Dynamics of Urbanization and City Structures: Optimality and Sustainability

Yuri Yegorov[1], Vienna, Austria

27 July 2023

Abstract. *The paper addresses the dynamics of urbanization and cities, their structures, driving forces for evolution and sustainability. It addresses a variety of issues, starting from the history of urbanization in the world, difference across regions and driving forces for it. Industrialization as well as wage differential between a city and rural area often becomes a driver of urbanization. Cities grow heterogeneously and form a complex pattern of cities with different sizes, in interaction between themselves and with rural area. An equilibrium emerges at the level of a city, as a balance of attracting and repelling forces. Attracting forces are usually linked with scale economies, while repelling with congestion. Then it also emerges between cities and rural areas, as well as between the network of cities. There are also externalities and global challenges for future cities, including natural hazards, hazards driven by humans as well as consequences caused by global warming and green transition. The special features of urbanization in Russia are also addressed. It has urbanization caused by industrialization in the 20th century, but now suffers from low population density in Siberia and its rural areas, which makes an access to its high endowment of natural resources per capita difficult.*

JEL Classification*: J61, N30, N50, Q00, R00.*

Keywords*: urbanization, city, equilibrium, optimality, Russia.*

1. Introduction

The process of urbanization drives the global development today. The goal of this paper is to approach the phenomenon of urbanization from different perspectives. They include: dynamics of urban share, concentration in large cities, discussion about the drivers of structural changes, equilibrium in cities and between cities and rural areas. It also shows how those factors interact in the case of Russian cities.

We observe the fast growth of the share of urban population, especially in the 20th century. Around 2000 about half of the global population lived in cities (Fig. 1), while in more industrialized countries this fraction is 75-80%. Both urban and rural population grow, but urban is growing much faster. We observe that not only the urbanization level (fraction of urban population), but also the pattern of settlement differs a lot across countries. Not only the fraction of urban population matters, but also its distribution across cities of different sizes. Some countries (like Australia and Japan) have a very high fraction (above 60%) of population living in large cities (above 1 million), while in other countries (including rich Germany in Europe) this fraction is below 10%.

[1] This paper is prepared for the 62th ERSA Congress in Alicante, Spain, 28-31 August 2023. Paper # 465, Session G04: Urban-Rural Relationships. Author: Economica, Austria, e-mail: yuri.yegorov@economica.at ..

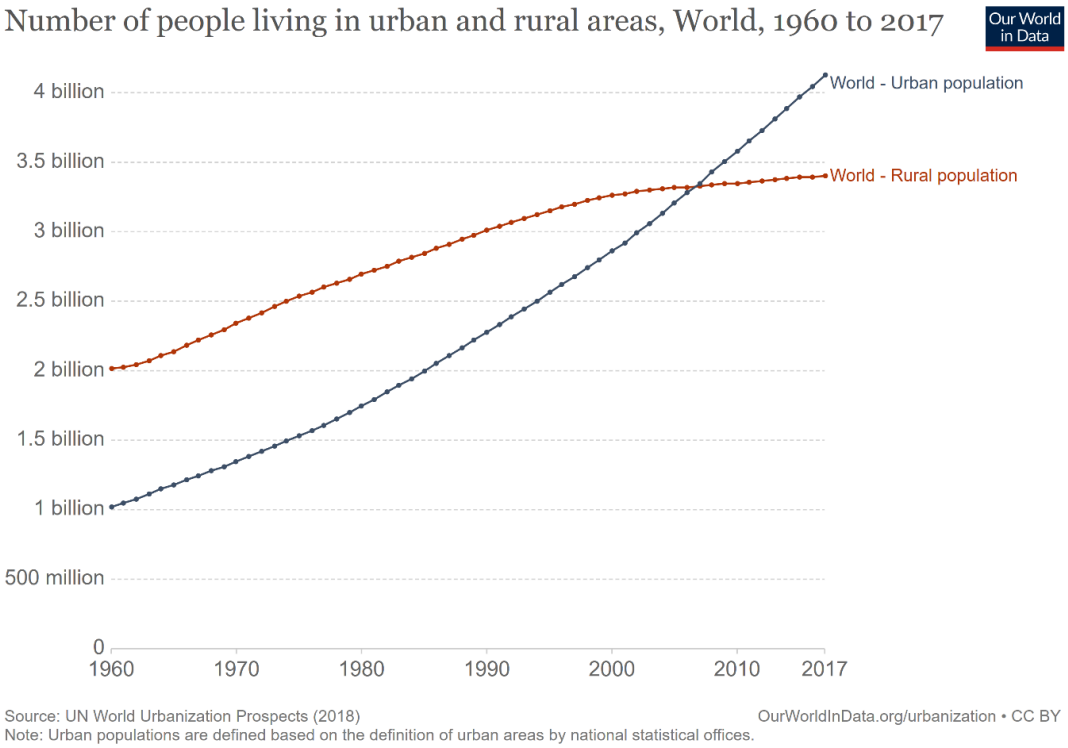

Fig. 1. Dynamics of urban and rural population in the world: 1960-2017. Source: https://ourworldindata.org/urbanization

