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INTELLIGENT CITY IN URBAN ECONOMICS AND REGIONAL SCIENCE

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Abstract: The article presents the concept of intelligent city. Cities are unquestionably central to many topics in economics and regional science: the business location, the driving forces for business, the economic growth factors, externalities and amenities, knowledge spillovers and knowledge hubs. But what, exactly, is city in this context. This paper argues that today city should be seen more as an intelligent economic system allowing the utilisation of economic and public value than a technology-rich and smartly managed place. Thinking about cities through this particular lens allows insights from a variety of fields – including public services analysis in urban economics, regional science studies and business studies in economic geography – to be applied. This opens new approaches to issues such as institutional and territorial origins of governance processes.

Keywords: City models, economic and public value, intelligent city, knowledge, urban growth and development.

JEL codes: O14, O18, R11

Introduction

The present study focuses on the need for an in-depth discussion on the concept of intelligent city. It seems particularly important in the context of the diluted and multiple meanings that can be found in the studies published in the last two decades on the idea of so-called smart cities (Mora & Bolici; Deakin 2017). Similarly to Komninos (2008), we assumed that we should differentiate between the specific nature of an intelligent city and the broadly understood smart city concept. In

addition, in Polish conditions a linguistic specificity occurs and certain media slogans are used to develop an idea that is equivalent to the term *smart*, sometimes translated as the adjective *intelligent* (Pol. *inteligentny*).

The proposed concept of intelligent city is referring to four connected ideas: so-called knowledge cities (Carrillo 2004, 2006; Erzakis *et al.* 2004) and learning cities (Glaeser 1999), Madanipour's spaces of knowledge (2011), Crevoisier's economic value of knowledge (2015), and public value of knowledge (O'Flynn 2007; Benington 2009; Moore 1995, 2013). Therefore, we may assume that the justification for the proposed concept (*i.e. intelligent city*) offers an alternative to the commonly accepted logic of the strategic thought provided for in the smart cities policy. With regard to the latter, it seems that too much focus is put on technological aspects, which results in a loss of the image of competitiveness and attractiveness of cities in the context of pragmatic values of economic and social growth in the city.

In conditions of: a) rapid transformation of urban space formed in the processes of implementation of new technologies, b) creation of new types of specific public space, c) evolution of the institution of the market and d) new behaviour patterns of stakeholders, new knowledge is generated that changes the functioning of the city and its organization, adding new values to the knowledge that can be parameterised and presented in the form of a new economic and public value. The main objective of this study is to attempt an epistemological verification whether the specific nature of knowledge in conditions created by contemporary urban spaces, markets and technologies which allow for adding economic and public value to its effects can be considered a factor strengthening urban and regional growth. The attempt of such reasoning is based on positive approach (Bish & Nourse 1975: 4). It is worth noticing that global corporations that develop the smart city idea for the cities in application terms are generating a certain technological pressure. Hence the question to what extent this pressure depends on acquiring new values for specific knowledge and how it affects the city's economic growth, as well as whether it is a burden or a trigger along with other values of knowledge applied in the cities, knowledge under the growing „intelligence of the city".

The first part of the study is devoted to the identification of the specific nature of economic models of a city. It forms the basis for formulating preliminary guidelines for the positive model of the conceptual intelligent city. The examples used below refer to the development of the core of this idea and the outline of operating regularities of this model.

1. Economic models of a city

According to Stiglitz (2000: 21-23), *...economy is... an extremely complex structure; to see what is going on, and to make predictions about what the consequences of a particular change… can be, one needs to separate out the essential from the inessential features... The fact that models make simplifying assumptions, that they leave out many details, is a virtue... Everybody – politicians as well as economists – uses models in discussing the effects of alternative policies (including that of local governments – author's note). The difference is that economists attempt*

to be explicit about their assumptions, and to be sure that their assumptions are consistent with each other and with the available evidence. Therefore it can be assumed that for an economist the idea of such defined model is useful above all for the assessment of regularities governing economic changes, or for learning other dimensions of those changes. For politicians, such models may constitute the basis for drawing normative conclusions about the desired conditions[1]. In this study, we assume that the economic model formulates certain hypotheses that can be considered relevant in the light of urban regularities analysed in subsequent studies. Verification of the preliminary model should allow for a relatively accurate description and offer the possibility of an approximated assessment of "reaction" of respective entities or space to different variables. Therefore, it is assumed that the need to compare the benefits and the costs of actions taken in the public area generates other type of thinking, focused on normative aspects that allow for the search of the best solutions in terms of the expediency criterion.

