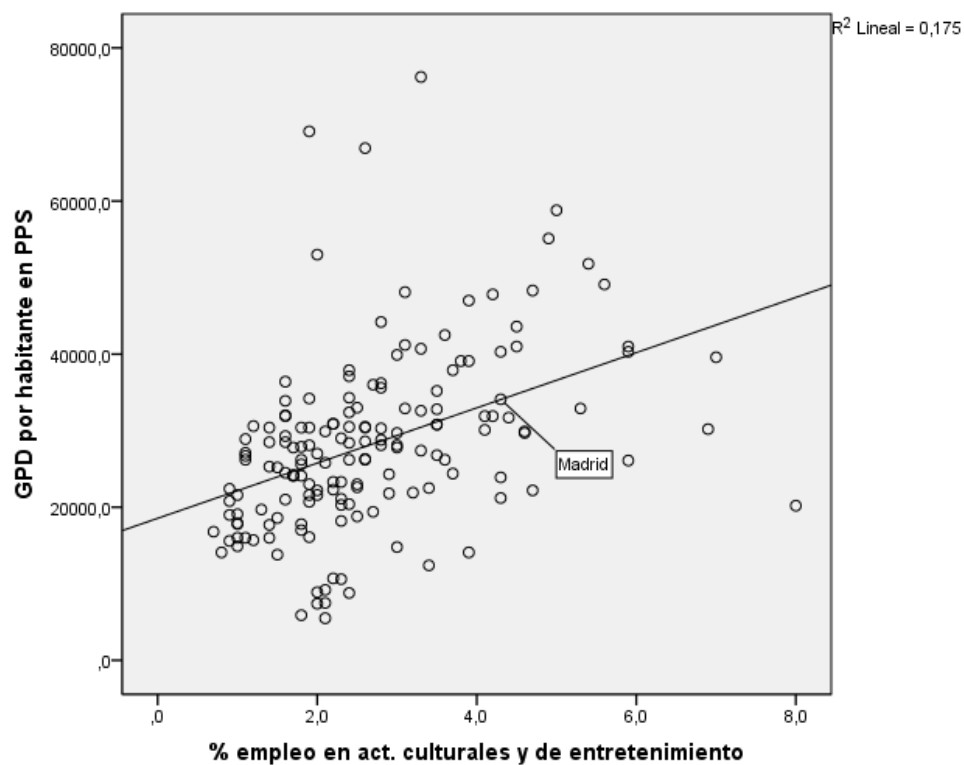


Figure 10. Relation between the GDP PC and the Surface for leisure and sport

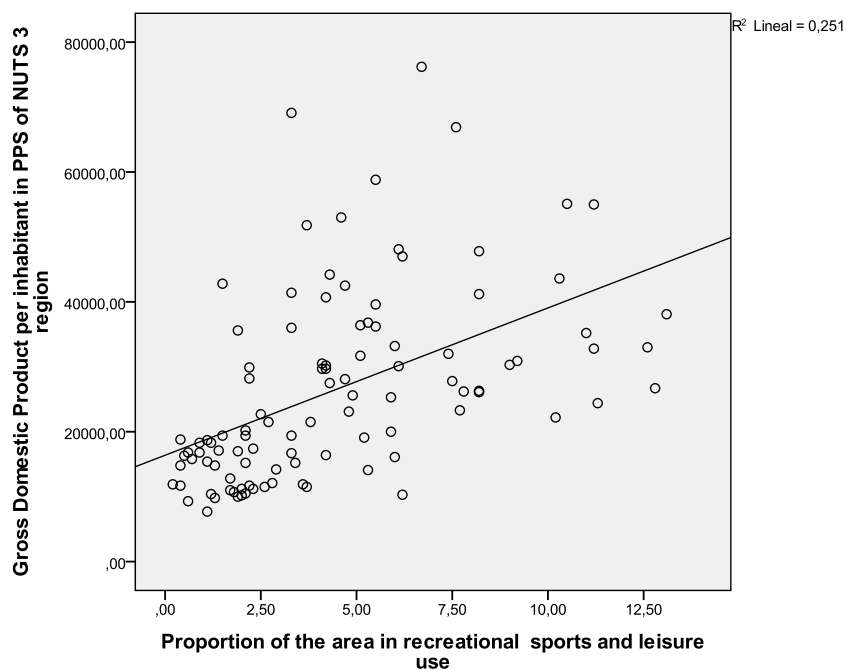