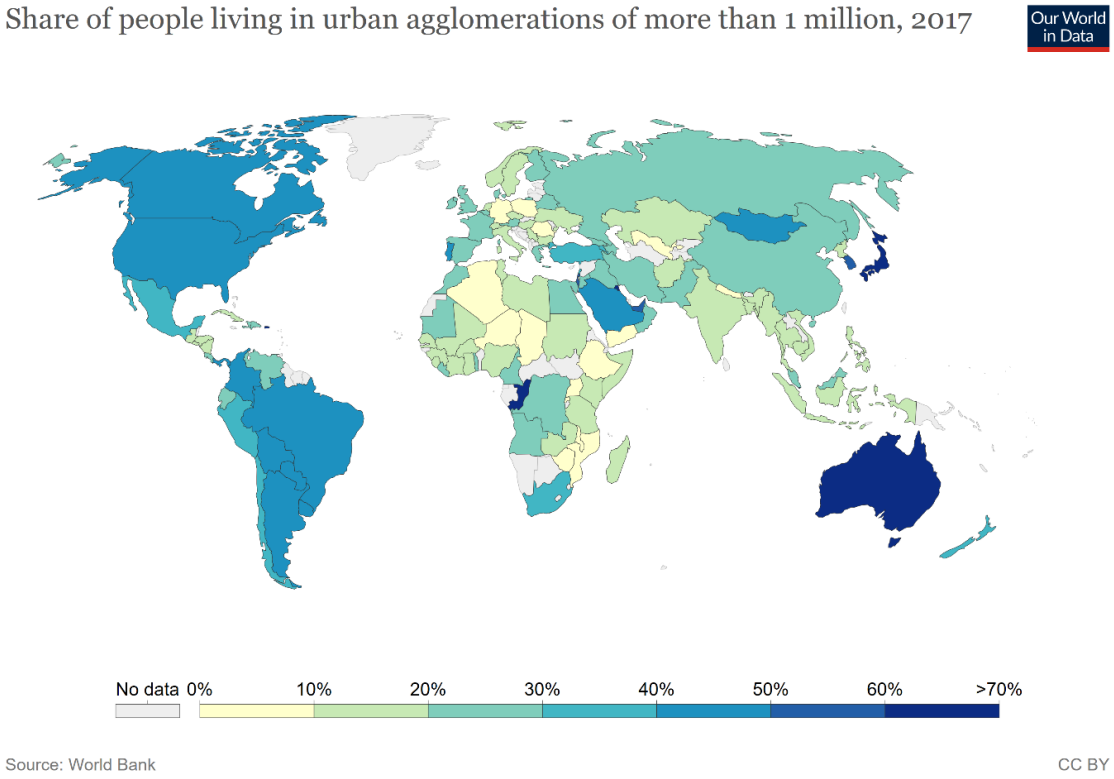

Fig. 2. Share of population living in cities with over 1 million inhabitants. Source: https://ourworldindata.org/urbanization

This fraction in the most of American countries is now between 40% and 50%. For most of the countries it is between 20% and 50%, which is a rather high concentration in cities-millionaires (Fig. 2).

The first goal of this paper is to find the drivers of urbanization and the changing role of cities in the historical period. The second goal is to understand whether contemporary challenges (global warming with shift to green energy, growing role of natural hazards as well as human driven threats (terrorism, pandemics) can weaken or increase the role of large cities.

Section 2 presents some stylized facts about dynamics of urbanization. Section 3 sketches the mechanisms responsible for city growth, as well as their interaction with rural areas and other cities. Section 4 addresses global challenges for cities and the question of their sustainability. Section 5 is devoted to a particular case of Russian urbanization. Section 6 concludes.

2. Dynamics of Urbanization

Consider the historical dynamics for the role of cities. Pre-historical humans lived in equilibrium with the nature, did only harvesting and did not need large communities. All population have been rural before the first structural change. Growth in productivity allowed to produce extra output beyond minimal food. Its distribution was unequal (Fochesato & Bowles, 2017). Then the first states emerged (Engels 1884). The conflict between states required build of defence and fortresses. Those fortresses included scale economies and were the drivers of city growth. Since agricultural activity is land intensive, it was impossible in cities, which became the home for craftsmanship, and later industry and services. Later the cities gained additional function of integrated markets, labour pools and innovations (Taylor, 2012).

More details about urban population growth are provided in the Fig. A1-A5 (Appendix). Countries like the USA, China and India have many large cities, while in many African and Latin American countries about 30-50% of the population live in one largest city (Fig. A2). Both world urban and rural population grow, but urban grows much faster, so that its fraction grows over time. It is expected that the absolute global quantity of rural population will peak around 2025 and then will decline (Fig. A4).

While first cities emerged several thousand years ago, the fraction of population living there, did not change fast. Before the industrial revolution most of GDP has been produced in agriculture. Fig. A2 shows that global rate of urbanization has been below 10% before 1800. Later this dynamic became heterogeneous across countries, being fast in the USA (the urban

share grew to 60% in the 19th century), followed by Japan (with growth from 10% to 90% in the 20th century. For China and India urbanization became fast in the 2nd half of the 20th century. Fig. A3 shows this process over longer historical period of 10000 years.