We may divide economic concepts explaining the meaning of factors having impact on the specific nature of the economic development into those based on material factors, or where such factors prevail (labour resources, financial capital), and those which indicate the crucial importance of non-material factors of territorial development (intellectual capital, enterprising approach, technologies, networks *etc.*). In the regional or urban context, economic studies also note that processes of changes observed in cities can be determined by many different factors integrating certain spatial forms. One cannot disagree with the assumption that non-material factors play and will be playing a fundamental role for the processes of growth and development of cities and regions. This view has been popular since the 1990s and it is represented by the theory of so-called knowledge economy (Lundvall 1992; Lawson & Lorenz 1999; Lundvall & Maskell 2002; for Poland, see Gaczek 2009). Technological changes considered the key driver for the possibilities of economic development were the subject of particular economic research of Romer (1986) and Lucas (1988), who dealt with their effects in the form of so-called knowledge spillovers. Lundvall (1992) and Nelson (1993) noted the relationships between entities resulting from formal and informal rules and roles (institutions). For them, such defined institutions were a causative factor of the development at the national level. In principle, regional importance of non-material factors has become more widely discussed in the context of the works of Krugman, Porter and Cooke. The latter (1992) reinforced the significance of relationships of institutional nature using innovation in the spatial dimension and developing the concept of regional innovative systems. Porter (1990) conditions competitiveness of companies on the agglomeration of industries and cluster relationships. Undoubtedly, non-material factors in regional and urban concepts were popularised in particular in the works of Krugman (1991) inspired by the specific nature of agglomerative benefits and spatially attributed benefits of knowledge. Marshall's research (1919) also experiences a certain revival. The multitude of approaches underlining the

[1] This reasoning seems closer to the idea of a smart city as technological change and public benefits determined by the trends promoted by politicians and large corporation lobby.

significance of non-material factors for economic changes in cities and regions has been intensifying since the beginning of the 1990s. One of the reasons was the creation and dissemination of the so-called knowledge economy concept. It seems that the currently dominating trend, much discussed and considered the determinant of change, is creative activity and innovations in cities (Trullen *et al.* 2013).

On the one hand, we may talk about an evolution of analyses of the processes of economic growth in cities and regions. On the other hand, the guidelines adopted for certain concepts explaining components of changes in cities and regions, which have been considered classical to date, are also verified. One example can be the economic base theory, which was verified in modern times. The importance of the so-called residential segment for urban development processes is emphasised (see Segessemann & Crevoisier 2016). Also the research techniques and tools associated with spatial analysis of social and economic processes, so firmly emphasised by Isard (1960) and the regional science advocates, are changing. New techniques and new research trends allowing for observation of the increasingly complex models of urban economic growth and development lead to a clear conclusion that non-material factors prevail over the material ones. It is the former that trigger and preserve economic changes, but also form the social and cultural image of cities, metropolitan areas and regions. One may note that among the tendencies which accompany the "emergence" of new factors of urban economic growth is accumulation by urban economies of agglomeration status of many external processes, using its connections with global corporations or other economies of metropolitan status. These relationships, temporary or long-lasting flows (Domański 2012) between cities result in a situation where focus is put on the types of impact that have only been partially analysed to date and that are so important for the processes of change. Similarly, cities of non-agglomerative nature, or smaller centres, can change under the influence of the so-called borrowed functions/borrowed markets from other cities and regions (Meijers *et al.* 2016, Meijers & Burger 2017). In addition, the "turbulence" of contemporary global economy, its susceptibility to various shocks, is the reason to seek new driving forces behind changes in cities and regions due to the need to diversify business activity, or to escape from the industrial monoculture. Those who think that sheltered economies better deal with economic shocks (Fratesi & Rodriguez-Pose 2016), are wrong. Globalisation of activity is exerting pressure in territories to create the competitive position of companies and sectors on the basis of innovative circles (Jewtuchowicz 2005). Civilisation trends, or technologisation, strengthen the significance of creative economy with its different sectors in cities and regions (Klasik 2011).

