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## Urban Growth and Its Impact on Development

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# URBAN GROWTH AND ITS IMPACT ON DEVELOPMENT: PRELIMINARY ANALYSIS

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## Abstract

According to a study by United Nations (UN) on urbanization, the world population living in cities has been increasing exponentially and will continue to do so in the next years. From 1950 to 2007 the percentage of urban population has increased from 29% to nearly 50% and UN projections say that in the year 2050 this number will be 70%. These numbers lead us to raise some questions: How will urbanization evolve in the future? How will it influence the development of each region/country? In this paper we describe the preliminary results obtained where in the analysis of the relation between urbanization rate and economic development (GDP per capita). We also describe the next steps into creating a macroeconomic model with contributions from urban economics and some empirical studies.

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## 1. Introduction

Historically, cities have always been centers for development either economic, scientific, political or even artistic; places like Rome, Paris, London and New York impacted development in several ways. In today's paradigm cities are relevant, not only as dispersed hubs, but also as a whole; cities concentrate about half of the global population and urban energy consumption represents 75% of the total, as stated in a CNN article (CNN, 2007; United Nations, 2007).

The issues about city growth and what drives their development are currently under the interest of many researchers, but these are relatively recent themes in the scientific world. Studies over city development have taken many different approaches, through computational or theoretical models to empirical studies. However, in the background research we haven't found a model that studied the city development using a macroeconomic model.

Urban economics is a field of economics that deals with these questions (Fujita, et al., 2001; Fujita, 2010). It studies the reasons and mechanisms by which agglomerations of populations and economic activity appear in a specific region. It uses microeconomics dynamics, like the balance of offer and demand and optimizations of profits by companies and families. In 2008, Paul Krugman received the Nobel Prize in Economic Sciences for his work

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in the development of spatial economics and trade theory. His biggest contribution was the *core-periphery model* which is a general equilibrium model of how increasing returns in the economy could impact spatial economic structure (Krugman, 1991). Other work, done in parallel to this one, relates urban growth with human capital with different city types (defined by the dominant economic activity) which created a model for cities sizes – measured by population – and number of cities by calculating, again, market equilibriums and tracking the decision that maximizes the utility of each agent (Black, et al., 1999).

A macroeconomic perspective has the big advantage of simplicity. By looking for general trends without describing the processes within it with detail, it is possible to consider less inputs that are, in most cases, easier to obtain. Finding disaggregated data is often one of the hardest parts of modeling. Using data aggregated at the country level makes this task easier. Other than that, most microeconomics studies rely on the hypothesis that the market is in equilibrium which, in reality, doesn't exist. Therefore, what we aim to do with this work is understand how to create a model that would answer the questions highlighted. This model would have, essentially, the philosophy of a macroeconomic model but will also include some issues discussed in urban economics. To do so, we will try to understand the trends of countries' urbanization rates and the dynamics between city size and its development.

In this paper it's described the work that has been done and the plans for the future work as this study is still under way. First, we will give an overview of the current trends in urbanization and some preliminary results obtained in our analysis. Afterwards, we will mention the methodologies and existing studies that will be used in the study of how to calculate city sizes and, with it, economic growth.