Fig. A5 shows the fraction of urban population positively correlates with GDP per capita. All countries with urbanization above 80% have GDP per capita above $10,000. This phenomenon can have several explanations, which will be discussed further in details. Clearly, low fraction of urban population means more rural areas and high agricultural employment. At the same time, higher income in cities does not imply higher utility, because price index (especially for housing) is also higher there.

3. Emerging of City Structures, Networks and Roles of Cities

The urbanization is not only quantitative, but also qualitative process. Cities are heterogeneous in many aspects, like size and wealth. There is empirically observed power law in the distribution of city sizes. It shows the absence of a unique optimal city size. There might be several reasons behind, among them: a) unobserved heterogeneity, b) disequilibrium process of growth, driven by scale economies, c) conflict of interests of investors and city dwellers.

3.1. City Growth, Scale Economies and Competition of Cities for the Population

Every city is a balance of centrifugal and centripetal forces. There are many papers devoted to this issue. On one hand, a city usually gives a higher wage comparing to rural area, and this drives rural-urban migration and is the source of city growth. On the other hand, prices in cities are also higher, and thus concentration of people gives negative externalitity. A balance of those forces gives an optimal city size. Since we observe distribution of cities of different sizes, equilibrium parametrically depends on other factors as well.

One quantitative model was suggested in (Mascarilla-i-Miro O &Yegorov, 2005). They also studied a question of two cities competing for people. Since both have scale economies, there might be no equilibrium, and one city can grow to its optimal size at the expense of other.

3.2. Interaction of Cities with Rural Areas and the Role of State in Equilibrium Dynamics

Von Thünen (1826) was the first to address the issue of equilibrium between city and rural area. He did that not only economically, but also in a spatial context, using 2-dimensional radially symmetrical space around an isolated city.

Christaller (1933) has developed the complex pattern of network of cities of different sizes and found that hexagon structure fits reality in the beginning of the 20th century in southern Germany and Austria.

Land as productive factor and transport costs interact and define the optimal size of plants as the trade-off between scale economies and transport costs (see Yegorov, 2016). Yegorov (2016) also presents a formal model of equilibrium between rural and urban areas, and their sensitivity to the prices of energy and agricultural goods. It was shown that rural population density is very sensitive to the price indices of both energy and agricultural goods. In the last decades those prices became highly volatile (especially near the crisis of 2008), and this made the whole structure of settlement suboptimal.

3.3. Emergence of Global Cities

The concept of global city was introduced in (Hall, 1966), who has defined them as the "central points for worldwide capital, production, talent and culture". The capital in those cities becomes an attractor for labour force, who migrates there. Friedmann (1986) views those cities as central points in spatial structure of the market. There were 18 core world cities (like London and Paris) and 12 semi-peripheral cities (like San Paolo). Sassen (1991) has developed the global city model, with global strategic role of them via economic, managerial, legal and executive functions.

3.4. Emergence of City Networks

A city network is formal or informal link between global cities. The global capital is highly incorporated within the major cities network structure. Friedmann (1986) claimed that the economic role of global (world) cities is assigned by TNCs as companies depend on global cities to be the platforms of TNCs global control capabilities.

Those networks can participate in global governance. The process of globalization is also driven by capital and TNC located in global cities.

3.5 Externalities in Cities

A city is formed by interaction between attracting and repelling forces. Attracting force is usually driven by scale economies. A larger city can produce more types of services, because some of them (like stadium, concert hall, specialized hospital) require minimal concentration of population (Trullen & Yegorov, 2003).

A city with the population about 1 million is often sufficient to accommodate all types of services. Further growth to 5-10 million creates congestion and high land rent. Further investment in its growth can bring profits to investors (via creation of new firms and jobs, but mostly important, additional land rent) but not the utility for its residents, who suffer from both congestion and high price index to rent a flat. At the same time, investors in flats benefit from this process. Yegorov (2017) have shown the growth of land rent component in housing price with the growth of city size.

From the perspective of citizens and state, it is better to have more smaller cities rather than few large, because this gives higher utility by lowering pollution, congestion and price index. But the interests of rich and investors in large cities move the process in opposite direction.

3.6. Capital Accumulation, Growing Disparity and Self Interest of Rich

Urbanization can create wealth from non-productive activity. This is collective land rent in a city, which is much higher today than the global value of agricultural rent. Yegorov (2017) has raised the question to whom it should belong. It is a collective phenomenon emerging from competition of people for the right to live in a particular city.

Harvey (1989) developed the concept of entrepreneurial cities, which attract capital and pull over multinational corporations to attract financial investments. He claimed that, born out of the spirit of capitalism, urban areas have merged political and economic activities and started to 'take the initiative' in the economic realm. This entrepreneurial character is widely criticized for worsening global social problems, namely inequality, by widening social division between low- and high-income classes.

4. Global Challenges and Sustainability of Cities

Today we observe many global challenges, and some of them come to large cities. Cities are vulnerable to both natural hazards and human driven hazards (like terrorism, pandemic).

4.1. Natural Hazards

Cities accumulate many residents and are vulnerable to natural hazards. Some hazards (like seismic) can be predicted statistically. Coastal cities are vulnerable to tsunami waves and the rise of ocean level (which can be medium term consequence of global warming, due to melting to ice in Greenland and Antarctic).