The above tendencies give rise to in-depth analysis of the importance of factors generally recognised under different concepts, but above all to the search for new factors, with which urban economies are transformed, stabilise the position of the existing industries fundamental for economic growth, or trigger the development of new sectors of growth. In the context of economic research, under the positive approach, such works can be developed due to the availability of new research techniques supported by ICT or GIS tools, where the latest models illustrate the topicality of scientific ideas, concepts and theories of growth of urban and regional

economies (see *e.g.* Contin *et al.* 2014). It also applies to normative models, plans, policies and strategies formulated with the use of constantly improved strategic planning tools or foresight studies (see *e.g.* Klasik *et al.* 2014).

Models of economic development of cities defined by Trullen *et al.* (2013) are based on the organisation and the specific nature of business activity, the effects of which are the source of advantages gained by businesses, and in consequence also affecting urban and regional growth, as well as social and cultural and spatial aspects of changes in cities. Apparently new types of activity and new consumption models, new definition of status and prestige, new needs related to lifestyle and new ways of building ties in cities, stimulate innovation and creativity. They are triggers of changes in the economic organisation of companies, spatial organisation and changes in the specific nature of production. After exceeding a certain critical mass, urban environment can influence not only urban management profile, but also urban economic profile with its sectors and business locations. To date, it seemed that the reverse was true.

Trullen *et al.* (2013: 237-244) believe in evolutionary nature of urban change. The first of the abovementioned models, the Taylor urban model (1900-1945) assumes specialisation and division of work with effects in the form of benefits of scale. Ford urban model developed after 1945 (theoretically until 1970) is mainly described in the context of effects of scale and mass production possible due to specialised machines, the rise in wages and salaries, increased demand for labour, and standardisation of the demand for products. Therefore, cities are developing mainly as monocentric structures, small metropolitan areas or megaregions are created. Flexible city (1970-1085) is a place where production processes are subordinated to the just-in-time formula and where focus is put on the high capacity to adapt to changes, resulting from the specific nature of demand. This urban model generates MAR effects (Marschall-Arrow-Romer), *i.e.* agglomerative effects associated with benefits related to location. Cities are becoming more polycentric, larger metropolitan areas are developing. Megaregions consolidate. Characteristic features of this urban economic model include *e.g.* cluster forms or industrial districts. Information city (1985-1995) is described as an economic model where business focuses on networking, developing the availability of ICT techniques and using the opportunities offered by globalisation processes. Business is generating profits mainly due to the spatial mobility of external benefits. Not only MAR, but also Jacobs external effects are important in this respect. Therefore, we may state that the source of business development is the search not only for the location with benefits resulting from regional specialisation, but also for the diversification and diversity of available resources. The years 1995-2020 are referred to as the knowledge city model. Creation, use and exchange of knowledge is the core aspect of this model. Cities become centres offering knowledge necessary for business development mainly due to the closeness of knowledge infrastructure, but also to the skills that are essential for the application of knowledge that are made available for urban communities. Apart from the benefits mentioned above with regard to information cities, additional profits are related to the competitiveness of cities. Cities compete with each other in terms of their knowledge capital and the ability

to accumulate new knowledge. Almost at the same time, the creative city model is developed (2005-2020), where business is using creativity as the basis for creating innovations. Creative economy is a combination of business, culture and art, whereas cities become "melting pots" of creativity. All urban models defined for years 1985 + are based on non-material factors and mark the beginning of strong networking of cities, their polycentrisation, as well as global expansion of megaregions (*e.g.* US, China), or strong global metropolitan areas (Europe).