Figure 11. Relation between the GDP PC and the population density

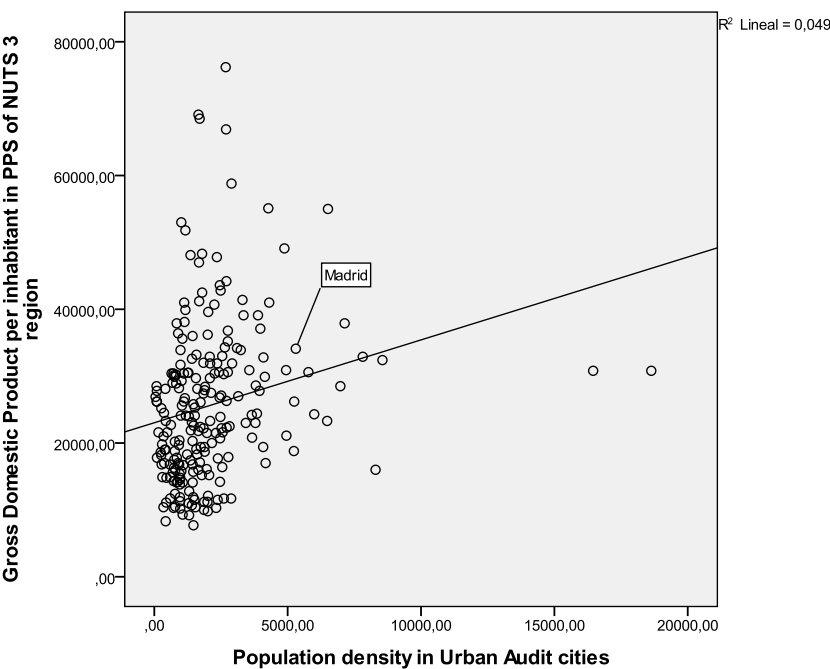


Figure 12. Relation between the GDP PC and the unemployment rate

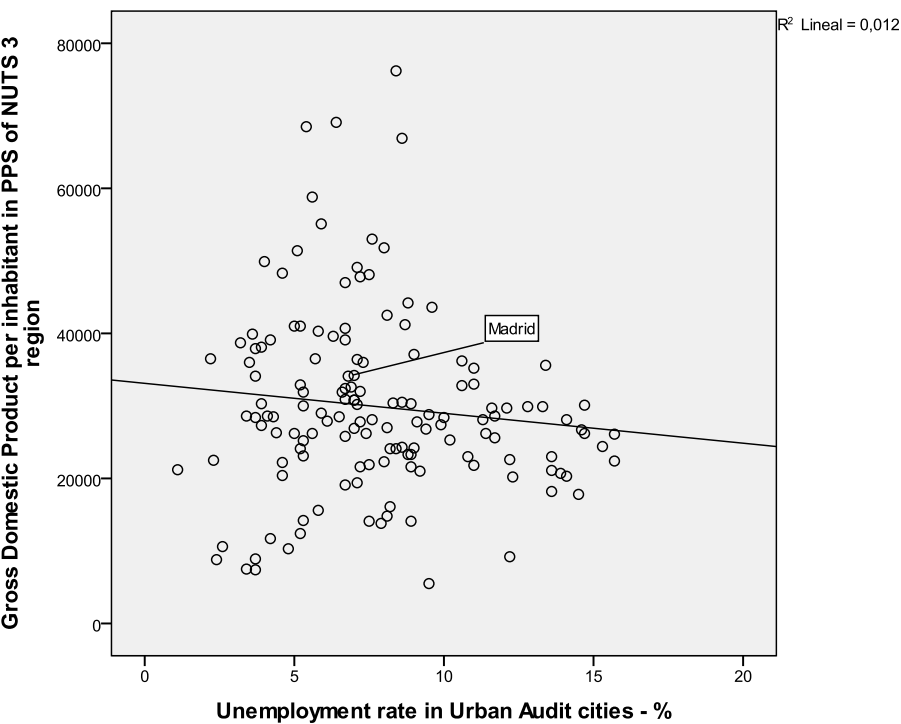