Transition to green energy is a remedy against global warming. However, its density is lower than for fossil fuels. Collection of wind and solar energy requires substantial territory,

and it is difficult to build a renewable power station of high capacity close to big cities, because territory is also expensive there.

4.2. Human Driven Hazards

Terrorism is human driven hazard. It became more important in the recent decades. Another hazard is caused by pandemics (like covid19). Cities are more vulnerable than rural areas because of higher population density.

4.3. About Optimal City Size in New Environment

The problem of optimal city size is usually approached as a balance between centrifugal and centripetal forces. This question can be addressed from either the position of central planner or by market forces.

The problem of central planner can be formulated like this: given the richness of the country, what would be the best allocation of its population on the territory to maximize the sum of individual utilities under given costs. Such approach was applied in planned economies, like the USSR and today in China. The problem is in biased measurement of individual utility by state.

If we allow for market forces to work fully, there is a possibility for externalities. The first is conflict of interests of developers and big investors (on one side) and residents, on the other side. Yegorov (2017) has calculated the dependence of the share of urban land rent in the total value of the housing in a city depending on its size. He also raised the question to whom it should belong. The problem of land rent is that it is a collective phenomenon of higher bids from residents willing to live in an attractive city. It does not contain construction costs, which are competitive. The willingness of people to reside in particular cities depends on their attractiveness (than comes from capital investment and jobs with higher wage). If a small city is as attractive from the wage perspective as a large one, nobody will go to large, because the congestion costs are higher there. At the same time, capital concentration in large (global) cities drives migration there, and the sizes grow above the level optimal for residents. This overgrowth is driven only by the interests of capital. Such allocation is not optimal (externality) and should be regulated. Now it is unclear is what manner a regulator can assign capital allocation across cities. Understanding the issue of emergence and ownership of global land rent and public discussions could be helpful.

New threats (consequences of global warming and pandemics) also work against large cities. Hence, the public interest might be in partial de-urbanization, especially for large cities. But the interests of private capital may contradict those interests.

4.5. About the Role of Monetary Disequilibrium

Czech (2013) argues that we currently undervalue agriculture. This can be another driver for urbanization beyond social optimality. High volatility of energy and food price indices also influences optimal allocation of people in space (Yegorov, 2016).

Departure from the Golden standard allowed to increase monetary mass beyond the global value of personally consumable goods. Price volatility for resources is caused much less by the changes in global demand and supply, but more by speculative activities in stock exchanges.

5. Special Features of Urbanization in Russia

In the case of Russia, the major transition from rural to urban settlement happened in the middle of the 20th century. In the beginning of the 20th century, 85% of Russian population was rural. Industrialization was fast in 1930-1940, accompanied by urbanization. In 1950, only 45% of people were living in cities. In 1960, already 53.7% of the population were living in cities. This positive rend of growing share of urban population was increasing till 1990, when it reached 73.4%. During the following 30 years the changes were slow, in the range 73% to 75%[2].

Russia, having the largest territory in the world and very low population density, is rich in both exhaustible and renewable resources. Today it concentrates more on exploitation of non-renewable resources (oil, gas, and metals) and exploits renewable resources even less than in the time of USSR. Extraction of exhaustible resources does not require large employment, contrary to harvesting renewable resources (like agriculture). In the last 50 years, many Russian villages have disappeared, especially in the North. Sustainable development of Russia needs higher dispersion of its population, because of necessity to harvest resources. In the USSR, there was wage premium in the Far East (in 1980 average wages in Far East were at 265 roubles per month, while in the central region they were at 165 roubles), and in 1960s the difference between in-migration to Far East and out-migration was 70-80 people per year per 10,000. Since 1992 this differential has declined, and out migration from Far East started to dominate (Yegorov, 1993).

[2] Source: https://www.macrotrends.net/countries/RUS/russia/urban-population

While in 1930-1950s urbanization was mostly driven by industrialization, afterwards rural depopulation was caused by bad agricultural policy, including not only low productivity due to climate problems, but also low wholesale prices for agricultural products. While in 1920s, Russian peasants could become rich (getting free land after the revolution of 1917), in 1930s moderately rich were named "kulaks" and expelled to Siberia[3]. The wages in collective farms were always lower than in industry[4], and this stimulated rural-urban migration.

The fraction of agricultural employment in the USSR was high for a long period: 48% in 1950, 39% in 1960, 25% in 1970 and 20% in 1980[5]. This was explaining why urbanization was not too fast, and the fraction of rural population was still above 25%, including the present moment. Note that many cities in the USSR were built for a certain industry, and the major employment was in the largest plant of that city. Transition of 1990s caused bankruptcy for a large fraction of industrial plants, and those cities had high unemployment. This stimulated out-migration either to large cities (Moscow, St. Petersburg), with employment opportunities in many sectors, or to rural areas.

Low population density in Russia has both positive (higher resource per capita) and negative effects. In particular, low population density creates problems with building dense infrastructure, making it impossible to deliver resource to a large distance, and having no local demand (Yegorov, 2009). For a return to efficient growth, it is important to create stimulus for relocation of population (like those in the USSR). While Russia still relies on resource exploitation, it is necessary to have a higher rural and Siberian population density to have access to them. In the case of re-industrialization there will be recovery of production in low populated areas because of closeness to resources (in line with the work of Weber, 1909).