2. Economic model of an intelligent city

The above typology of cities allows for at least two observations. Firstly, cities have considerably changed their economic models, and city authorities who seek to use such changes in order to maintain economic growth and improve the living conditions must notice that cities in the economic and social dimension have become extremely sensitive to their relationships with the surrounding environment. Secondly, due to common human mobility, cities or perhaps rather urban areas combining the functions of work, residence and leisure have become areas with a growing openness and dynamics of change. Competition as the condition of urban economic growth is stronger than before associated with constant improvement of offers that increase the quality of life. Therefore, it seems that a new economic model is needed. One may assume that it could be an intelligent city model, where localisation and urbanisation economies are directly correlated. Such model assumes, firstly, that as fast as it is the case with ICT technologies, information whose acquisition has been expensive to date now becomes accessible, similarly to the knowledge accumulated in cities by companies or business circles becomes the basis for learning how to generate economic value and public value. Economic value is generated with the use of different types of available knowledge in the physical and virtual urban space. Such knowledge is available not only due to university-based scientific activity, or research activity in companies, but by the publication of open data or knowledge of different users sharing it with others. Secondly, economic value does not only apply to the business sector, but also to the city and its space. It is used to create public value. This is possible as a result of the cooperation and institutional solutions, as well as dedicated urban technological solutions. For the public sector and businesses, the foundation is the co-created and co-exploited knowledge, which is signalled by the wide spreading concepts of sharing economy and knowledge as commons. According to Rifkin (2016: 257-258), *The global collapse of the Second Industrial Revolution economy in the summer of 2008 was a wake-up call... There was real worry of another Great Depression – we settled for calling it the Great Recession... For the first time, millions of families began to look over all the stuff they didn't need and hadn't even fully paid for... The distributed, collaborative nature of the Internet allowed millions of people to find the right match-ups to share whatever they could spare with what others could use...* Rifkin's appeal to recognise the collaborative economy, the sharing economy based on zero marginal costs, as equal to the capitalist economy thanks to effects of scale, gives raise to radical challenges. Some

of them are related to the learning of rules and roles by users, and trying to control external effects. To use only two examples, planning processes in urban space, or provision of public services, are a particularly convenient area to potentially include the user's knowledge and to create public value. Business processes referring to co-production models, or the idea of open innovation, allow for the generation of economic value and the use of external effects. The difficulty lies with the "integration" of public and business value and with the development of an urban model (economic model of an intelligent city) where it is possible to achieve a long-lasting positive snowball effect (or rather the effect of a certain critical mass of changes) based on new or improved business offers and new or higher-standard urban offers. Urban markets, spaces and technologies not only create the physical conditions for company location, but they form the basis of identifying the business and public value. Therefore, it should be hypothesised that the availability of knowledge in *urban technologies* and urban spaces as well as classically understood (i.e. after the regional knowledge production function) sources of knowledge is a causative factor in such model.

Traditional regional knowledge production function using the Cobb-Douglas function assumes that investments include research and development in industrial laboratories, at universities and in research institutes. It is assumed that as a result of knowledge spillovers from public units, according to Jaffe's studies (1989), the economic effect of technological knowledge applied by businesses is being locally strengthened. This was confirmed by the expansion of that function by Feldman and Florida (1994). It was not until the studies of Anselin et al. (1997) and Varga (1998) that it was proved that effects in the form of increased ability to generate innovative products due to research processes differed in terms of the spatial range, in the sense that university research had on average three times smaller spatial spillover range compared to the research conducted in industrial laboratories. Two issues are worth noting. Firstly, a simple function requires taking into account of both the intraregional and the interregional flows. More complex types of analysis using the knowledge production function have been developed mainly after 2000, as the criticism of the baseline model. They are taking into account *e.g.* (a) internal variables relating to cooperation and business relations, specialisation and diversification of business activity, or mobility; and (b) external variables: share of foreign capital, participation in the research under the EU framework programmes, capital ties with corporations (multinational parent / affiliate), imports, patents, or migrations (see Varga and Horvath 2015). Secondly, the research confirms the significance of technological knowledge in the local scale for effects achieved by businesses in the form of economic value; in the case of Anselin and Varga studies, spatial range was determined as statistical metropolitan areas in the US). Little do we know about the effect that can be achieved in the form of public value and its integration role in the context of business effects.

Therefore, the intelligent city model does not only focus on innovative activity "thanks to cities", as it is embedded in business processes of companies located in those cities, or in their functional areas. It is also about the specific nature of the public sector, with its local government segment, which both due to business and

global pressure, but also to social and civilisation pressure, is using new solutions, new technologies in the process of creating, financing and providing urban offers, and it is opening to changes inspired by different urban users. Such measures are becoming one of the key driving forces for business and social activity, as well as an opportunity to initiate new sectors that are vital for urban economy. As it is the case with the reverse economic base theory where it is demonstrated that residential sectors might possibly be important for the economy, here it is possible to formulate a hypothesis that new emerging sectors combining public value and business value will form a durable foundation of economic growth and improvement of the quality of life in the age of sharing economy.