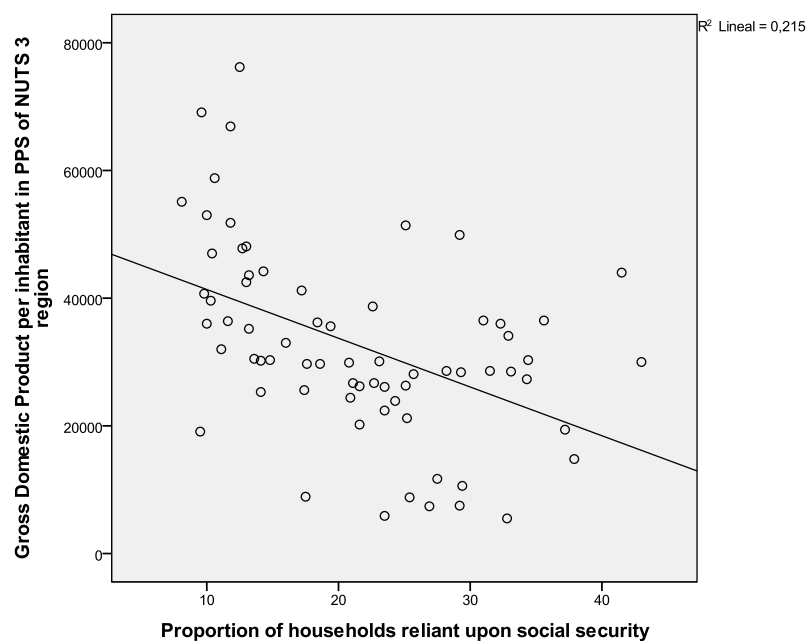
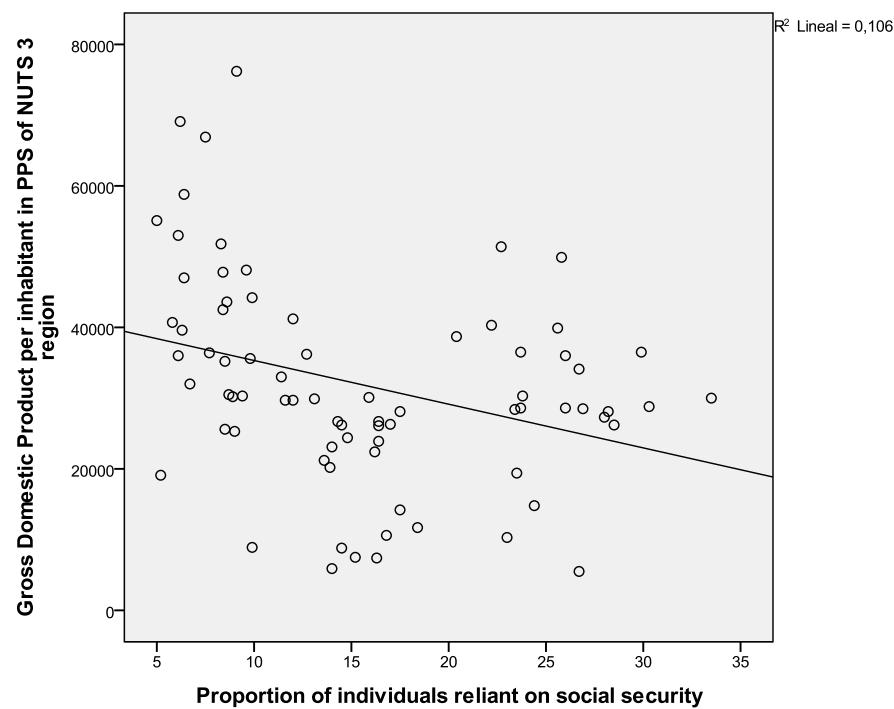


Figure 13. Relation between the GDP PC and the rate of homes with social security dependents*