6. Conclusions

This article presents some ideas about the complex process of urbanization. It is no longer a mere spatial division of people in rural and urban areas in order to either engage in agricultural production and harvesting mineral resources (rural) or in manufacturing and services (urban). We observe a tendency of continuing growth of urban population and a tendency of stabilization of the global rural population. Both the fraction of urban population and their distribution in cities of different sizes differ across countries. Some countries (like Australia) have a tendency

[3] Source: https://en.wikipedia.org/wiki/Agriculture_in_the_Soviet_Union
[4] Industrial wage in the USSR was 109% of the national average in 1955-1987
[5] Source: https://www.marxists.org/history/ussr/government/economics/statistics/worker-dist.htm

of dominant growth of cities-millionaires, while in others the capital becomes the major attracting centre. In other countries (like Germany) there is preference to live in small cities.

This shows that the mechanisms driving city growth can differ across countries. Very often wage differential between a city and rural area becomes such a driver. But in other cases not all cities are equally attractive, and even not all large cities are equally attractive. The difference can be explained by closeness to political power (migration to a country capital city) or membership of a city in some global network of cities, which gives some wage and employment advantage.

Cities grow heterogeneously and form a complex pattern of cities with different sizes, in interaction between themselves and with rural area. While von Thünen (1826) was the first to study such equilibrium pattern between a city and rural area around, there was not so much research about this issue later. Yegorov (2016) tries to explain such interaction and equilibrium between urban and rural areas. Such equilibrium is determined by complex spatial optimization process and is sensitive to key parameters (like food and energy prices) which became very volatile recently. This means that measures of make price volatility lower serves the interest of optimal allocation of population in space.

While cities have their own interests, the optimal location of population in a country should be a balance between urban and rural interests. Not only the interests of large cities (driven by capital concentration there), but also the interests of smaller cities and rural areas should be taken into account by central planner.

Cities are facing many challenges including natural hazards and hazards driven by humans. Climate change and a necessity of green transition can make further urbanization non sustainable and even reverse it.

The process of urbanization in Russia and the USSR was driven by industrialization in 1930-1950s. Further there was state policy to relocate people to Siberia and Far East by an incentive of wage premium. However, the reverse of incentives in 1990s (caused by liberal reforms) made a shock for this settlement which was optimal for harvesting of natural resource and related manufacturing.

Literature

1. Czech B. (2013) The Supply Shock: Economic Growth at the Crossroads and the Steady State Solution. - New Society Publishers, 367 p.
2. Christaller, Walter. (1933) Die zentralen Orte in Süddeutschland. Jena: Gustav Fischer

3. Engels F. (1884) Origin of the Family, Private Property, and the State. - Hottingen-Zurich.
4. Fochesato M., Bowles S. (2017) Technology, Institutions, and Wealth Inequality over Eleven Millenia. – SFI WP 2017-08-032.
5. Friedmann, J. (1986). The world city hypothesis, *Development and Change*, 17, pp. 69–83 (reprinted in: N. Brenner and R. Keil (Eds) *The Global Cities Reader*, ch. 7. Abingdon: Routledge).
6. Hall P. G. (1966). *The World Cities*. London: Weidenfeld and Nicolson.
7. Harvey, D. (1989). From managerialism to entrepreneurialism: the transformation in urban governance in late capitalism. *Geografiska Annaler*, 71B, pp. 3–17.
8. Mascarilla-i-Miro O., Yegorov Y. (2005) Modelling Functional Area and Commuting Flows, *Cuadernos de Economia*, vol.28, p.39-56.
9. Sassen, S. (1991). *The Global City: New York, London, Tokyo*. Princeton, NJ: Princeton University Press.
10. Taylor P.J. (2012). Extraordinary cities: Early 'city-ness' and the origins of agriculture and states. *International Journal of Urban and Regional Research* 36 (3): 415–447.
11. Trullen J., Yegorov Y. (2003) Polycentric Urban Models. - University of Barcelona, unpublished manuscript; DOI: 10.13140/RG.2.1.1194.9607.
12. Von Thünen (1826) The Isolated State.
13. Weber A. (1909) Über den Standort der Industrien. Erster Teil: Reine Theorie des Standorts, -Tübingen.
14. Yegorov Y. (1993) Russian Economic Migration. – Graduate Research Paper, CEU, Economics, Prague, 45 pp.
15. Yegorov Y. (2009) Socio-economic influences of population density. - *Chinese Business Review*, vol.8, No. 7, p.1-12.
16. Yegorov Y. (2016) Population Structures in Russia: Optimality and Dependence on Parameters of Global Evolution, *Region*, v.3(1), p.87-104.
17. Yegorov Y. (2017) Aggregate and Average Land Rent in Cities", paper # 560, 57th ERSA Congress, Groningen, the Netherlands, 29.08-01.09.2017.
18. Yegorov Y. (2018) Modelling of Growth and Collapse of Empires. - Presentation at the 14th Viennese conference on Optimal Control and Dynamic Games, 3-6 July 2018.