The adopted assumptions allow for asking the question to what extent cities are ready for and interested in the analysis of such processes in the economic sense, to what extent such logic is the basis of investment decisions, to what extent using the category of effectiveness of the achieved objectives prevails, and to what extent the fair share of the offer is such a basis. System conditions are also relevant in this respect.

3. Public services as one of the main pillars of the intelligent city model

In urban economy, (urban) public services play a special role. The supply and the demand for urban public services follow other rules than those applicable to commercial services. Public services which involve local government segment of the public sector are mainly services that are spatially "assigned" to the given city, functional area (agglomeration), or region. Therefore, it can be assumed that the economic area of services in the operating sense is mainly affected by such factors as: the number of recipients in a given area, the spatial scale, the competitive and complementary offer and the cost of its production/provision. Their financing involves public funds, and their specific nature often excludes using only the economic calculation for their implementation. Therefore, provision of public services, by definition offered as goods (also the common good) available to the community, faces a number of problems related to the unreliability of market mechanisms. As a result, the final price for the recipient often does not reflect the cost of the services. The price for the recipient may of course result from the rules of market calculation of costs; nonetheless, given the public character of goods, occurrence of external effects and creation of a natural monopoly may also be dictated by certain political decisions or system regulations where the approach based on maximisation of public availability of the offer for the largest possible group of recipients can prevail. Such a framework of urban economy very often triggers the search for new solutions related to the efficiency, effectiveness and fairness of their provision (Kuźnik *et al.* 2013).

For entities which are naturally responsible not only for their social assessment related to the standards, but mainly for the economic side of the services offered

under urban economy, provision of the services as such is less important than its incorporation in:

- the logic of the urban product value chain;
- urban infrastructure and technologies which improve productivity and results and reduce transaction costs for all city users;
- the process of learning in local circles, in segments of the knowledge-based economy; knowledge-based communities.

Such mechanisms determine the fundamental questions whether:

- to take into account the fact that the product is created in the value chain – from the creation, through distribution, to consumption, and what the consequences for future product development are;
- to treat "modern" urban products as a source of economisation of users' activity – *e.g.* a road facilitating commuting and reducing costs, rather than a road described by express road parameters hence with permanent traffic jams...
- to treat urban products generating new spillover solutions (with the innovation "spiral") as priorities.

A key aspect of urban services (products) management is the constant process of mutual activation and learning of business, scientific and political local (supralocal) circles. Here, learning is not a linear process, but a stepwise one, and seeking new solutions including innovative urban products is its essence. Cooperation using such foundations for the economy of modern urban products is absolutely critical for the benefits gained by urban users. Consequently, entities offering services are becoming a part of the wider ecosystem where permanent social innovation processes emerge. On the one hand, development of new behaviours and new trends in the area of public urban services is often the result of social innovations; on the other hand, it is becoming the basis for identification of new solutions, implementations, which in time may take the form of public innovations. Unlike technological innovations where the key factor is technological progress, social innovations are affected by new social practices, or new forms of product organisation. They often become the basis for negotiating new forms of co-governance and co-management in the cities. The origin of social innovations also lies with social entrepreneurship. They are derived from entrepreneurship of entities being members of social organisations, whereas innovations are reflected in mechanisms of satisfaction of not yet fully satisfied needs. Nevertheless, as it is underlined today, social innovations are not exclusively attributed to social organisations. They can be and often are initiated by politicians or public organisations.

Social innovations are important for urban economy, taking into account the need to overcome certain barriers for development, such as those related to climate or ageing processes that can only be take place due to social innovations. Thus, social innovations are new ideas which allow for responding to social needs without maximisation of profit. An innovation awareness of the trigger is the niche between what is and what should be and between what users expect and what is globally offered by local governments, companies and non-governmental organizations today. Creation of new technologies and new knowledge supports the development of such niches both by users and by businesses.