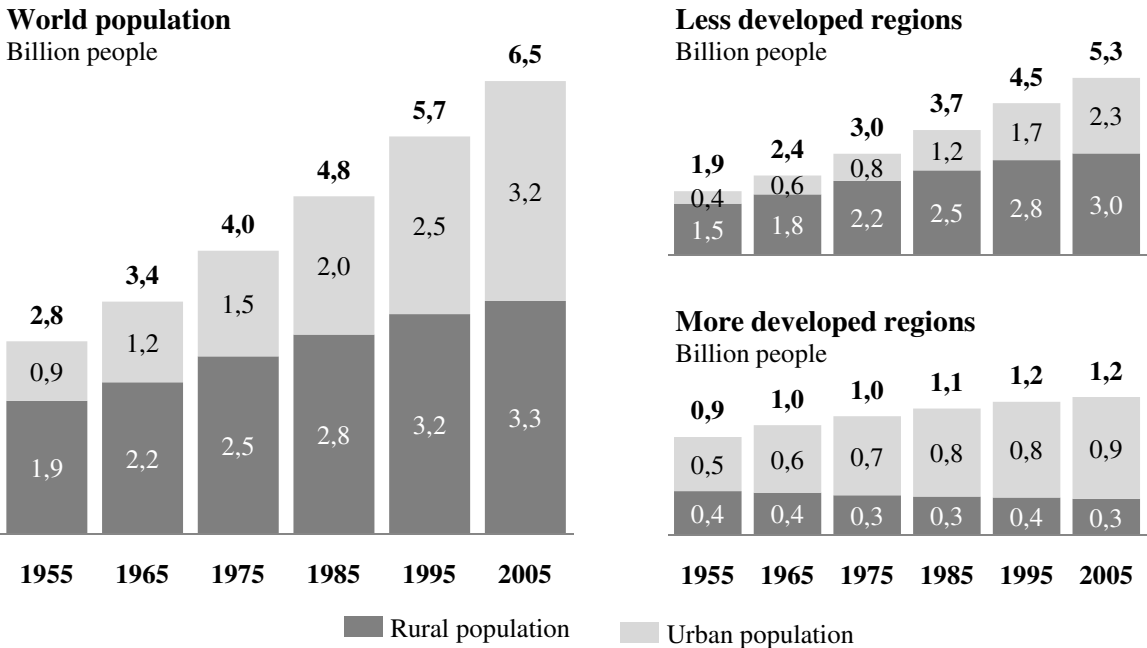
## **2. Urbanization**

### ***2.1. Available data and observed trends***

According to the information available in the database of UN, summarized in Graph 1, the world population living in cities has been increasing exponentially (United Nations, 2008). The urban population grew from 0,9 billion in 1955 to more than the triple, 3,2 billion in 2005. This growth has been caused by two different processes:

1. Growth of population as a whole. The world population in 2005 is 2,3 times larger than it was 50 years before;
2. Migration from rural to urban areas. World urban population percentage grew from 31% in 1955 to 49% in 2005.

It is also possible to see that, in less developed regions, the urbanization process is due to both processes. The population in these regions is increasing tremendously and the share of urban population more than doubled (from nearly 20% to more than 40%). However, in more developed regions, the increase of urban population is explained mostly by the migration process translated in the increase of the percentage of urban population from 56% to 74%. Total population in these regions has increased slightly showing stabilization in the latest years. Although there are some concerns about the standardization of the definition of what must be considered urban population or not (United Nations, 1974; Cohen, 2004; Cohen, 2006), the UN data this is, to the date, the most complete collection of data that exist.



Graph 1 – World population distribution between rural and urban areas between 1955 and 2005 (United Nations, 2008)

One other fact to take into consideration is how this urbanization happens in terms of its distribution throughout the cities. A study made in the United States found that urban population growth happened, mostly, in smaller cities and not in mega cities such as New-York or Los Angeles whose population has been stable in the latest years (Alig, et al., 2004). Looking at the statistics of the census of the United States it is also possible to see that the number of cities has grown significantly, which also shows that urbanization is happening in smaller population aggregations (U.S. Census Bureau, 1993). However, it is important to stress that, in developing countries, the population growth occurs in all cities, which means that population is growing in small cities as well, but also in the largest ones (Cohen, 2004).

That is in the origin of new mega cities in developing countries that have emerged in the last decades.

## **2.2. Prediction of future trends**

In order to study the role of cities in the future development of a region it is very important to understand and make scenarios for the trends of urban population growth.

### *2.2.1. Extrapolation of temporal trends*

UN are the providers of the projections of urban and rural population that have been widely used in the scientific community. The most recent document available that describes the methods used is from 1974 (United Nations, 1974). In the absence of any information about the update of this methodology we assumed that it did not suffer a significant change until today and we will analyze it as it was described in that report.

The projections made are based in past trends of population evolution throughout the years in urban and rural zones. The *tempo of urbanization* (as the trend of urban developments is called in this study) is estimated using the difference between the rates of urban and rural population growth. This measure was chosen because it eliminates a number of existent problems in other used measures of it such as the annual gain in percentage of urban population or the annual rate of gain in percentage of urban population. It delivers reasonable results for an indefinite period of time independently of the level of urbanization, the rate of growth in total world population observed and no matter if the rural population is increasing or decreasing. One other reason to this option is that it describes the dynamics of attractiveness of cities in comparison with urban areas.