Appendix. Figures

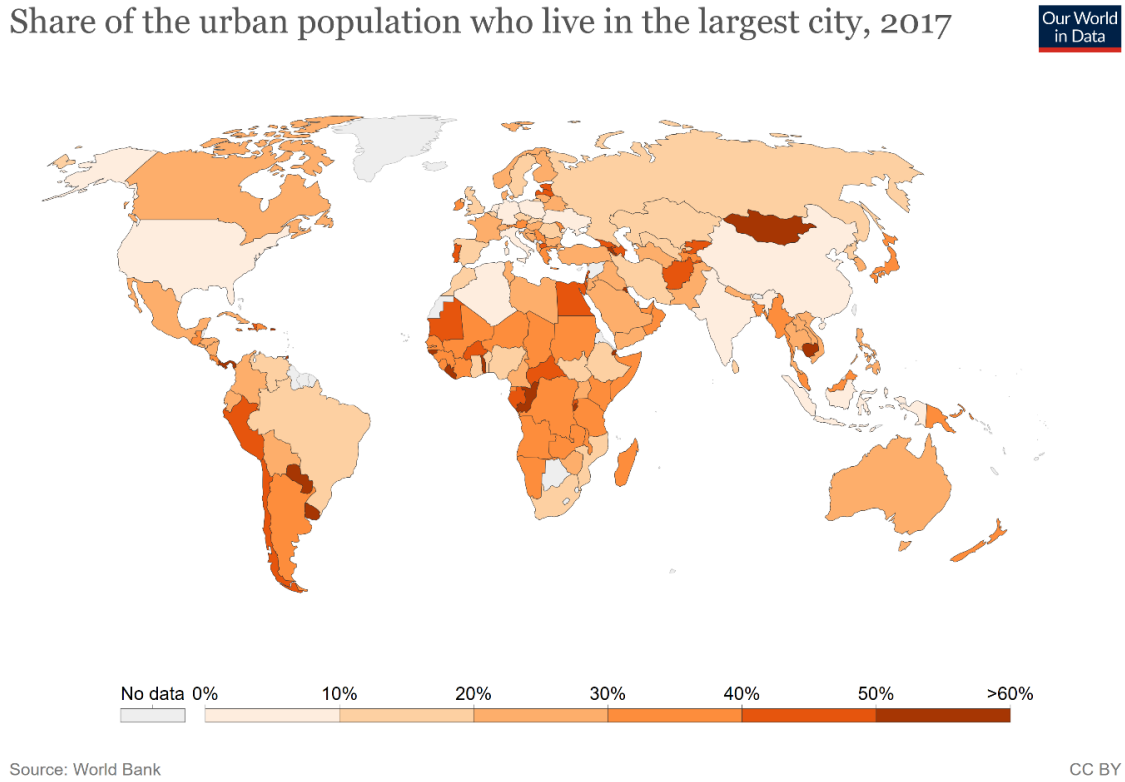

Fig. A1. Shares of country population living in the largest city in 2017

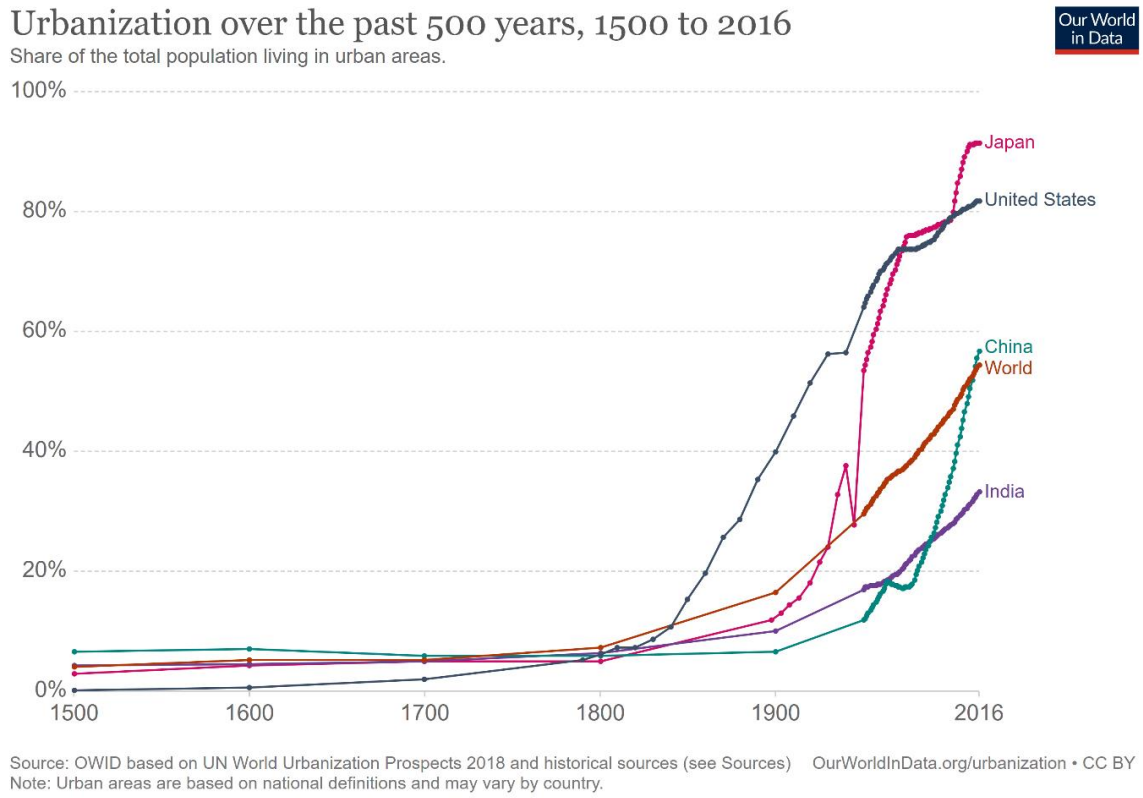