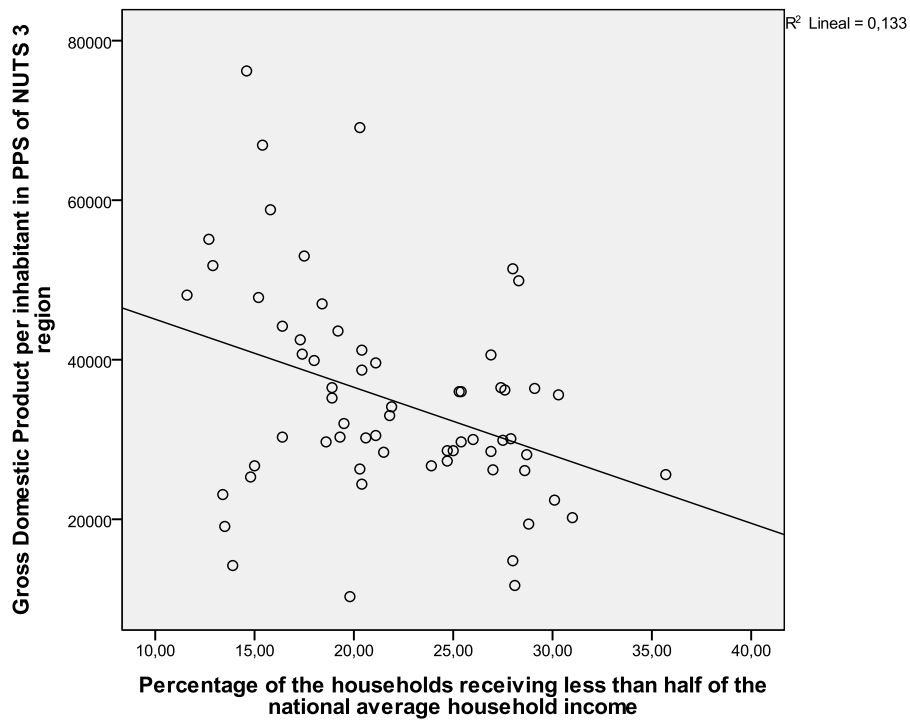
* There are no data for Madrid

Figure 14. Relation between the GDP PC and the rate of social security dependent individuals*



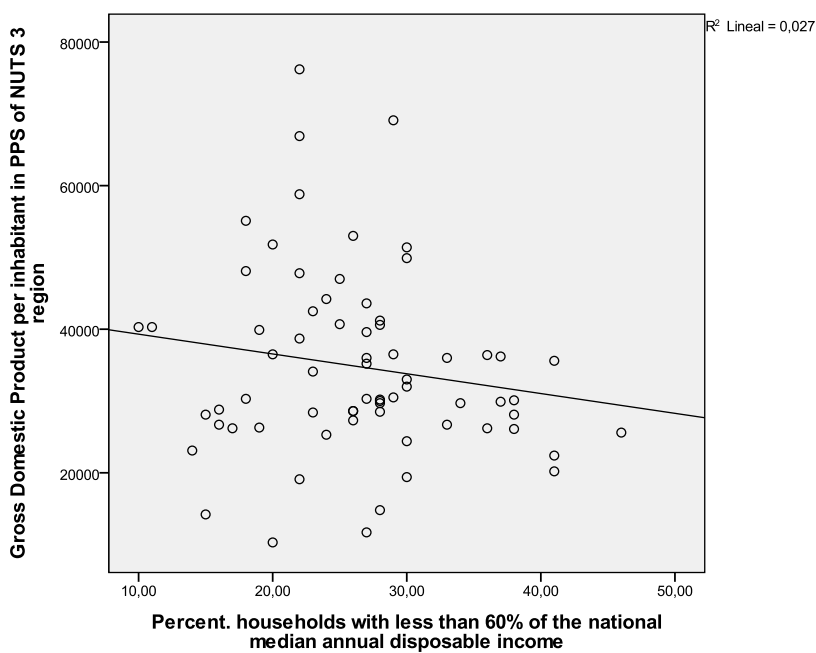
* There are no data for Madrid.

Figure 15. Relation between the GDP PC and the rate of homes with incomes under 50% of the average*



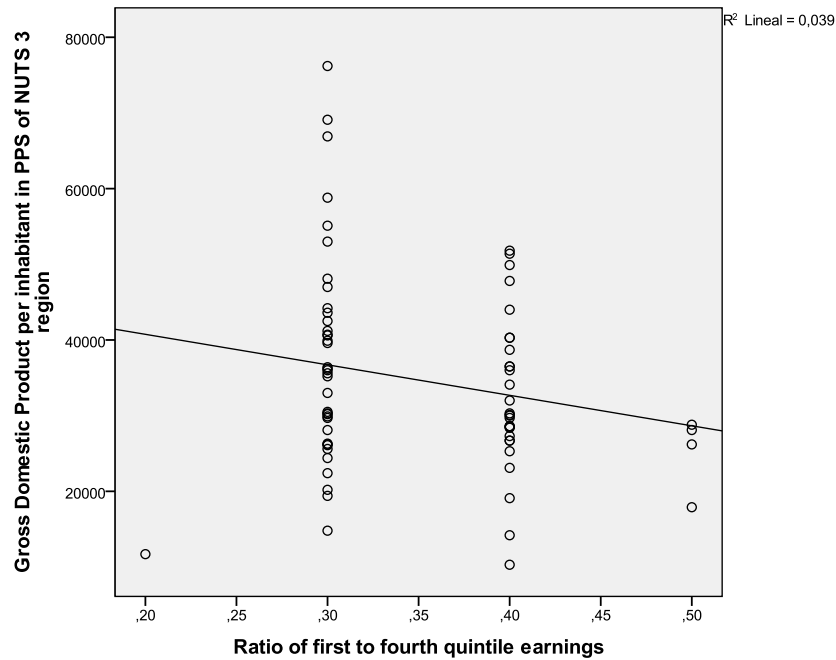
* There are no data for Madrid.