However, we believe that an analysis that only uses time trends don't illustrate the dynamics of the urbanization process. A correlation between the level of development of a region and its level of urbanization seems evident looking at the difference between the profiles of more and less developed regions shown in Graph 1. Considering this fact, we believe that, to calculate more accurate projections, they must include, at least, one input related with the level of development in resemblance with other studies such as demographic transition (Myrskylä, et al., 2009).

### *2.2.2. Relation of urbanization and economic growth*

Processes that lead to change of urbanization levels, such as migrations from rural areas to cities and different fertility rates, are heavily influenced by economic decisions. In fact, the change of sectors that dominate the economy that most countries go through (from

agriculture, to industry, to services) fosters a continuously higher level of population concentration (Henderson, 2003). As the shift of sectors is linked to economic development one may argue that growth is one of the most important factors that influence the evolution of the urban population percentage.

Henderson (2003) tested the hypothesis that urbanization and urban concentration (here measured as primacy) drives growth. Although this is the opposite relation that we are trying to find, this might be a cyclic relation as already purposed in a paper in which he had participated (Black, et al., 1999). Using panel data he found that there was only a clear causal relation between urban concentration and growth. Other studies followed performing similar analysis (Bertinelli, et al., 2007). Asadoorian (2008) has also used economic indicators to make projections of urban growth until 2100 so they could be used in the EPPA (Emissions Predictions and Policy Analysis) model being developed at MIT. He used as proxy for population density the national population per unit of arable land to avoid the problems of urban zones definitions, already mentioned.

### 2.2.3. *Analysis of the impact of economic growth in urbanization*

As mentioned before, we believe there is a strong relation between the economic growth of a country and its urbanization rates. To verify this hypothesis we gathered a set of data which includes 180 countries in the period between 1960 and 2005 with annual records (with a few exceptions). In our analysis we used demographic data (total and urban population) collected by UN, available in the website NationMaster (NationMaster, 2010). Economic development proxy used was GDP per capita as constant prices (US dollar being 2000 the base year) also available in the NationMaster website (NationMaster, 2010).

To create a function that could describe the relation we had to consider the following boundary conditions:

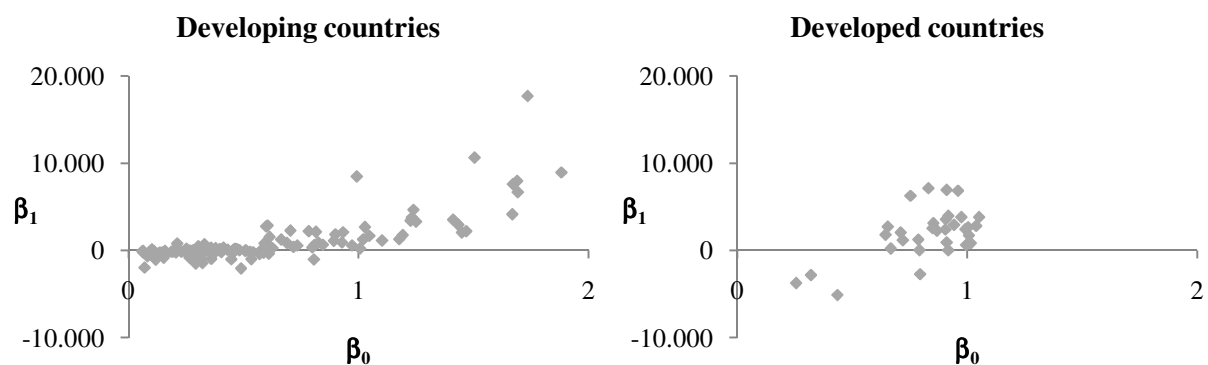
1. When  $GDP_{per\ capita} = 0 \implies Urb=0$ . When the level of economic activity of a regions is zero it is assumed that that area is deserted.
2.  $Urb \leq 1, \forall GDP_{per\ capita} \in [0, +\infty[$ . Urbanization rate can't exceed the 100% so the function has to consider the existence of a *plateau* that can be equal or less than 1.