Fig. A2. Urbanization dynamics over 500 years

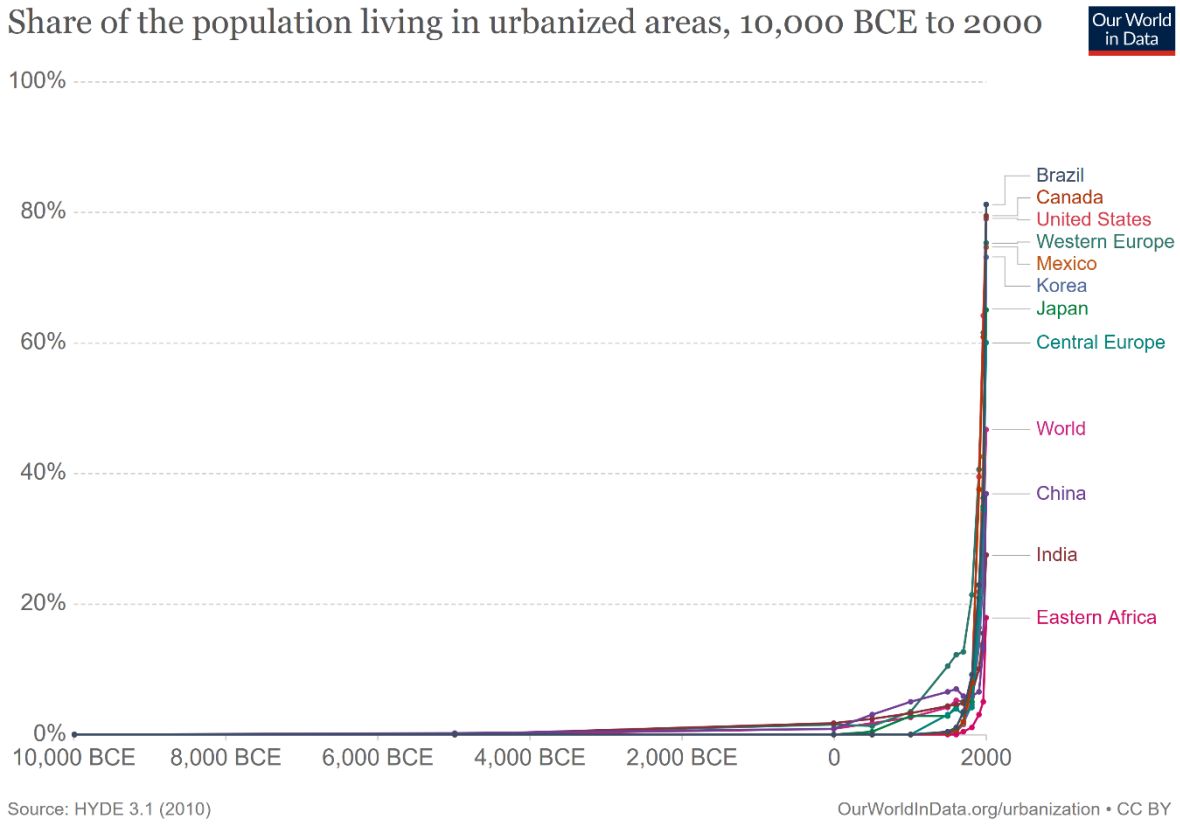

Fig. A3. Urbanization dynamics for 1000 years.