If we assume that business activity that can be observed worldwide is the source of inspiration and creation of new products, to the same extent as internal ideas in a company, and if we accept that it is difficult to build a team of the best professionals within a single organisation, and that apart from being generated, knowledge should also be transferred and disseminated, our activity may be referred to as the beginning of operational thinking about the new urban economic models. Such assumptions form the basis of the so-called co-production of services with regard to local benefits for which the local government is responsible. Co-production of services is understood as a repeated interaction between the professional back office of the operator providing the services as and the users in order to pro-actively discover, understand and meet current and future expectations. Thus, co-production does not assume a purely reactive activity complementary to social expectations. Such perception of public services results from the possibility to involve the user in the cooperation process; therefore, it does not need to apply to all components of public services, or to all public services. Its scope is determined based on three levels of activity. Firstly, it is the so-called "clean" consumer co-production, aimed at quality improvement and at affecting the existing public services offered in the cities. Secondly, focus is on the so-called participatory co-production, where the improvement refers to the planning process of the already existing services due to social engagement. Finally and thirdly, advanced co-production of services is defined as the one that combines experiences related to the used services while improving their quality and specific nature on the one hand, and participatory planning of this part of the services that permits to create new approaches to the provision, implementation, or improvement of services, while becoming a basis for innovation in the public sector on the other hand. Each time the object around which the co-production is rationalised is knowledge and its flows. At the stage of testing or contracting services it is possible to have knowledge about the conditions of their spatial provision, but not fully see the specific nature of the dynamically changing local labour markets, or the specific nature of social exclusion. Therefore, user's knowledge may be essential for each of the abovementioned model situations not only for the improvement of the services or increasing its standard, but also for generation of new fragments of the services in an innovative manner.

This practice, applied in cities, shifts the focus from the classical innovative process set to generate business benefits based on the available knowledge, towards interaction in support of the community and inclusion of the user as a collective supply of knowledge. Provision of information about urban processes under open data systems is not only one of the possible streams of knowledge about the improvement of public services which as part of enterprising search for the possible changes may take the form of social innovations, as it is generally used by such corporations as IBM or SIEMENS to generate new business products. It is mainly a new area for seeking business benefits, creating new markets and new sectors of the economy.

4. Conclusions and theses for further research

One should agree with the assumption that non-material factors play and will be playing a fundamental role for the processes of economic growth and the quality of life in cities and regions. On the other hand, it seems that the regularities concerning public and business effects generated by processes of creation, dissemination and transfer of various types of knowledge still require in-depth discourse. This is particularly important if we recognise cities as places where not only a growing number of residents concentrate, but mainly as areas marked by openness and great dynamics of flows of people or knowledge.

The proposed concept of intelligent city constitutes an attempt to identify the positive, rather than normative, theoretical basis explaining urban ideas for which the so-called smart city is a common category. Based on the ideas related to urban economy and developing the diachronic typology of urban economic models suggested by Trullen *et al.* (2013), the concept of intelligent city could constitute a new direction in the economic studies debate. In particular, it can be important for new research in urban economy and the related urban development. It has been demonstrated that the factors affecting economic growth and improvement of the quality of life in cities in the last two decades mainly include knowledge, creation and technologies applied in specific business organisation systems. It seems that the economic model of an intelligent city will complement other modern urban economic models.

If case studies[2] are applied at this stage to formulate the model instead of econometric apparatus, it seems that the idea of an intelligent city may be important for the explanation of urban growth. With regard to urban development, knowledge-enabling governance which applies to decision-making processes that accompany social and economic transformations in intelligent cities should be identified with the mechanism of creating knowledge applied in support of economic value and public value rather than treated as the object of a multi-player game where the stakes are investment location decisions, or more generally development processes. However, this approach requires separate elaboration.

Finally, one may think that implementation of solutions resulting from changes described in model assumptions are particularly important today for the economic growth in cities and metropolitan areas. Due to the fact that such solutions create new activities, their effects should be assessed in a long-term perspective. Such assessment should mainly take into account the aspect of the critical mass of changes as well as acknowledge that they are the basis for development of new sectors, increase in urban potentials of knowledge absorption, rather than "simple" effectiveness calculations. Similarly, social and public innovations are important in the processes of raising the quality and standards of urban products offering new opportunities for creating the quality of life in cities and triggers for the development of companies.

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[2] Given the nature of this study, they have not been discussed in this article and they are subject of a separate analysis.

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