Taking into consideration these conditions, the logarithm function, which seems, for most cases, the function that describes the curve seen, cannot be applied. So, we used a function similar to the logarithm but that satisfies the above conditions, being  $\beta_0$  e  $\beta_1$  the parameters of the function:

$$\text{Urb} = \frac{\beta_0 \times \text{GDP}_{\text{per capita}}}{\beta_1 + \text{GDP}_{\text{per capita}}} \quad [1]$$

We chose to make the analysis independently to each country as we expected that, although equation [1] fits most of countries data, the parameters obtained would be different as, because of cultural diversity and geographical factors, for example, the behavior of the curve may vary. Looking at equation [1] we can see that the limit of Urb when  $\text{GDP}_{\text{per capita}}$  tends to infinity is  $\beta_0$ , being the parameter  $\beta_1$  the one that indicates how fast the *plateau* is reached. To estimate the parameters we used a non-linear least square minimization method that was implemented using STATA.

Dividing the results according to the countries' classification by the UN of developing and developed countries (United Nations, 2009), we get the plotting shown in Graph 2.



Graph 2 – Values for the parameters obtained for developing and developed countries

There are a few results that don't respect the second condition ( $\beta_0 \leq 1$ ), mainly for developing countries. This happens as most of these countries are in the initial phase of the curve and the *plateau* values are yet difficult to predict. The dispersion observed in developing countries graph is due to the same reason. In the developed countries, the distribution of the parameters' values is much more concentrated as most of them have reached the asymptotical value for urbanization rate or that are near of it. The three countries that are in the bottom left corner are (from the left to the right): Slovenia, Czech Republic and Brunei; which are, among the developed countries, a sample which growth is recent and very inconstant with the  $\text{GDP}_{\text{per capita}}$  increasing and decreasing during the years of the data collected.

We don't present a statistical evaluation of the results as, for that, we still have to test the robustness of our analysis.

There is one other problem with this analysis which is the non standardization of the definition of what is urban area or not between different countries, already mentioned. As the

meaning of urban population change so do the parameters estimated here, not because the trend is different, but because the definition differs.

### 2.3. *Distribution of city sizes*

People living in cities are growing in number as we have seen in the previous section. However, to understand what this implies in terms of city growth, one should know how the urban population is distributed. Scenarios where only few large cities exist are very different from others where urban population is distributed through multiple cities which size does not differ one from the other significantly.

Since the beginning of the XX<sup>th</sup> century, it has been proposed by a number of researchers that the distribution of city sizes obeys to a Pareto Distribution described by equation [2].

$$\log(r) = \log(A) - \delta \log(S) \quad [2]$$

r - rank of the city; S – size of the city (population); A - positive constant;  $\delta$  – constant;

More recently, using data from the Statistical Abstract of the United States, it has been found a strong statistical relation between the rank of a city (in terms of population dimension) and its size; a relation that is described by equation 1 in the particular case where  $\delta$  equals to one. This specific case of the Pareto Distribution is called Rank Size Rule [3] or, most commonly, Zipf's Law because George Zipf was the first, in 1949, to show a number of empirical patterns in social sciences of this form, including city sizes distribution. This same equation can be written in terms of probability distribution (3) which provides the possibility of dealing with a continuous function (Gabaix, 1999; Gabaix, 1999; Fujita, et al., 2001; Ioannides, et al., 2003). A recent study proved that this law holds even for cities with population as low as around 10,000 inhabitants (Rozenfeld, et al., 2009).

$$\log(r) = \log(A) - \log(S) \Leftrightarrow r = A/S \quad [3]$$

$$P(\text{Size} > S) = \alpha/S \quad [4]$$

$\alpha$  – positive parameter

Gabaix (1999) gave an explanation to this distribution behavior that has shown considerable support. He shows how it is possible to obtain Zipf's Law mathematically,



considering that Gibrat's Law is true. Gibrat's Law is a statement of what happens if it is considered that cities grow stochastically:

*“(...) there are a fixed number of cities (...), and that, over time, their sizes grow (and possibly shrink) stochastically. Assume only that, at least for a certain range of (normalized) sizes, the cities follow similar processes; i.e., their growth processes have a common mean (equal to the mean city growth rate) and a common variance.”*

*(Gabaix 1999)*

However, the hypothesis that cities growth behaves stochastically goes against the very own basis of urban economics that cities emerge and develop due to economic driven choices of industries and people. Taking this into consideration, Fujita et al (2001) argues that the power law observed in Zipf's Law is due to randomness of connections of cities in space and not of cities growth.