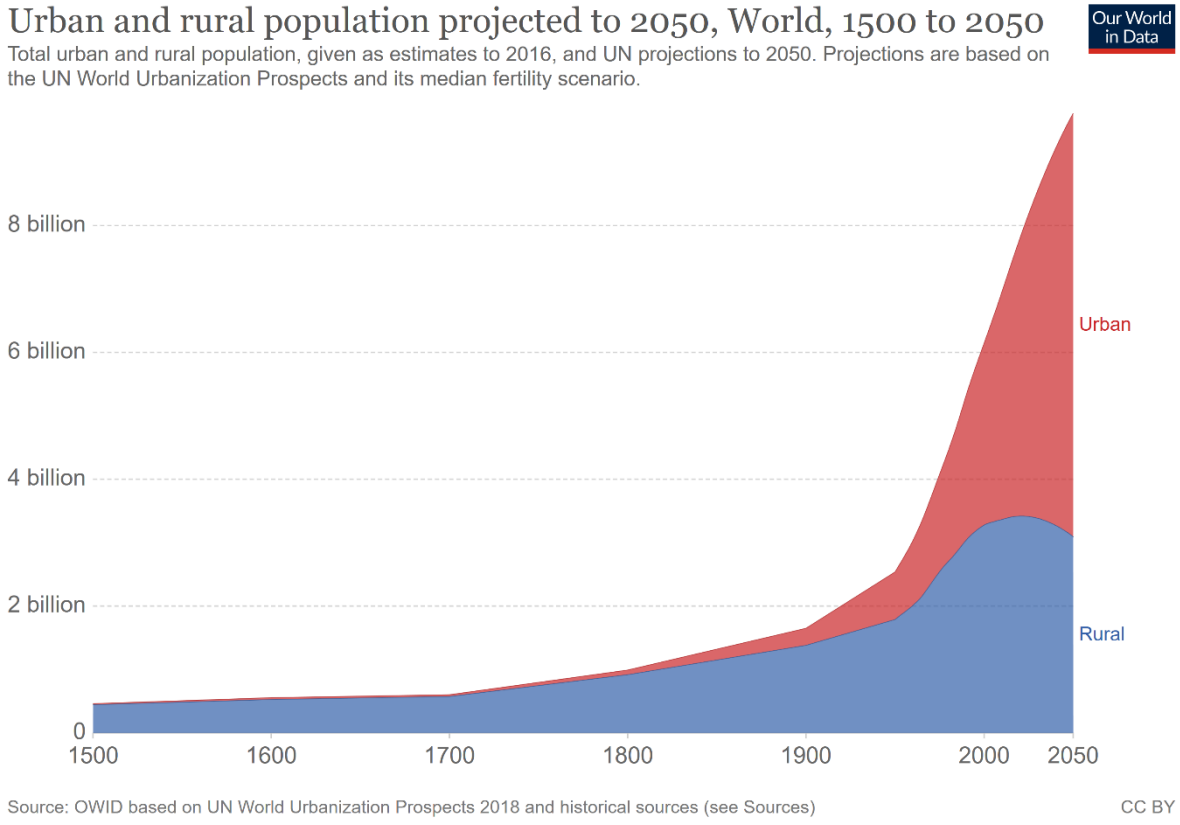

Fig. A4. Dynamics of urban and rural population and projection till 2050.

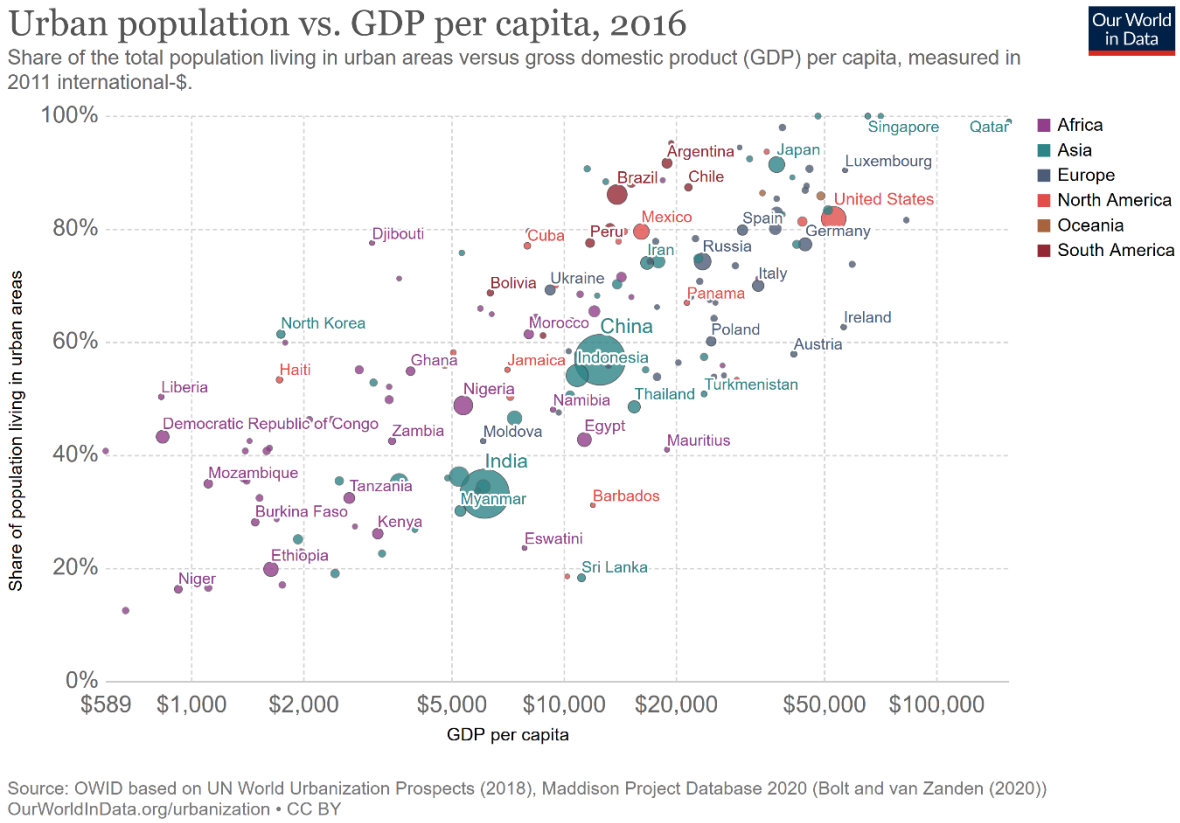

Fig. A5. The fraction of urban population and GDP per capita.