Figure 16. Relation between the GDP PC and the rate of homes with incomes under the 60% of the average*



* There are no data for Madrid

Figure 17. Relation between the GDP PC and the income distribution*, **



* Measured by the quotient between the first and the forth quintile of incomes.

** . There are no data for Madrid

Figure 18. Number of days with de PM10 particles concentration exceeding 50 microgram/m3

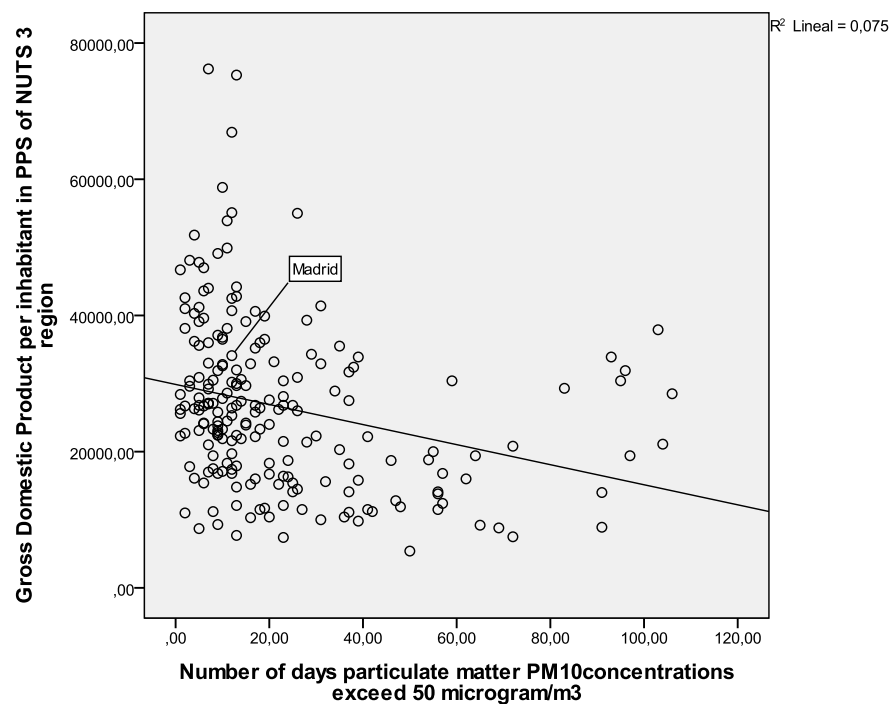


Figure 19. Concentration of accumulated ozone exceeding 70 microgram/m³

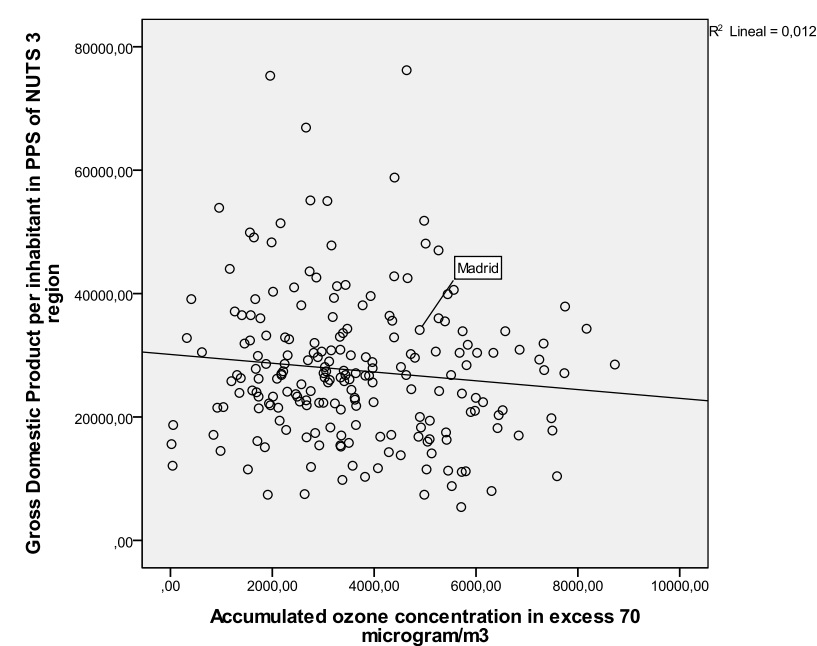


Figure 20. Annual Concentration average of NO₂