Despite all of the controversy behind the explanations of this phenomenon, the empirical studies have shown that Zipf's Law is a good form to describe the distribution of a country's cities sizes. Knowing the total urban population and the number of cities it is possible to calculate the population of each city in a country:

$$P_{urb} = \sum_{i=1}^N \frac{S_i}{i} \Leftrightarrow S_1 = \frac{P_{urb}}{\sum_{i=1}^N \frac{1}{i}} \quad [5]$$

$P_{urb}$  – total urban population;  $N$  – number of cities;  $S_1$  – size of the largest city

### 3. Cities development

As mentioned before, there is a branch of economics that studied the reasons and processes that lead to the formation of agglomeration of people: urban economics. However, for the purpose of this work, we intend to follow a slightly different perspective using the neoclassical theory of growth developed by Solow where output ( $Y$ ) is modeled using capital ( $K$ ) and effective labor ( $LA$  -  $L$  being labor and  $A$  labor efficiency) (Romer, 1996). This model is mainly applicable to entire countries or whole economies, so the application to an urban system requires a few adaptations. Cities are dynamic systems, with changing boundaries and a big flow of materials and people. Transportation costs are crucial to the layout and attractiveness of a city, as first concluded by Von Thünen in the XIX<sup>th</sup> century (Fujita, et al., 2001; Katzman, 1974).

Looking at cities included in the same country it is possible to observe a relation between their sizes and different indicators of their activity (Bettencourt, et al., 2007). In fact, larger

cities have bigger productivities per capita, following a scaling law of the form give by equation [6] with a coefficient  $\beta$  superior to one.

$$I = I_0 S^\beta \quad [6]$$

$I$  – indicator value;  $I_0$  – positive constant;  $S$  – size of the city (population);  $\beta$  – relation coefficient

Therefore, the size of a city has an influence in its output! But how can we model this? An explanation for this relation has been presented (Arbesman, et al., 2009) but it uses merely a tree network configuration of society and relations between people. In our model we aim to relate our inputs with city size in a way that this relation can also be explained in an economic way.

#### **4. Impact of urbanization on countries' development**

This final issue refers to the final goal of this research work. In this phase I want to understand what the impacts of a country's growing urbanization in its economic development are. Some authors found that urban concentration is statistically related with growth, at least until a certain limit (Black, et al., 1999; Bertinelli, et al., 2007), but the concentration of population in urban areas (big or small), and the way that the population is distributed has also an impact in the way development occurs as it has been studied in urban economics and other empirical studies.

The proposed methodology to construct a solid model to analyze these issues will use much more facts and models, some of them that are planned to be developed in answering the previous research questions. Here is a description of it:

1. Use the urbanization trends found to obtain the total urban population of a region/country, considering that the total population of that area is known.
2. Apply Zipf's law of distribution of cities so the size of each city depends only on the number of how many exist.
3. Model development of the urbanized part of the region through cities sizes. By development I consider, in this case, the economic growth (production function). For this, we will use the model mentioned in the previous chapter.

For the values of the rural part of the region, which are not calculated in point three, I will calculate the economic output as:

$$X_{\text{Rural}} = X_N / 2 \times P_{\text{Rural}} \quad [7]$$

$X_{\text{Rural}}$  – total rural economic output;  $X_N$  - economic output of the smallest city;  $P_{\text{Rural}}$  – rural population

This approximation is possible due to the small scale of these systems being considered, for these cases that economic output and energy use are linear functions of city size (linear approximation). For the values of the total population within the region/country we will use the projections made by the UN where demographic processes (such as demographic transition) are already included in the methodology.

## 5. Final remarks

As this is an ongoing work, there are no specific conclusions to highlight. For the preliminary results it seems that a relation between the growth of urban population percentage and economic development of a country are related. However, it is not possible to identify clearly a pattern of how this relation is analyzing the results for different countries. Further work is needed such as the inclusion of other inputs in the function and the analysis of the importance of time trends in the urbanization evolution.

The proposal of a theory with a new perspective that joins models from different areas of economy is the biggest achievement of this work.

## 6. References

- Alig Ralph J., Kline Jeffrey D. and Lichtenstein Mark** Urbanization on the US landscape: looking ahead in the 21st century [Journal] // Landscape and Urban Planning. - 2004. - 2-3 : Vol. 69. - pp. 219-234.
- Arbesman Samuel, Kleinberg Jon and Strogatz Steven** Superlinear Scaling For Innovation in Cities [Journal]. - January 30, 2009. - Vol. 79. - pp. (016115)1-5.
- Asadoorian Malcom O.** Simulating Spatial Distribution of Population and Emissions to 2100 [Journal] // Environmental and Resource Economics. - 2008. - 3 : Vol. 39. - pp. 199-221.
- Bertinelli Luisito and Strobl Eric** Urbanisation, Urban Concentration and Economic Development [Journal] // Urban Studies. - 2007. - 13 : Vol. 44. - pp. 2499-2510.
- Bettencourt Luís [et al.]** Growth, Innovation, Scaling, and the Pace of Life in Cities [Journal]. - April 2007. - Vol. 104. - pp. 7301-7306.
- Black Duncan and Henderson Vernon** A Theory of Urban Growth [Journal] // Journal of Political Economics. - 1999. - 2 : Vol. 107.

**CNN** All about: Cities and Energy Consumption - CNN [Online] // CNN. - December 31, 2007. - May 2008. -

<http://edition.cnn.com/2007/TECH/12/31/eco.cities/index.html#cnnSTCText>.

**Cohen Barney** Urban Growth in Developing Countries: A Review of Current Trends and a Caution Regarding Existing Forecasts [Journal] // World Development. - 2004. - 1 : Vol. 23. - pp. 23-51.

**Cohen Barney** Urbanization in Developing Countries: Current trends, future projections, and key challenges for sustainability [Journal] // Technology in Society. - 2006. - Vol. 28. - pp. 63-80.

**Fujita Masahisa** The Evolution of Spatial Economics: from Thünen to the new economic geography [Journal] // The Japanese Economic Review. - 2010. - 1 : Vol. 61. - pp. 1-32.

**Fujita Masahisa, Krugman Paul and Venables Anthony J.** The Spatial Economy: Cities, Regions, and International Trade [Book]. - [s.l.] : MIT Press, 2001.

**Gabaix Xavier** Zipf's Law and the Growth of Cities [Journal] // New Ideas on Economic Growth. - May 1999. - 2 : Vol. 89. - pp. 129-132.

**Gabaix Xavier** Zipf's Law for Cities: an Explanation [Journal] // The Quarterly Journal of Economics. - August 1999. - 3 : Vol. 114. - pp. 739-767.

**Henderson Vernon** The Urbanization Process and Economic Growth: The so-what question [Journal] // Journal of Economic Growth. - 2003. - 8. - pp. 47-71.

**Ioannides Yannis M. and Overmanb Henry G.** Zipf's law for cities: an empirical examination [Journal] // Regional Science & Urban Economics. - 2003. - Vol. 233. - pp. 127-137.

**Katzman Martin T.** The Von Thuenen Paradigm, the Industrial-Urban Hypothesis, and the Spatial Structure of Agriculture [Journal] // American Journal Agricultural Economics. - 1974. - 4 : Vol. 57. - pp. 683-696.

**Krugman Paul** Increasing Returns and Economic Geography [Journal] // The Journal of Political Economy. - 1991. - 3 : Vol. 99. - pp. 483-499.

**Myrskylä Mikko, Kohler Hans-Peter and Billari Francesco C.** Advances in Development Reverse Fertility Declines [Journal] // Nature. - 2009. - Vol. 460. - pp. 741-743.

**NationMaster** NationMaster - World Statistics, Country Comparisons [Online]. - 2010. - April 2010. - <http://www.nationmaster.com/index.php>.

**Romer David** Advanced Macroeconomics [Book]. - [s.l.] : MacGraw-Hill, 1996.

**Rozenfeld Hernán [et al.]** The Area and Population: New insights from a different perspective on cities [Report]. - 2009.

**U.S. Census Bureau** [Online] // Population: 1790 to 1990. - 1993. - December 28, 2009. - <http://www.census.gov/population/www/censusdata/files/table-4.pdf>.

**United Nations** Human Development Report 2009 [Online] // Reports| Global Reports. - 2009. - <http://hdr.undp.org/en/reports/global/hdr2009/>. - May 2010.

**United Nations** Methods for Projections of Urban and Rural Population [Report] : Manuals on methods of estimating population - Manual VIII. - New York : [s.n.], 1974.

**United Nations** World Urbanization Prospects - The 2007 Revision [Report]. - New York : [s.n.], 2007.

**United Nations** World Urbanization Prospects: The 2007 Revision Population Database [Online] // United Nations: Development. - 2008. - March 23, 2010. - <http://esa.un.org/unup/>.